IFIP Working Group 9.4: Implications of Information and Digital Technologies for Development

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Conference Theme: Resilient ICT4D
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Proceedings

Edited by Silvia Masiero and Petter Nielsen
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The COVID-19 emergency has posed a heavy burden on health infrastructures in the developing world. As an unprecedented crisis, the pandemic has had severe social, redistributional and economic impacts on vulnerable groups, affecting the development processes that the IFIP Working Group 9.4 on Implications of Information and Digital Technologies for Development has traditionally dealt with. With the new disease posing a development challenge for all nations, a global development paradigm (Oldekop et al., 2020) emerged in studying responses to it. In the spirit of “making a better world” with ICTs that characterises the ethos of ICT4D (Walsham, 2012), engagements with such responses have interested our research during the pandemic.

At the same time, ICT4D research on topics different from the ongoing crisis is itself influenced by the pandemic in diverse ways. Planning and conducting fieldwork in the forms we knew it became impracticable, with researchers having to resort to alternative ways to access respondents and field sites. Conferencing, and with it the interactions that are crucial to our academic growth have abruptly moved to the digital world, with new affordances (such as abating barriers of cost and travel) but also new constraints, connected to the digital recreation of a traditionally physical world. Resilience, seen with Heeks and Ospina (2019) as the ability of systems to cope with external shocks and trends, became crucial to us as ICT4D colleagues, both in the conduct of research and in the interactional aspects of our lives as academic community.

Against this backdrop, a Resilient ICT4D is what has emerged from the COVID-19 crisis, and the theme inspiring our Virtual IFIP 9.4 Conference on Implications of Information and Digital Technologies for Development to take place on 26-28 May 2021. While pertaining to themes of ICT4D research in and beyond the pandemic, the tracks in the conference are underpinned by the need for a resilient attitude that, in the face of one of the greatest shocks ever suffered by humanity, keeps alive the spirit of “making a better world” with ICTs.

References
RESILIENT ICT4D: BUILDING AND SUSTAINING OUR COMMUNITY IN PANDEMIC TIMES

Silvia Masiero, University of Oslo, Norway, silvima@ifi.uio.no
Petter Nielsen, University of Oslo, Norway, pnielsen@ifi.uio.no

The impacts of the COVID-19 pandemic, disproportionally affecting vulnerable people and deepening pre-existing inequalities (Drèze, 2020; Qureshi, 2021), have interested the very same “development” processes that the IFIP Working Group 9.4 on the Implications of Information and Digital Technologies for Development has dealt with over time. A global development paradigm (Oldekop et al., 2020) has emerged in response to the global nature of the crisis, infusing new meaning in the spirit of “making a better world” with ICTs (Walsham, 2012) that always have characterised ICT4D research. Such a new meaning contextualises our research in the landscape of the first pandemic of the datafied society (Milan & Trerè, 2020), coming to terms with the silencing of narratives from the margins within the pandemic (Milan et al., 2021) – in Qureshi’s (2021) words, a “pandemics within the pandemic” producing new socio-economic inequities in a state of global emergency.

The landscape of the pandemic has affected the way ICT4D research is conducted, discussed and communicated. The conduct of “fieldwork” as we knew it in a world of few mobility restrictions, as well as the community participation that has systematically characterised ICT4D research production over the last decades (Walsham, 2017) have become impracticable. In a world of movement restrictions, the “new normal” are digital interactions. Conferencing, the space where research is communicated and our community is built and rebuilt, constituting the soul of IFIP 9.4, has had to be equally rebuilt for a digital world, changing the taken-for-granted practices that have characterised the community for the past decades. Resilience, seen with Heeks and Ospina (2019) as “the ability of systems to cope with external shocks and trends”, has become fundamental in the making of research and in the interactive aspects of communicating it.

It was these considerations that brought us to choose Resilient ICT4D as the theme of the 1st IFIP 9.4 Virtual Conference on Implications of Information and Digital Technologies for Development, which took place on 26-28 May 2021. The Conference was, in the first place, an occasion to leverage the digital means to abate the barriers – of geography, geopolitical constraints, movement costs and viability – that characterise conferencing in the physical world, and whose removal has allowed community conversations that would have been very difficult in the physical world scenario. Organised virtually, with a shared governance model led by a collective of 32 Track Chairs without a host institution, the event was also a route to questioning the unilateral organisational model taken for granted when conferencing. Such a combination of the digital means with shared governance has afforded the creation of 13 conference tracks, reflecting communities from different walks of ICT4D and generating new occasions for cross-community mutual learning.

A DIFFERENT PHD DAY
When launching the First IFIP 9.4 Virtual Conference, the question of how to organise a PhD Day – a space for PhD candidates from around the globe to convene and discuss research and the academic world – immediately came to mind. One route to do this, following the blueprint of multiple “doctoral consortia” from academic disciplines, was that of formulating a call for applications, then selecting the “best” ones and forming a small group of 15-20 to run the event. Such a model would have had some value: small groups, it is known, allow for better interaction.
and greater room for one-to-one mentoring than large ones. They also afford discussion of people’s specific research topics, often ending up focusing on the “publishability” of the material and various strategies to “thrive” as productive researchers in the academic world.

Leveraging the virtual means, the PhD day at the IFIP 9.4 Virtual Conference chose to propose an alternative to such a paradigm. We started with the choice of uncapped participation: every PhD candidate who registered, with a deadline of 11 May, was invited to join the event and the discussions taking place in it. This is how a group of 74 PhD candidates, from 27 countries and mentored by 25 faculty members, was formed, and participated in three parallel sessions – conveniently named "networking-mentoring tables" – throughout the day. The online means, creating the possibility to divide the group into parallel rooms and putting together students and faculty, afforded the possibility to create as many groups as requested, fostering meaningful conversations and bypassing the idea of "selecting the best applications" entrenched in many doctoral consortia.

Significant was, in a similar vein, the choice of the panels held during the Conference PhD day. The first panel, named “Lessons from the PhD Journey”, was conveyed by five colleagues – two close to finishing their PhDs, three who finished recently – to share insights from the PhD journey with the group, fostering many questions especially from candidates that made a more recent start into their doctoral programmes. The second panel, named "Academic Careers with a Human Face", brought together four academics reflecting on the challenges that an academic career brings to us: reflections covered the (lack of) sustainability of an academic sector that favours hyperproductivity over mental and physical health, and strategies were shared, by all four panellists, to imagine and live academia in ways that respect the work-life balance and enhance happiness. Participation was strong, and both panels acted in constructive, but open, contrast with the "publishing panels" typical of academic conferences, where the importance of horizontal learning and the preservation of health and happiness are less than frequently noted and emphasised.

A SHARED GOVERNANCE MODEL

While conferencing in the physical world involves – by its very nature – the presence of a host institution, taking care of logistics and organisation, the same does not hold for virtual conferencing. As opposed to events held in a physical space, led and managed by one (or more) institutions related to it, online conferencing allows something different: a model where the “host” is indeed the virtual space, open and accessible to everyone pending infrastructural constraints. The most evident barrier this bypasses – participation of colleagues who would otherwise be constrained by financial, travel-related or visa restrictions – is accompanied by a more hidden barrier, that of unilateral decision making tied to location and organisational responsibilities. It is this second barrier that a shared governance model, independent of institutions or constraints, aims to overcome.

The First IFIP 9.4 Virtual Conference was announced in December 2020, with a Call for Tracks that invited colleagues from inside – and, crucially, outside – ICT4D to propose conference tracks, with the note that all Track Chairs would be conference organisers. Having received 14 track proposals, bringing together 32 Track Chairs from different backgrounds, fields and walks of ICT4D, the Conference was run by the Track Chairs committee as a collective that, meeting periodically in the run-up to the event, took crucial decisions on tracks, keynote speaker invitations, proposed panels and workshops, important practical matters and topics to be engaged by the group. Such a varied committee was then responsible for the programme and is making: advertising the event through multiple networks, building on such networks’ knowledge and community expertise, afforded reaching out beyond the core that characterised the tradition of IFIP 9.4 for the last decades. Of the 13 Conference Tracks featured in the event, some appeared this year for the first time: among others, ICTs and Data Justice, Feminist and Queer Approaches to Information Systems in Developing
Countries, and Potential and Risks of ICTs for Development. These opened new terrains of discussion in an established conference group.

Arisen as a result of the affordance of digital means, the shared governance model proposed at the Conference allowed us to discover, and indeed leverage, a way of conferencing that distributes decision-making across a collective, maximising the representation of participating groups and affording conversation on key decisional aspects. Reflecting ex-post on such an experience, we find great value in a model that makes voicing distributed rather than unilateral, and believe that such a model – with the due changes and adaptations – can be made to persist in a post-pandemic physical world, leveraging the lessons learned here towards the ubiquity of community voicing.

FREE AND OPEN ACCESS
The 1st virtual IFIP 9.4 conference registration was 0 (in any currency), and participants could register until the last day of the Conference. The committee edited and published the proceedings on the IFIP 9.4 website. Thus, in a spirit of openness, anyone could participate at the Conference and the papers are not behind payment walls but openly available for anyone to access and read.

ACROSS TOPICS, ACROSS FIELDS
Resulting from the above-mentioned Call for Tracks, the First IFIP 9.4 Virtual Conference grouped together a wide span of topics from within and beyond the core of ICT4D. The 13 Tracks featured in the Conference were:

- ICT and Resilience Building: Climate Change, Pandemic, and Other Stressors
- Digital Platforms in, from and in-between the Global South and North
- Data Science in Public Health
- ICT4D and Data Justice
- Our Digital Lives (IFIP 9.5 Track)
- Digital Social Enterprises & COVID-19: Enablers, Sustainability & Pathways
- Feminist and Queer Approaches to Information Systems in Developing Countries
- Displacements, ICTs, and #NewNormal
- Digital Authoritarianism and Fundamentalism: Problems and Solutions
- The Role of ICT in Achieving Social Justice (ICT4SJ)
- Potential and risks of advanced technologies in the Global South
- Digitalisation for Indigenous Emancipation
- General Track

Beyond the convening of tracks held this year for the first time at IFIP 9.4, the Conference featured Track 5, “Our Digital Lives”, managed and convened by IFIP WG 9.5 and bringing together papers that explored the intersections between the two IFIP Working Groups. Track 5 was a great experience of collaboration between IFIP WGs, and we look forward to building on the interactions created there to work towards future collaborative events.

Spanning across fields were also the four panels of practitioners and colleagues that the Conference featured. The panels convened in the event were respectively on:

- Open Data in the Global South: Challenges and Lessons Learned
- Digital Labour in the Global South
- Deconstructing Notions of Resilience
- Feminist Approaches to Information Systems and Digital Technologies for Development

All panels, chaired by members of the IFIP 9.4 Community, featured colleagues from research, practice and civil society who brought insights on the immediate relevance of the panel's topics for
Resilient ICT4D. We can’t help noticing, once again, how panel compositions from across countries, contexts and regions were made possible by digital means that democratised conference participation, allowing exchanges of insights that would have been made impossible or very difficult by physical barriers.

By the same token, what the Conference afforded was encounters of colleagues and potential authors with the Editors of three Special Issues, launched by journals from the discipline and holding currently open, or soon to be opened, Calls for Papers:

- Information Technology for Development Special Issue on Understanding Local Social Processes in ICT4D research
- MIS Quarterly Special Issue on Social Justice
- Information Systems Journal & Electronic Journal of Information Systems in Developing Countries Special Issue on Digital Transformation in Latin America: Challenges and Opportunities.

In the Special Issue workshops run for each Call for Papers, Editors established a conversation with the audience and colleagues with paper ideas, creating spaces of reflection on how to bring such ideas forward. It should be noted that the format was not created in open opposition with the "Meet the Editors" panels that are common in mainstream discipline conferences, usually characterised by crammed rooms and a hierarchical dichotomy of an audience of early-career researchers striving for tenure – and a panel of seniors dictating directions for publishing, with varying degrees of empathetic understanding of the struggles lived by early-career colleagues. However, the spaces of horizontal conversation created through the virtual space served as a route to circumvent that dichotomy, enabling author-editor conversations and problematising the idea of "learn how to publish in a top journal" that is somehow transmitted. As one of the Editors who joined put it, the Conference was an occasion for the editors themselves to get to know the IFIP 9.4 community and start a process of interaction with it.

WHERE NEXT?

The original reason for a virtual convening of the IFIP 9.4 Conference was the postponing of the 16th edition, planned for Lima in 2021, to the next year, given the COVID-19 pandemic. The current conditions, with the impacts of the pandemic perduing on a global scale, do not make it possible to know the likelihood of an in-person meeting in a year from now. What is visible, however, are the lessons learned in need to arrange an online gathering of over 400 registered people, and the decreased barriers and shared governance model that this experience of "Resilient ICT4D" has entailed.

As a result, we believe the lessons of resilience, solidarity and interactions learned in these pandemic times are here to stay. The hope of in-person meetings in the near future remains strong – what is not lost however, is the learnings that over a year in a digital world has entailed. Looking forward from the experience of our first virtual IFIP 9.4 Conference, what we see is a free, open-access, democratising conference model becoming known to the community, and the many reasons to embed the lessons of such a model in the conferences and events that will come next.

REFERENCES


ORGANIZATIONAL RESILIENCE BETWEEN COMPETING NETWORKS OF INFOMEDIARIES: A CASE STUDY IN CIVIL SOCIETY RESILIENCE IN HONG KONG

Sophie Zinser, United Nations University Institute in Macau, sophie.zinser01@gmail.com
Hannah Thinyane, United Nations University Institute in Macau, hannah@unu.edu

Abstract: This study explores how non-governmental organizations (NGOs) in Hong Kong can be considered as ‘infomediaries’ (UNDP, 2003) in their use of information and communication technologies (ICTs) to support resilience-building across a growing population of migrant domestic workers (MDWs). It also acknowledges MDWs effective existing self-organizing community networks, including religious groups and labour unions. This study maps how NGO infomediaries are currently supporting MDW communities. It posits that NGOs are uniquely capable of developing ICTs grounded in local legal, psychological, and cultural contexts to improve MDW community resilience. The study finds that the fragmented nature of technology use between NGO infomediaries and the competition between NGOs for funding hinders NGO infomediaries’ ability to support building lasting resilience within the MDW community. Recommendations from this study seek to align NGO infomediary tool development more closely with the MDW community in Hong Kong’s existing communicative ecologies. It considers NGOs as infomediaries capable of adapting and streamlining various linkages across grassroots MDW social organizations, local community leaders, and governments that impact the MDW community. This study is a tool for NGO infomediaries to understand the types of resilience networks that they are uniquely capable of building with MDWs in Hong Kong.

Keywords: Migrant domestic workers (MDWs), non-governmental organizations (NGOs), infomediaries, resilience, policy recommendations

1 INTRODUCTION

COVID-19 has deeply impacted the global labour market, particularly when it comes to migrant domestic workers (MDWs). New estimates by the International Labour Organisation (ILO) reveal that 37% of female MDWs are at risk of unemployment (“Livelihoods,” 2020). This is also particularly pronounced in Hong Kong, Special Administrative Region (SAR), home to a majority female demographic of over 390,000 MDWs from Philippines and Indonesia. Because Hong Kong’s live-in rule stipulates that MDWs must live with their employers (GovHK, 2020), many MDWs who have recently been let go due to pandemic conditions currently lack shelter and other resources due to COVID-19. As a result, Hong Kong’s dozens of non-governmental organizations (NGOs) who provide services to support this population’s evolving needs are overwhelmed. Since January 2020, local headlines in Hong Kong reported testimonials from MDWs and NGO workers on difficult conditions facing MDWs including the acquisition of new debts, high recruitment agency and/or visa fees due to changed circumstances, and even struggles with homelessness (Siu & Bethoux, 2020).

This community’s needs will only increase as social distancing and travel restrictions fluctuate. Therefore, an urgent communication gap has evolved between NGOs and the MDW communities in Hong Kong. Information communication technologies (ICTs) are increasingly being used to
improve communication between the NGO sector and the populations that they serve. These tools do not themselves have agency, but can be developed and designed to empower worker balance of information asymmetries that exist within exploitative employer-employee relationships (Thinyane & Sassetti, 2020). But prominent gaps exist in understanding how NGOs as infomediaries can better use technology to access services and/or other forms of support in Hong Kong.

We understand labour exploitation as a spectrum, ranging from labour compliance at one end, through various labour and criminal law violations, to extreme exploitation or ‘forced labour’ at the other (Skrivankova, 2010). With this in mind, we can see that work situations that begin as consensual and mutually beneficial, can transform to oppressive and exploitative environments. These types of changes in work conditions can occur as a result of changes in personal (e.g. age), situational (e.g. employment type, migration status), or circumstantial (e.g. economic downturn) vulnerabilities. In addition, these types of vulnerabilities often reinforce and compound each other.

It is important to contextualize NGO infomediaries’ engagements with MDWs in the context of the incredible self-organizing capacity of MDWs across multiple local grassroots organizations. In fact, since its coordinated actions for the anti-World Trade Organization (WTO) protests hosted in Hong Kong in 2005, the MDW community in Hong Kong is widely considered one of the most self-organized groups for grassroots action and activism (Bethoux, 2020). This is particularly true when compared to other MDW communities in Singapore, Taiwan, Malaysia, and the Gulf States. As a whole, the NGO infomediaries who are the subject of our study do not have broad-based engagement with these activist NGOs or labour unions. Instead, they exist instead inside their own insular discursive layer of NGOs most of whom receive funding from international organizations or local advocacy groups composed of mostly expats. The dissonance between communication between activist NGOs/union organizers and NGO levels in the MDW community in Hong Kong is an area demanding further study.

Studies have shown that information and communication technologies for development (ICT4D) can be designed to facilitate the social accountability necessary for the NGO sector to hold states accountable for services provided (Grandvoinnet, Aslam, & Raha, 2015). We are particularly interested in if and how NGO infomediaries for MDWs in Hong Kong can better develop ICTs grounded in local legal, psychological, and cultural contexts. In the conclusion section of this paper, we hope to suggest recommendations such that any ICTs designed by NGO infomediaries are used to improve MDW decision-making and directly catalyse adaptive responses to protracted crises – across governments, NGOs, and local grassroots organizations.

2 THEORETICAL LINKAGES: RESILIENCE, COMMUNICATIVE ECLOGIES, INFOMEDIARIES

The ability of global systems to “withstand, recover from, adapt to, and potentially transform amid external stressors,” is referred to as resilience (Heeks & Ospina, 2019). Originally coined as a term to defining the capacity of ecological systems to withstand change, the term “resilience” has been found to be both ‘abstract and malleable enough’ to bring seemingly divergent fields and sectors – across security, finance, and development infrastructure – under the umbrella of a single metric (Walker & Cooper, 2011: 144). Resilience-building’s importance is also predicated upon an increasingly turbulent global environment, in which populations must survive emergent such as climate change, pandemics, and financial crises.

Since the 2008 financial crisis and subsequent worsening of global inequality, discourse analysis on resilience reveals its growing prominence in the public policy sphere, particularly across the employment, health, and welfare sectors. (Allen & Bull 2018; Burman 2018) Subjects in need of
resilience in the discourse are often lower-class women whose narratives centre around ‘personal crises or accomplishments decoupled from economic and social circuits of accumulation and dispossession’ (Gill & Ograd, 2018, p. 479). These vulnerable tales of struggle are contrasted with a group of imagined mostly middle-class Western women who are able to draw on networks of information, psychological, and financial support to actualize resilience in an increasingly chaos-defined world (Gill, 2018). Idealized subjects’ success in the context of resilience frameworks rely on constructive relational contexts, in which communication and information-based resources are vital steps towards improving their circumstances. (Jefferis & Teron, 2018). We refer to the agents operating within these constructive relational contexts as “infomediaries,” – short for information intermediaries – who ‘synthesise, translate, simplify and direct information on behalf of others.’ (UNDP, 2003). In the context of MDW communities in Hong Kong, we consider NGOs to be necessary infomediaries because they are bridging gaps between MDW communities, decision makers in government, and local legal and social services systems. Infomediaries here act as the missing link between those in need of building resilience and the idealized scenario of groups meeting resilience objectives.

Literature on the relationship of information communication technology for development (ICT4D) to resilience situates the concept in a broader moral and social context of the societies that it references (Heeks & Ospina 2019). This uniquely offers alternatives to other streams of resilience literature that largely focus on recovery and continuity of vulnerable communities because it suggests that tools can be designed enabling communities to adapt to different methods of resilience. New avenues for a critical perspective on resilience can therefore be found in ICT4D studies that identify the need for increased adaptation and solution-focused approaches (Chen, 2015). Without these emphases on adaptation, communities may remain resiliently poor, or alternatively inequitable societies will not sustain in the long-term (Marais, 2015:436, Wilkinson & Pickett, 2010).

Hong Kong’s MDW community is a fitting case study for resilience as it has also been the recipient of rapid patterns of technology diffusion. Specifically, internet plans for mobile phones have become cheaper, as public Wi-Fi uptake – particularly across Asia – has increased alongside a nearly universal adoption of social media as a communication tool between social groups and across diverse socioeconomic classes, race, gender, and national backgrounds. ICTs have become the go-to sources for information and data that drives individual decision-making processes – regarding everything from reporting data to sharing tips on arrival and recruitment processes for workers (Heeks & Ospina 2019). The sources and credibility of the information that MDWs are exposed to on social media to inform their decision making is a significant gap that demands further empirical study. Any study of how use of ICTs impact MDW communities in Hong Kong should take into account the depths of existing in-person and digital relational networks. Multi-stakeholder roles in technology solutions can be best approached through an ecosystem perspective, because all interactions between relevant stakeholders need to be considered when mapping the most effective pathways for solutions (Thinyane & Goldkind, 2018).

To interrogate how infomediaries operate in Hong Kong, it is important to consider the existing systems that perpetuate the spread of information within Hong Kong between NGOs, faith-based organizations, individual MDWs, MDW community, labour associations, and local government officials. Just as resilience studies have their origins in ecology, Tacchi, Slater and Hearn’s (2003) definition of communicative ecologies is another helpful model for holistically perceiving of discourse by, about, and for MDWs in Hong Kong. Communicative ecology is a conceptual model used to represent the relationships between layers of discourse, social interactions (whether people or groups of people), and technology within a particular community. It relies on an ecological metaphor to understand the “processes that involve a mix of media, organized in specific ways,
through which people connect with their social networks” (2003, p. 17). More than just a mapping of which platforms NGOs, MDWs, and government officials use, this approach addresses the nuance of how patterns and processes of communication already occur. Subsequently, a communicative ecology interrogates the value and worth of such communication networks based on the ‘levels of strata’ or activity in which they already inhabit (Thinyane & Siebörger 2017). These technological levels are broad, encompassing everything from face-to-face communication (no-tech) and traditional media (television, radio – low tech) approaches, to more high-tech approaches including social media and customer relationship management (CRM) data management systems. Levels of how and why groups communicate with each other can be diverse, change overtime, and impact each other. Interactions across these technological layers can occur across different types of technology reception and input: one to many, one on one, many to many, and more horizontal, peer to peer communication (Foth & Hearn, 2007, p. 9). The social layer consists of the ways that the people are organized (informal social networks, associations, communities, legal entities). The discursive layer consists of the content that is discussed between different groups of people, using different technologies. Further, just as external social factors or patterns can influence technology usage, technology can impact existing discursive and/or social patterns (Hearn et al., 2014, p. 8). This conceptual model allows the researcher to frame communication of MDW infomediaries in the context of existing complex and nuanced communication structures.

Over the course of this study, we interrogated NGO infomediary-designed or developed ICT solutions to build (or impede) resilience for the growing, diverse community of MDWs in Hong Kong. Understanding resilience in the context of communicative ecologies in which MDWs are already participating encourages bottom-up decision making and increasing transparency between MDWs, and the NGOs/governments that serve them.

3 METHODOLOGY

As this research is intended as an exploratory study, we did not aim to seek a representative sample. We did not interview MDWs themselves due to restrictions on interviews and difficulties in accessing research interviews with MDWs posed by COVID-19 conditions. We also focused exclusively on the NGO community because our interest was in focusing the research on ICT tool development opportunities to build resilience for NGOs working with Hong Kong’s MDW community. As was previously mentioned, too often the burden of resilience building falls directly on the community in need of resilience themselves. This study instead gives us a rich picture not of what MDWs think about their own communication models but how NGOs working closely with MDWs perceive that discourse. That being said, a glaring gap in this study remains the lack of input from MDWs themselves; an area necessary for further study once COVID-19 conditions and therefore interview access improves.

From November-December 2020, the [Anonymised] Research Team conducted interviews with 23 NGO workers from 14 NGOs. During the period of initial consultation, the IOM’s Hong Kong Sub-Office acted as a mediating agency between researchers and local stakeholders. IOM wielded its integral local network, referring researchers to a wide range of direct and indirect stakeholders working on or around issues relating to MDWs. Once this initial round of interviews was completed in late November 2020, contacts were obtained through a snowball sampling method from participants. To anonymise responses, each NGO has been assigned a letter and a unique number referring to each participant from each organization. As an example, two respondents from Organization A participated in interviews. Quotations from the first respondent will be referred to as A1 and quotations from the second respondent will be referred to as A2 in the remainder of this document. Table 1 summarizes key details for each of the organizations involved in this study. As
this table indicates, participating organizations worked either: exclusively with MDWs; or with a combination of MDWs, ethnic minorities in Hong Kong, refugees and/or other marginalized groups as their beneficiaries.

<table>
<thead>
<tr>
<th>Organization Code</th>
<th>Number of Participants</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>NGO offering legal and social support to ethnic minorities in Hong Kong, priority focus on MDWs</td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>Organization supporting pregnant MDWs in Hong Kong</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>Think Tank / advocacy organization offering a range of programs to end human trafficking and forced labour in Hong Kong</td>
</tr>
<tr>
<td>D</td>
<td>1</td>
<td>Organization supporting with MDWs’ employers in Hong Kong</td>
</tr>
<tr>
<td>E</td>
<td>1</td>
<td>Organization protecting the rights of MDWs and ethnic minority groups in Hong Kong</td>
</tr>
<tr>
<td>F</td>
<td>2</td>
<td>Organization working to support the legal rights of migrants in Asia, develops preventative solutions to MDW issues to enlist MDWs in validating their experiences with corrupt employment agencies</td>
</tr>
<tr>
<td>G</td>
<td>1</td>
<td>Legal rights and advocacy organization working with marginalized populations in Hong Kong</td>
</tr>
<tr>
<td>H</td>
<td>2</td>
<td>Organization working to empower migrant domestic workers in Hong Kong via online training and peer support</td>
</tr>
<tr>
<td>I</td>
<td>3</td>
<td>Advocacy organization that works to provide legal support to refugees and migrants in Hong Kong</td>
</tr>
<tr>
<td>J</td>
<td>1</td>
<td>Lead volunteer at local community shelter for MDWs affiliated with NGO A, academic researching MDWs in Hong Kong</td>
</tr>
<tr>
<td>K</td>
<td>1</td>
<td>Domestic helper agency supporting more ethical hiring of domestic workers in Hong Kong</td>
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<tr>
<td>L</td>
<td>1</td>
<td>Works with other NGOs and social enterprises that work with MDWs to identify their needs and connect them with pro-bono lawyer networks</td>
</tr>
<tr>
<td>M</td>
<td>1</td>
<td>Offers financial literacy training, support, and resources to MDWs in Hong Kong</td>
</tr>
<tr>
<td>N</td>
<td>1</td>
<td>Organization that provides funding and legal support to other organizations</td>
</tr>
</tbody>
</table>

Table 1: Participating organizations

Interviews followed a semi-structured format, with eight interview questions, that shaped the direction of a semi-structured conversation. These questions covered participant perspectives on urgent needs facing migrant domestic workers in Hong Kong, current patterns of access to and use of technology, and the types of case-based support that MDW clients were accessing already. Interviews were transcribed and underwent three rounds of inductive coding using Nvivo to track and uncover results. Themes that were uncovered are presented in the next section to map the current resilience capacity for MDWs in HK from the NGO perspective.
4 RESULTS

This study provides an opportunity to understand how NGO infomediaries could redesign or improve existing ICT usage and communication patterns internally, across other NGOs, and to engage with the populations that they serve; focusing on an adaptive approach to building resilience. It assumes that NGOs will remain distanced from other types of grassroots worker associations that work with MDWs and thus does not claim that technology advances can alter divides that exist in current communicative ecologies surrounding MDWs in Hong Kong.

4.1 Context: MDWs Face a Deeply Oppressive Culture in Hong Kong

All 14 interviews contained vivid descriptions of physical, financial, or emotional mistreatment of MDWs at the hands of employment agencies, money lenders, the Hong Kong government, other NGOs, employers, or a combination therein. One participant who supports MDWs in situations of labour exploitation and forced labour described this oppressive treatment as:

...There is this sort of feeling that they [MDWs] must have done something wrong. When in reality, it’s the system or employer that has done something wrong. [G1]

From this comment it is clear that anti-immigrant racism, perceptions of MDWs as ‘victims’ rather than as professional employees, and decades of mistreatment have created a homogenously oppressive culture for MDWs in Hong Kong.

Employers’ powers of access and control extended to MDWs’ use of technology in Hong Kong. Withholding of ICT tools became a prominent outlet for employers to exert power and control.

Some employers are not happy because they think it distracts domestic workers from their work. That’s why some ask the domestic workers to give their phone to them [E1]

The taboo and restrictive culture around phone usage in what is both a workplace and the home is leading to confusion of MDWs, even when they need to use their phone for work.

Sometimes the workers find it difficult to ask questions of their employer like “When can I use my phone? There is something that I want to read up on online pertaining to my job, when can I do that?” Workers don’t feel good about asking their employer those questions. How they access tech in their workplace depends on employer’s personality and preferences [D1]

The above examples remind us that developing ICT tools for NGOs to improve MDW resilience in Hong Kong must acknowledge the pervasively oppressive culture those workers face in their workplace daily.

4.2 Widely Held Perception that More Data will Lead to Better Policy/Programs for MDWs

Asked to describe the type of problems faced at work, NGOs pointed to the need for more nuanced data types about the population of MDWs currently in Hong Kong from the government side. Statistics needed included the current number of MDWs in Hong Kong grouped by origin country (A1,C3,G1,J1), the number of currently and previously detained MDWs (E1, I1, L1), the number of MDWs who have lodged complaints of sexual harassment against their employers (B3, I1 and L1), and the number of MDWs who currently have cases that have yet to be resolved in court (I1 and L1). It was unclear whether NGOs were not able to access this information because they had not filed a data information request to necessary government or immigration officials, or because the government was slow or inactive when it came to sharing data. NGO K claimed that they had submitted many government requests but had not received a proper response. NGO F bemoaned the inability of peer NGOs to lodge appropriate government requests, insisting that the information was
readily available. NGO A claimed that they and their team had not thought to file an information request from the government and remarked that they would look into how to do that. The various opinions on how easily accessible this data was reflected different approaches across these NGOs and offers another example of a fragmented information sharing across the sector.

A1, F2, J1, M1 all mentioned how a gap in available data could result from the fact that MDWs are often hesitant to report situations of money laundering or lodge complaints due to long waits for trial times, or otherwise feared speaking up in defence of their rights. One interview with NGO J commented:

The hesitance comes from a sense of helplessness because of all of the structural constraints. These women are very traumatized, and most of them just have to continue, don’t have a choice, only way they can support their children and families is to go again….They can work with NGOs, but will take a long time before anything changes. [J1]

These gaps were further exacerbated by the racism that MDWs face often when coming forward. A representative from legal NGO G commented that:

The overt racism that we have experienced in tribunals in lower courts here in government is absolutely shocking. I remember going to tribunals and our clients were shouted at by the tribunal officers. [G1]

MDW hesitancy in reporting may stem from justified fears of overt aggression and racism from the Hong Kong government.

Others mentioned that the burden of designing data-sharing systems should come from Hong Kong’s NGOs and civil society themselves. One representative from NGO E had specific recommendations about how NGOs could design a system to identify bad employers. She asked:

How do we know that this employer is good? Sometimes we don’t know. So then the agency will not pass the information if there is a rape case that is being lodged, we [the NGOs] will not know this information…[because] there is a data protection. How can this information be available or if it’s possible so that the domestic workers can decide that they don’t want to work here. [E1]

K1, D1 and E1 – all representatives of NGOs that work closely with employers – mentioned that without designing such a system, oppressive employers can continue to operate in the MDW community, which can have disastrously negative impacts.

4.3 Rich Communicative Networks Already Exist Among MDWs

All NGO worker respondents noted that the primary tool that they used to communicate with MDWs was Facebook, either through messenger or group chats. Beyond traditional communication metrics, NGOs had different and often novel ways to make use of this platform. NGO H, which works with MDWs and online education, spoke about how Facebook maintains communication and a sense of community with alumni of their courses. A representative NGO C referenced the difficulties in communicating with MDWs and their families back home as health or psychological issues arose in Hong Kong. A third NGO B that works closely with MDWs who are pregnant spoke about how even facilitating social spaces for activities such as dancing, singing karaoke, or gameplay online. NGO F that works on preventative solutions to MDW issues Facebook to enlist MDWs in validating their experiences with corrupt employment agencies said:

So we will post content, or maybe they will post us a tip…[for] a suspicious agency on the street. We will post the photo being like “does anyone know this agency?” and then people...
will comment, usually within like 20 minutes. [They will say] Oh that’s my agency, I used that five years ago, three years ago, two years ago. This sort of engagement is a lot less intimidating than downloading an app. [F2]

In this example, NGOs were able to effectively act as infomediaries through engaging with MDWs using technology that they already use.

### 4.4 Solution Building Exercise Reflects Fragmented and Competitive Nature Amongst NGOs working with MDWs

As a whole, NGO staff gave mixed reviews on the potential of mobile apps to support MDW’s access to information on either government or NGO services available in response to issues that may arise. While over half of surveyed organizations remained hopeful on the potential success of app-based solutions to aggregate data on MDWs in HK, many also cited fragmentation of service provision across NGOs and prior failed attempts to centralize information as issues around long-term uptake of such tools.

One worker with NGO E who personally had decades of work experience across several organizations that supported MDWs remarked that this has been a long-standing conversation across the sector:

> In Hong Kong, a lot of us have talked about having one place where domestic workers can find everything. There are bits of things everywhere, but there should be one tech portal in any form, one tech portal in terms of where they could access everything that they need. [E2]

Another representative from NGO A, a faith-based organization that works closely with MDWs suggested:

> There is a lot of bits of information out there. We have FAQs... for legal issues and their rights. There are a lot of information all over the place, bring all of that together in one easily accessible place. There is a lot of knowledge and experience and expertise, but it is all very disparate. [A1]

Given the generalist nature with which this solution was proposed, it was assumed that no single NGO had either a comprehensive understanding of the necessary information to build this database nor the resources to build something that centralized all data into one place. Further, representatives from all three of the aforementioned NGOs [A1, B1, E2] expressed that it would be difficult to find collaborative funding for such a project, and seven NGOs total [A1, B1, E2, F1, I1, L1, M1] – half of total respondents – made remarks regarding the “competitive” and/or “limited” nature of funding for the NGO sector in Hong Kong. Although not always drawn as a direct correlation, perhaps in some ways this fragmentation has developed as a bulwark towards progress across the sector.

### 4.5 The Importance of “Proactive” or “Preventative” Tech Tools and Solutions

Remarkably, responses that mentioned the importance of “proactive” or “preventative” solutions were discussed across all 14 interviews. In one section of the interviews, researchers brainstormed with respondents about potential pathways for ICTs to support MDWs in Hong Kong. Representatives from five NGOs [C2, D1, F1, F2, G1, L1] identified a need for more “proactive” or “preventative” solutions to issues facing MDWs in Hong Kong. NGO C remarked that:

> One thing that collectively in civil society and government can do is be more responsive to the environment under which foreign domestic workers operate. For example, for the COVID-19 situation, how can improvements now not be playing catch up but be pre-
emptive or have a faster response rate to meeting some of the needs of the workers that are coming to us. [C2]

NGOs also had varying ideas regarding what “proactive” solutions really meant; that is how they could build ICT tools that would proactively build MDW resilience. As it is often expensive for MDWs to stay in Hong Kong without employment during an ongoing court case, NGO E, a legal organization that works with MDWs, suggested that:

*Many financially need to drop their court cases in HK... then maybe allowing them to continue their cases through video interviews through not being in HK would help a lot of our clients. Especially when in COVID-19 they can’t travel to come back for a police interview.* [E1]

NGO D that worked with employers of MDWs suggested providing MDWs and their employers with standardized yet culturally- and linguistically specific training to better manage MDWs or better understand the job responsibilities of being a MDW in Hong Kong. NGO G that had worked with MDWs on identifying harmful employment agencies suggested creating an ICT tool in the form of a privacy-preserving data repository for aggregating legal cases to be put forward to stop financial fraud in its tracks. Others suggested that NGOs may have the potential to design tools that would give a more broad-based view of the gaps in technology literacy for MDWs before they arrive in Hong Kong.

5 DISCUSSION

This work builds on existing research on the critical and primary role of filling gaps in local social services and mobilizing local communities (Bopp, Harmon, & Voida, 2017; Zhang & Gutierrez, 2007; Thinyane & Goldkind, 2018). In doing so, it identifies significant potential for the nuanced insights from the NGOs described in this study to be leveraged and integrated into resilience-building initiatives at a policy level, whether through Hong Kong’s local government or a broader set of multilateral actors. Participants noted that MDWs are increasingly reliant on social media platforms (Facebook and WhatsApp) to communicate with one another, create community within Hong Kong, and exchange information on everything from their daily life to financial issues. To increase their efficacy, it became clear that there is an urgent need for NGOs to work with MDWs in Hong Kong to refer vulnerable cases among peer networks and identify issues as they arise. However, while Section 4.4 revealed a strong emphasis on data collection from MDWs, the risks and limitations of NGOs to collect data points given emerging data privacy concerns and MDW comfort with giving information over to NGOs based on socio-cultural perceptions of data as “personal information” remained unaddressed in our interviews, and perhaps an area of further study.

Many respondents remarked that significant gaps in the way that their funding streams were structured limited the widespread applicability of their programs across the entire MDW community and thus the efficacy of their impact. While fragmentation within the sector is endemic to civil society organizations globally, we believe it is exacerbated in the Hong Kong context. Many participants expressed exhaustion at combatting the systemic social issues that had existed since the original arrival of MDWs to Hong Kong from Indonesia and the Philippines throughout the 1970s. The purpose of each individual NGO’s services did come across as diverse and therefore potentially symbiotic for collaboration with those of other organizations. For example, one targeted only pregnant MDWs, one focused on providing training for MDWs in financial literacy. But in practice, particularly regarding how these organizations described working with or for one another, they seemed to be competing for some of the same funding or limited funding streams, all to meet the
needs of a small sub-section of Hong Kong’s MDW population. Whether access to increased funding could lead NGOs closer towards effectively support a larger part of that population, or if large segments of Hong Kong’s MDW population do not require NGOs’ specialized services, was unclear given the current level of analysis. Given the findings in Section 4.4, one area for future research based on this study’s findings would be the interactions between NGOs and MDWs and funders with long-term resilience in mind. The nature of the communication between the donors and the “beneficiaries” themselves is an area that likely needs improvement, and could be discussed in future studies.

6 CONCLUSION

Through the recommendations made by NGOs, this study shows the ways in which Hong Kong’s NGO community that works with its MDW population is uniquely capable of designing ICT use for integration with existing platforms grounded in local contexts that might improve MDW the community’s resilience.

As resilience-building is only now becoming more of a focus for the UN’s international development agenda (IDA 2019), leveraging our understanding of how low-income mostly female communities like MDWs use technology will become increasingly integral to strengthening the levels or strata of resilience for both MDWs and their infomediaries. But using ICTs to improve MDW communities’ resilience in the face of external shocks does nothing to address the root causes of those shocks in the first place. Given Section 4.3’s discussion of MDWs existing self-organizing support networks, it also treats a fine line of moving the needle on responsibility for non-resilience closer to the communities of MDWs themselves, rather than the aforementioned social, cultural, and legal systems that perpetuate their vulnerability in Hong Kong. Therefore, NGO capacity to offer adaptive solutions to resilience in this space remains promising – as is evidenced in Section 4.2 and 4.5 – yet long-term capacity for NGOs to enact broad based change alone is nearly impossible given the complexity of the problem. However, with increased access to MDWs, NGO actors have the potential to make meaningful contributions to improving resilience for MDWs in Hong Kong. Through the lens of communicative ecologies, we in pointed out in Section 2 how MDWs are deeply engrained in the systems and networks of their community, which are often monitored and engaged with closely through NGO infomediaries.

Perhaps some of the dissonance in engaging across sectors to build resilience – particularly when competitive self-organization is involved – stems from confusion around how international development concepts such as resilience can actually support communities to better withstand existing shocks. SDG 8 for example – to “promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all” – does not recognize the role of civil society actors towards promoting decent work. Nor does it provide clear pathways or guidelines for meaningful engagement with the diverse cross section of stakeholders with whom the SDGs’ indicators necessitate engagement (Thinyane & Goldkind 2018). NGOs that work closely with MDWs were found to be integral to the increased direct participation of those workers towards brokering increased collaboration for social indicators. However, without alterations to the socio-legal system that build MDW communities’ resilience, NGOs – while armed with the right tools – will not be able to realise the full potential of their contributions to the wider MDW community.

When considered as artifacts that when empathetically designed can rapidly adapt to solve nuanced problems, we assume that technology can be uniquely designed to improve communication across changing conditions. (Kumar, Karusala, Ismail, et al., 2019; Dombrowski, 2016: 16). But significant competition amongst those networks can prove a bulwark towards more effective attempts at communicating and exchanging ideas. Therefore, the focus of tools developed going forward should
remain rooted in workers’ experience without implying a possible failure of MDWs themselves to build resilience. Tools should instead highlight the positive potential of NGO infomediaries to work across levels of social organizations to affect change through – as was referenced numerous times across the study – developing proactive, preventative solutions. This will sustain resilience through providing information not just amongst members of diverse MDW communities but transmit that information upwards to local government and multilateral organizations.

REFERENCES


DIGITAL RESILIENCE AND THE CONTINUANCE USE OF MOBILE PAYMENT SERVICES

Muftawu Dzang Alhassan, Stellenbosch University, South Africa, 25727907@sun.ac.za
Martin Butler, Stellenbosch University, South Africa

Abstract: The use of mobile payment services is an essential contributor to financial inclusion in emerging markets. Unfortunately, the service has become a platform for fraud. Mobile payment users need to be digitally resilient to continue using the service after adverse events. However, there is scant literature on users' continuance use of mobile payment services in the post-event of fraud. The focal point of prior literature has been on technology adoption or threat avoidance to implement policies that protect users. Analysing the relationship between individual digital resilience and post-adoption behavioural patterns will enable service providers to support individual digital resilience to promote users' continuance use of the service. This research aims to develop and empirically validate a conceptual model to examine individual digital resilience in the context of the continuance use of mobile payments. The model will be based on protection motivation theory. Survey data will be obtained from victims of mobile payment fraud and other users who continue using the service despite their knowledge of mobile payment fraud. The results from this study are expected to make key contributions to theory, practice, and policy in the areas of digital resilience, mobile payments, and ICT4D.

Keywords: continuance of use, digital resilience, mobile payments, post-adoption, protection motivation

1. INTRODUCTION

The growth of the mobile payment services sector is an essential contributor to financial inclusion in developing countries (Senyo & Osabutey, 2020). This sector has facilitated individuals' access to low-cost and reliable financial services, especially in developing countries (Liébana-Cabanillas et al., 2019).

Mobile payment service innovations such as m-pesa in Kenya and Tanzania have transformed into ubiquitous mobile payment platforms (Varga, 2017) that enable users to move funds at their convenience (Iman, 2018). The mobile payment success was replicated in Ghana by the Mobile Telecommunication Network (MTN) in 2009. This was followed by other telecommunication providers Vodafone and AirtelTigo, leading to increased mobile payment transactions and active users (Alhassan et al., 2020).

Unfortunately, mobile payment services have become an avenue for fraud (Akomea-Frimpong et al., 2019). This is particularly evident in developing countries where high levels of fraud are apparent (Provencal, 2017). Cybercriminals often rely on social engineering approaches to lure mobile money subscribers into revealing their mobile credentials that can be used to illegally withdraw money from the users' mobile money wallets (Annan, 2017; Pradigdia et al., 2019). More sophisticated attacks involve taking control over a user's mobile device to access payment applications or telecommunications systems (Ali et al., 2019).
Service providers should pay more attention to the safety of users' information and financial assets due to widespread issues of fraud in mobile payments (Humbani & Wiese, 2020; Ofori et al., 2017). When mobile payments are secure and financial service providers guarantee users' information and funds against fraudsters, users' trust in the service will increase, leading to the continuance use of the service (Kumar et al., 2017; Odoom & Kosiba, 2020).

Despite several measures instituted by mobile payment service providers to help curb fraud (Priezkalns, 2020), an increasing number of users report being victims of mobile payment fraud (Ankiilu, 2017). A total of 365 mobile money fraud cases are reported daily by MTN users in Ghana (Larnyoh, 2020). In spite of fraudulent events, the use of mobile payments continues to grow. Significant research is directed at mobile technology adoption and threat avoidance (Butler, 2020), literature exploring the intrinsic factors that ensure individuals' continuance use of technologies remains limited (Liao et al., 2009).

The study proposes 'individual digital resilience' as a capability that enable users to continue using mobile payments in the post-event of fraud. Our research aims to answer the following question: What are the antecedents of individual digital resilience and the effect thereof of the continuance of mobile payment services?

2. PRIOR LITERATURE

2.1. Digital Resilience

The concept of resilience emerged from ecological studies of the 1970s. Holling (1973) introduced resilience and proposed that "resilience determines the persistence of relationships within a system and is a measure of the ability of these systems to absorb changes of state variables, driving variables, and parameters and still persist" (Holling, 1973, p.18). When systems break down as a result of disruptions, they must recover, preferably, to their former state (Zhang & Zhao, 2019). Recovery will ensure business continuity and mitigate losses arising from adverse events (Onwubiko, 2020).

In recent years, the term resilience has been applied in several contexts and for different concepts. In Information Systems (IS) research, the term digital resilience has emanated and gained popularity due to the emergence of digital and cyber-attacks that threaten individuals, companies, and governments (Hammond & Cooper, 2015; Kohn, 2020a). Organisational (digital) resilience is actively researched and can be described as recovery from digital attacks on data, networks, and computers (Rothrock, 2018).

However, resilience also refers to individual capabilities. Literature at the individual level primarily deals with digital skills and capabilities (van Laar et al., 2020) and less with individual digital resilience at the same level as organisational resilience. Individual resilience is presented in IS literature as the ability to avoid or withstand a cyberattack or the degree of information security awareness (McCormac et al., 2018; Udwan et al., 2020). In the omnipresence of cyber threats, and given the initial conceptualisation of the construct of individual resilience, it is also essential for users of technology to develop resilience to recover from adverse cyber events.

For this study, we define individual digital resilience as the ability of a user to withstand and recover from an adverse technology usage event. The study will use mobile payment services to investigate the phenomena due to the widespread use despite the occurrence of fraudulent events. Prior studies at the individual level have related resilience to traits such as threat appraisal, coping (O'Leary, 1998), perseverance, positive emotion, meaning-making, and growth (Amir, 2012; Connor & Davidson, 2003; Wagnild & Young, 1993).
Digital resilience studies at the individual level have primarily examined how individuals can leverage technologies to build resilience to prevent disruptions (Tim et al., 2020; Udwan et al., 2020). Users' digital resilience in the event of disruptions and its effect on the continuance use of the service or technology has received less attention. Literature (Camp et al., 2019; Majchrzak et al., 2018) has called for studies to examine individual digital resilience from different perspectives. For instance, Kohn (2020b) recommended studies to explore network effects of resilience on individuals and work communities. Liao et al. (2009) introduced the Technology Continuance Theory (CTC) whilst acknowledging that multiple factors, like expectation confirmation, requires further scrutiny to understand the impact on the continuance of technology usage.

Understanding individual digital resilience and how it influences post behavioural intent will enable technology developers, service providers, and governments to prioritise their limited resources and promote intended benefits to protect users’ information and funds.

2.2. Digital Resilience in Mobile Payments

Digital financial services can reduce transaction costs and extend an individual's access to greater social connections (Lyons et al., 2019). In the event of disruptions, individuals can rely on these social connections that contribute to their resilience because of the systemic effect of the networks (Jack & Suri, 2014). Being digitally resilient is more than a skillset to cope with using technologies.

Krishnan, Johri, Chandrasekaran and Pal (2019) argued that the adoption of digital payments enabled Indian citizens to build resilience when the government decided to end the use of a particular legal tender. The study showed that individuals who possessed adequate digital skills were more resilient to the disruption and continued to rely on digital payments for cash transactions. In his instance, poor individuals in rural settlements exhibited greater resilience than poor urban dwellers showing the complexity of the attributes that could potentially define and contribute towards digital resilience.

Fraud has become a universal threat that negatively affects the survival of individuals, businesses, and economies (Kovács & David, 2016). Mobile payment services are no exception to this vexing problem (Akomea-Frimpong et al., 2019), with mobile money fraud in Ghana increasing from 278 cases in 2015, to 388 in 2016 (Ankiilu, 2017).

<table>
<thead>
<tr>
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<td>32,554,346</td>
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<tr>
<td>Active mobile money accounts</td>
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<td>8,313,283</td>
<td>11,119,376</td>
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</tr>
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*Source: Bank of Ghana (2018)*

Table 1. Mobile payment usage in Ghana

Table 1 indicates the growth in mobile payment usage in Ghana from the year 2012 to 2018. It is evident that individuals continue to use the service, despite issues of reported fraud (Yeboah, 2021).

2.3. Antecedents of digital resilience

Research in technology adaption has evolved significantly with the multiple versions of technology acceptance models (Tsai et al., 2016) and threat avoidance models prominent in the IS literature. The antecedents of technology acceptance, like performance expectancy, effort expectancy, facilitating conditions, social influence, and perceived security, are actively researched (Legowo, 2019).

Conversely, factors that lead to higher levels of individual resilience are not part of the active academic discourse, nor have they been presented concisely. Still, the development of digital skills is widely acknowledged as a driver of digital resilience. Van Laar (2020) noticed a lack of
appreciation of social determinants such as social support in understanding digital skills and argued for a comprehensive view on the skills dimension. Digital resilience potentially encapsulates other factors like the facilitating conditions, risk propensity, perceived usefulness, trust and self-efficacy (Chang, 2010; Susanto et al., 2016). As a construct, there are many potential drivers of individual digital resilience, but this is not yet fully defined or widely used.

We intend to address both the lack in definition and measurement of digital resilience and the impact of digital resilience on the continuance of the use of technology. Using a service like mobile payments that 1) continues to grow, 2) seems resilient in its operations and 3) is subject to adverse events provides a relevant context to explore the phenomena. Exploring the factors that contribute to higher levels of individual digital resilience is essential in an increasingly digitised world.

3. PROPOSED THEORY

To answer the research question, a conceptual model for understanding individual digital resilience based on a modification of the Protection Motivation Theory (PMT) from Rogers (1975) will be created.

The basic tenets of the PMT are that when confronted with a threat(s), an individual experiences two cognitive processes of threat appraisal and coping appraisal. *Threat appraisal* involves a process of analysing (1) perceived threat vulnerability, and (2) perceived threat severity. *Coping appraisal*, on the other hand, involves evaluating (1) the efficacy of the potential adaptive responses to a threat (*response efficacy*); (2) the ability to successfully carry out the recommended responses (*self-efficacy*); and (3) the *response costs* associated with the engagement in an adaptive coping strategy.

The PMT has been adapted and applied in different contexts. In IS research, for example, the PMT has been used to investigate information security behaviours (Hassandoust & Techatassanasoontorn, 2018; Yang et al., 2020). Studies in this area show how users engage in secure behaviours to protect their data and information from intruders (Giwah et al., 2019). However, while the PMT has been able to significantly explain individuals' secure behaviour, there is proof that extended versions of the PMT are more accurate under certain conditions (Aurigemma & Mattson, 2018; Ifinedo, 2012).

The extension proposed in this study is done by including *individual digital resilience* as a construct that is influenced by the threat and coping appraisal dimensions of the PMT. This is indicated in Figure 1. The rationale for relying on the PMT in our study is that past studies highlighted threat appraisals and coping appraisal (such as self-efficacy) as dimensions of individual resilience (O'Leary, 1998; Ledesma, 2014).

The use of PMT and individual digital resilience will enable the study to examine how (1) threat and coping appraisal dimensions of PMT influence individual digital resilience, and (2) individual digital resilience influences the continuance use of mobile payment services.
4. PROPOSED METHODOLOGY

A survey instrument will be developed to collect data from users of mobile payment services that have been victims of fraud or knows about fraud and continue using mobile payment services. Data will also be collected from mobile phone users that have stopped using mobile payment services. The qualifying question for inclusion is thus not current usage but prior or current usage of mobile payment services.

Measurement items will be adapted from previous studies and measured using a five-point Likert scale. Individual digital resilience will be adapted from the studies by Amir (2012) and include additional items that define antecedents of digital resilience from a comprehensive literature review. The measurement items for threat and coping appraisal will use questions developed by Liang and Xue (2010) and Tsai, Jiang, Alhabash, Larose, Rifon and Cotten (2016). Measurement items for the continuance use of mobile payment services will be drawn from Shao, Zhang and Guo (2019).

Additional measures that could influence individual digital resilience from studies that used and adapted the Technology Continuance Theory (Liao et al., 2009) will be added to the model to ensure a rich data set for further analysis. Extensive demographic data, including education, geographical location, and other factors that could play a role in risk perception, will be included. A measure of digital skills and social influences will also be included in the research instrument.

The survey will be administered in Ghana due to the richness of the available information in a country with high mobile payment usage and regular fraudulent events to whom users may have been exposed or have knowledge of. Getting users who decided to continue and discontinue mobile payment services are essential for the study to determine the model’s accuracy.

We will analyse the survey data using Partial Least Squares-Structural Equation Modelling (PLS-SEM). PLS-SEM will enable the researcher(s) to examine the effect sizes between the variables in the model. The researchers will investigate the mediating effects of individual digital resilience on the linkages between the threat and coping appraisal dimensions of the PMT and mobile payment continuance use. Hair, Risher, Sarstedt and Ringle (2019) argued that PLS-SEM was appropriate for studies that tested models with second-order constructs and mediating variables.

5. EXPECTED RESULTS

The objective of the research is to examine the antecedents of individual digital resilience on the continuance of mobile payment services use. Multiple outcomes are expected.

First, we expect to empirically confirm that mobile payment users will engage in threat and coping appraisals before and after falling victim to fraud, or gaining knowledge about fraudulent activities. Through this, they may be growing their level of digital resilience to continue to use the service, irrespective of adverse events.

However, the extent of digital resilience may vary amongst users of mobile payment services. Some users may display high levels of resilience to continue using the service whilst others may not. It is anticipated that users with lower levels of digital resilience will show a higher propensity to discontinue mobile payment services after experiencing an adverse event or learning about these events.

Furthermore, the study will examine the mediating effects of individual digital resilience on the nexus between the threat and coping appraisal dimensions of the PMT and mobile payment continuance use.
Finally, other constructs that may influence individual digital resilience from existing theoretical models will be analysed to potentially enhance the structural model to improve the ability to predict the continuance of use and provide new directions for research on individual digital resilience.

6. CONCLUSION AND EXPECTED CONTRIBUTION

Results from this study are expected to make several contributions to theory and practice in the areas of digital resilience, mobile payments, and ICT4D.

First, this study is novel in the combination of the PMT and digital resilience to examine individual digital resilience and the continuance use of mobile payment services in a developing country. This combination will provide valuable insights into how (1) mobile payment users develop resilience through threat and coping appraisals and (2) individual digital resilience influence the continuance use of the service in the post-event of fraud.

Second, the study contributes to the limited research on individual digital resilience with previous literature focusing on organisational, community, and technology infrastructure digital resilience. The development and validation of an instrument to measure digital resilience, based on robust theory, will contribute to research options in this underdeveloped area of growing interest.

Practitioners and policymakers will be able to use the research results to develop interventions that will develop individual digital resilience. The study will enhance the continuance use of mobile payment services by defining appropriate interventions.

REFERENCES AND CITATIONS


DESCRIPTING EMERGENCY REMOTE TEACHING USING A LEARNING MANAGEMENT SYSTEM: A SOUTH AFRICAN COVID-19 STUDY OF RESILIENCE THROUGH ICT

Ammar Canani, CITANDA, University of Cape Town, South Africa, cnnamnn001@myuct.ac.za
Lisa F. Seymour, CITANDA, University of Cape Town, South Africa, lisa.seymour@uct.ac.za

Abstract: In an effort to counter the spread of COVID-19 many schools were forced to shut down. Primary schools in South Africa were forced to shift to emergency remote teaching abruptly relying on using a Learning Management System (LMS) to aid their teaching. LMSs helped primary schools build resilience to cope with unexpected events. An opportunity rose to study the affordances and constraints faced when using a LMS for remote teaching, specifically for primary school learners (‘Gen Z’) – a largely ignored area of research. Through a case study of 6 schools, this research describes the affordances and constraints of the LMS supported teaching system in use in primary schools. Affordances related to schools, learners and teachers while constraints were classified from a financial, technological, school, learner and teacher perspective. Noteworthy affordances included using LMSs as notice boards and satisfying parents, the key stakeholders. In terms of constraints, the digital divide was a recurring theme while device and data costs were consistently a limitation. There were many cases of schools not realizing the full potential of LMS usage. This research should be useful for primary schools wanting to use a LMS for their teaching.

Keywords: Learning Management System, LMS, Emergency Remote Learning, ERT, COVID-19, primary school, Gen Z, South Africa.

1. INTRODUCTION
COVID-19 was declared a pandemic leading South Africa to a state of national disaster causing schools to shut down more than once (Morais, 2020; Ncwane, 2020; Ntsabo, 2020; Spinelli & Pellino, 2020). Primary schools were forced to abruptly shift to emergency remote teaching (ERT) without preparedness (Ncwane, 2020) relying on learning management systems (LMS) to aid in teaching (Van Wyk, 2020).

A LMS is used to manage, create and deliver content, manage courses, create automated tests, track learner progress (Kraleva, Sabani, & Kralev, 2019) and facilitate communication between teachers and learners (Kasim & Khalid, 2016) while removing the need for physical presence as it available at any time and place using an internet connection (Walker, Lindner, Murphrey, & Dooley, 2016).

The traditional classroom setting does not meet the interest of primary learners, ‘Gen Z’ (born after 1996), increasing the need to have digital tools for learning (Karthickeyan, Rajasekaran, & Unyapho, 2019). With the emergence of new technologies, teaching methodologies have advanced adding pressure on LMSs to adapt (Kraleva, Sabani, Kralev, & Kostadinova, 2020; Sabariah, Santos, & Ferdiana, 2019) such as enabling mobile learning (Kongsgard & Krumsvik, 2016). Primary school learners show positive attitudes towards using a LMS in their learning as mobile learning has improved learning and teaching (Karalar & Sidekli, 2017). A large gap exists in the literature for primary learners (Gen Z) that hasn’t been researched extensively such as LMS and mobile learning.
(Haßler, Major, & Hennessy, 2016; Karalar & Sidekli, 2017; Kraleva et al., 2020; Sabariah et al., 2019). Little is known on how organizations use technologies during a crisis (Mirbabaie, Bunker, Stieglitz, Marx, & Ehnis, 2020; Sakurai & Chughtai, 2020). Most studies reviewed by the researchers focused on tertiary education.

This research aimed to answer the question: What are the affordances and constraints of using a LMS in South African primary schools for remote teaching during the COVID pandemic? This research did not use any theoretical framework and themes were inductively derived. The research can assist any educational institution looking to move from a traditional classroom environment to incorporating a LMS in teaching. Management or executive teams in schools will through learning from other’s experiences, maximise affordances and reduce constraints with LMS usage. The next section reviews the literature, followed by the research method used, the findings and ending with the conclusion.

2. LITERATURE REVIEW

To understand the affordances and constraints of using a LMS, this literature review will touch on ERT that increased the reliance on using a LMS (Van Wyk, 2020), the background of LMSs and literature on affordances and constraints of LMSs.

2.1. Emergency Remote Teaching

Due to COVID-19, ERT was implemented providing an alternative way of delivering education during a crisis (Hodges, Moore, Lockee, Trust, & Bond, 2020). ERT aims to give quick access to learning material as opposed to a robust environment for learning (Pohan, 2020). ERT is a short-term solution to creatively find a way to continue teaching (Hodges et al., 2020). During 2020, South Africa launched the ‘COVID-19 Learner Support’ initiative providing COVID-19 TV and Radio stations (SABC, 2020) and resources on zero-rated platforms (Department of Basic Education, 2020).

2.2. Resilience

Resilience refers to the ability of systems to cope with unexpected events (Heeks & Ospina, 2019). Resilience is mostly known as a system property and a response to an event (Heeks & Ospina, 2019). A LMS supports teaching, and hence is part of the teaching system providing resilience to schools (Kraleva et al., 2019; Sarkar, Wingreen, & Ascroft, 2016). Therefore, a LMS provides resilience of an information system outcome system (RISOS) (Heeks & Ospina, 2019).

2.3. Background of LMS

The LMS originated at the University of Illinois in 1960 with Programmed Logic for Automated Teaching Operations (PLATO) and ‘LMS’ was coined as the management of the system (Chaubey & Bhattacharya, 2015). It began as Integrated Learning System (ILS) providing instructional content (Watson & Watson, 2007). In 1990, the first software based LMS was launched (Chaubey & Bhattacharya, 2015) and implementation grew in the early 2000s with the internet (Roy, 2017). Currently, a LMS, also called an online learning platform (Aldiab, Chowdhury, Kootsookos, Alam, & Alam, 2019), describes many systems working together providing online learning services.

2.4. Affordances of a LMS

An affordance refers to a completed action between a user and an IT artifact which emerges after an active exploration from a user in a certain context (Lanamäki, Thapa, & Stendal, 2017). Affordances do not refer to canonical features of an artifact but how they are ‘seen as’ by the user (Lanamäki et al., 2017).

The literature refers to four affordances from features provided by a LMS – accessibility, interactivity (Holmes & Prieto-Rodriguez, 2018), scalability and standardization (Ramírez-Correa, Rondan-Cataluña, Arenas-Gaitán, & Alfaro-Perez, 2017). Accessibility refers to being able to
access content at any time and place using an active internet connection (Aldiab et al., 2019; Berking & Gallagher, 2016; Chaubey & Bhattacharya, 2015; Epping, 2010; Kasim & Khalid, 2016) while supporting different devices (Aldiab et al., 2019). Interactivity refers to having an attractive environment (Aldiab et al., 2019), user friendliness and ease of usage (Kasim & Khalid, 2016; Kraljeva et al., 2019) providing on-demand content delivery facilitating interaction between teachers and learners (Berking & Gallagher, 2016). Scalability refers to integrating with external tools (Aldiab et al., 2019), exchanging data with other systems (Kraljeva et al., 2019) and the reusing or combining of components of a LMS (Berking & Gallagher, 2016). Lastly, standardization refers to setting of tests, keeping learner records, tracking and reporting progress and identifying learners at risk (Berking & Gallagher, 2016; Kraljeva et al., 2019).

Other affordances are referred to in the literature as benefits. For example, from the school’s perspective teaching can continue online as a LMS allows remote learning eliminating the physical logistics (Mafuna & Wadesango, 2012; Ndobe, 2018). The LMS offers a central repository accessible from any place at any time (Berking & Gallagher, 2016; Holmes & Prieto-Rodriguez, 2018; Kraljeva et al., 2019, 2020; Papadakis, Kalogiannakis, Sifaki, & Vidakis, 2017).

Mobile learning is enabled. Learners show positive attitudes towards using tablets and can use mobile phones although sometimes with poor accessibility (Karalar & Sidekli, 2017; Papadakis et al., 2017). Using tablets has shown to improve learners’ academic performances and motor skills (Hubber et al., 2016). A LMS helps build resilience in learners and educational institutions as they are able to cope through unexpected events (Ayebi-Arthur, 2017; Heeks & Ospina, 2019; Wadi, Abdul Rahim, & Yusoff, 2020).

From the learner’s perspective, it provides an appealing environment that is easy to use and is user friendly supporting gamification and catering to the demands of ‘Gen Z’ teaching techniques (Aldiab et al., 2019; Berking & Gallagher, 2016; Coates, James, & Baldwin, 2005; Kraljeva et al., 2019, 2020). It allows to cater to learning methods of primary school learners, promoting learning subtly (Ting, 2019) to a point that learners “own the text” (Kongsgård & Krumsvik, 2016, p. 261). It empowers learners to work at their own pace and method of studying and equips them with technical skills (Kulshrestha & Kant, 2013).

Teachers get more time for planning, decreasing the administrative load. Teaching quality improves as teachers develop technical skills, reflect on their teaching methodologies and work collaboratively to overcome challenges while being able to experience content as a learner (Lonn & Teasley, 2009; Underwood, Cavendish, & Lawson, 2006; Unwin et al., 2010; Walker et al., 2016; Zheng et al., 2018). Teachers use various applications for teaching and learners become more creative with collaboration and group work, increasing active participation from learners (Kongsgård & Krumsvik, 2016). It shifts the focus of learning to the matter on hand leaving the topics out of scope to be handled by technology (Ben-Zvi, 2009).

2.5. Constraints of LMS Usage

A major constraint with LMS usage is cost. There are several costs that schools incur when using a LMS. Educational institutions opt for open-source LMSs, instead of licensed ones, to reduce maintenance and improvement costs (Anand & Eswaran, 2018; Kasim & Khalid, 2016). Yet free versions of LMSs have limited capabilities and additional costs are incurred to train staff members (Kraljeva et al., 2019; Walker et al., 2016). Most people living in Sub-Saharan Africa live under $1.90 (R27) a day (United Nations, n.d.). 54% of South Africans do not own a computer, 62% have access to the internet using their phones of which 36% have never connected to the internet (Isbell, 2020). Therefore, the costs to provide devices and data to learners falls on the educational institutions such as the University of Cape Town or University of Witwatersrand that provided data and laptops to learners (Vermeulen, 2020).

Having access to the internet, good bandwidth and a personal computer to be able to access a LMS is a challenge for learners (Hillier, 2018; Mtebe, 2015; Unwin et al., 2010). Lack of ICT literacy
creates barriers for using a LMS (Hillier, 2018). English not being the first language of learners affects the effectiveness of a LMS (Sackstein, Coleman, & Ndobe, 2019). Lack of computer laboratories in primary schools due to insufficient resources affects access (Mark & Emmanuel, 2019).

Due to a lack of time, teachers are not trained as it affects their time for planning thus hindering adoption of a LMS and a lack of technical support causes teachers to resist the new changes (Coleman & Mtshazi, 2017; Sackstein et al., 2019; Unwin et al., 2010; Walker et al., 2016; Zheng et al., 2018). Adoption usually comes from the top-down, increasing resistance from teachers (Mtebe, 2015). Even teachers that use a LMS do not use it to its full potential affecting return on investment (Bousbahi & Alrazgan, 2015).

LMSs are made in developed countries where children are exposed to technology at a young age (Sackstein et al., 2019). As of 2017, 22% of South Africans had access to ICT infrastructures (International Telecommunication Union, 2017). The gap has increased the digital divide in terms of social resources, cognitive resources and material resources (Lembani, Gunter, Breines, & Dalu, 2020). Due to lack of funding, most primary schools haven’t been able to benefit from using a LMS (Chigona, Chigona, Kayongo, & Kausa, 2010).

To conclude, ERT is not fully understood (Hodges et al., 2020). With new technologies emerging, teaching methodologies have changed forcing LMSs to adapt (Kraleva et al., 2020). Primary school learners remain to be extensively researched with regards to using a LMS (Kraleva et al., 2019; Sabariah et al., 2019).

3. METHOD

This section describes how the research was conducted while stating the assumptions and limitations. The purpose of this research was to describe the affordances and constraints of using a LMS for remote primary school teaching in times of crisis. The research question states ‘what is’ by describing and analysing the purpose of the research without explaining causality or making predictions (Gregor, 2006). An interpretive philosophy was adopted to understand the experience from the participant’s perspective (Cussen & Cooney, 2017; Díaz Andrade, 2009). The assumption was that reality is a social construct that the researcher drives to reveal (Walsham, 1995). The philosophy helped give an insight about experiences from the perspective of the person living it (Díaz Andrade, 2009). The strategy of the research was a multiple-case study (Yin, 2009) where each school was a case. A case study was used as it provides insights not available from other strategies using multiple sources of data (Rowley, 2002). Prior to contacting any schools, permission was obtained from the university’s ethics committee and the Western Cape Education Department. All participants consented to the research and were free to leave at any time. The research happened throughout 2020. The criterion used to select schools were:

- A primary school
- Based in South Africa
- Affected by COVID-19
- Used a LMS

Six primary schools based in Cape Town were chosen meeting the criterion. There were three public fee-paying schools, one public fee-paying school privately funded, one private fee-paying school and one semi-private fee-paying school. Each school had different infrastructure and accessibility levels to use a LMS. While most schools used Google Classroom there was a spread of the number of years a LMS had been used at the school. Table 1 lists schools selected with the ID being the case.

<table>
<thead>
<tr>
<th>ID</th>
<th>School Type</th>
<th>Infrastructure</th>
<th>Accessibility</th>
<th>LMS used</th>
<th>LMS Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>Public non-fee paying privately funded</td>
<td>Good</td>
<td>High</td>
<td>Google Classroom</td>
<td>5</td>
</tr>
</tbody>
</table>
Judgement sampling was utilized to pick participants best fit to achieve the purpose of this research (Marshall, 1996) along with convenience sampling – selecting participants accessible for the research (Etikan, Musa, & Alkassim, 2016). The researcher was referred to schools by an expert working with LMSs in primary school. Teachers available and willing to be interviewed formed part of the sample. Participants were interviewed using online conferencing tools. Participants provided documentation to the researcher such as relevant policies. Semi-structured interviews with open-ended questions were done following an interview guide. The interview guide was developed using the research question in mind while being guided by the literature reviewed (Figure 1).

**Table 1. Schools Selected**

<table>
<thead>
<tr>
<th>ID</th>
<th>Role</th>
<th>Subjects</th>
<th>Teaching Years</th>
<th>LMS Years</th>
</tr>
</thead>
<tbody>
<tr>
<td>C2</td>
<td>Public fee-paying school</td>
<td>Average, Medium</td>
<td>Google Classroom</td>
<td>6</td>
</tr>
<tr>
<td>C3</td>
<td>Private fee-paying school</td>
<td>Excellent, Very High</td>
<td>Google Classroom</td>
<td>10</td>
</tr>
<tr>
<td>C4</td>
<td>Semi-private fee-paying school</td>
<td>Average, Medium</td>
<td>Google Classroom</td>
<td>0</td>
</tr>
<tr>
<td>C5</td>
<td>Public fee-paying school</td>
<td>Average, Medium</td>
<td>Worksheet Cloud</td>
<td>0</td>
</tr>
<tr>
<td>C6</td>
<td>Public fee-paying school</td>
<td>Average, Low</td>
<td>Google Classroom</td>
<td>3</td>
</tr>
</tbody>
</table>

**Figure 1. Excerpt of the Interview Guide**

Interviews were recorded with consent from participants and later transcribed. Table 2 lists all participants interviewed. Participant IDs start with the case number and followed by the participant number from the case.
Canani & Seymour

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Table 2. Participants Interviewed

| C6P1 | Grade 6 and 7 teacher | Afrikaans and Technology | 6 | 3 |

NVivo was utilized to code and analyse the data gathered. Transcripts of every interview were coded to find themes. Figure 2 shows initial coding. Themes were analytical outputs created by the intersection of the researcher’s assumptions, analytical skills and resources and the data itself without using pre-existing codes (Braun & Clarke, 2019; Terry, Hayfield, Clarke, & Braun, 2017). Themes did not emerge from the data but were reflectively developed and generated (Braun & Clarke, 2019). To find themes, six phases of reflexive thematic analysis were used (Braun & Clarke, 2006):

1. Getting to know the data. The researcher became familiar with the data after transcribing and preparing it for analyses. This involved reading over the data more than once.

2. Generating initial codes. The researcher generated codes after each interview. The researcher then grouped common subjects together and reanalysed to generate more codes. Any point raised by a participant that touched on the research question was coded. Similar points were coded on the same code.

3. Finding themes. The researcher identified patterns emerging creating themes iteratively after each interview. Reviewing the existing codes, the researcher identified ‘bigger-picture’ themes that encompassed the codes.

4. Going over themes. Themes were reviewed to identify relevance to the theme and sub-themes were established. Themes were grouped into sub-groups as parent themes were generated from the existing themes.

5. Defining themes. Using gerund coding (Charmaz & Keller, 2016), themes were named to give explanation of the theme.

6. Generating a report. Using the data, the researcher wrote up the themes.

Figure 2. Data Analysis on NVivo

4. FINDINGS

Several themes were generated from the data collected, even though some themes overlapped with one another, it did not affect the classification of the finding. Contradicting themes were discussed at the first instance. The next section reports on the affordances and constraints of using a LMS. Affordances were classified as actions completed between a LMS and a user (Lanamäki et al., 2017). Constraints had a lot of overlap but the context specific to an actor was used as a guide for
classification. Classifications were guided by the actor in the context of the theme emerging using the literature reviewed as a guide.

4.1. Affordances of a LMS

The affordances of a LMS have been classified based on the participant in the relevant LMS system or sub-system being the school (Table 3), the learner (Table 4) or the teacher (Table 5). These will now be discussed.

As classes were shut down, schools shifted to remote learning a key affordance of using a LMS. The literature refers to learners being able to access a LMS from any place at any time (Walker et al., 2016). A new affordance found was that a LMS enabled avoiding human and surface contact. For C2P2 their LMS became the only way of teaching – a new theme that was generated as literature shows that in primary schools a LMS is normally only used to supplement physical teaching (Berking & Gallagher, 2016). Going digital and paperless improved the storing and retrieving of documents – not initially found in the literature but a feature of information systems (Marsh, 2018). Some participants noted that they did not achieve the expected affordance of going paperless supporting literature’s claim of this potential of using a LMS not always being realized (Bousbahi & Alrazgan, 2015). Improvement of teaching quality was in line with literature. Communication improvement through using a LMS, while noted in the literature was found to extend to using a LMS to send announcements to parents. Satisfying parent needs, an important consideration for primary schools (Teachwire, 2016), was identified as a new theme. Multiple school stakeholders could access content in their LMS with ease using different devices as noted in the literature. Flexible usage of a LMS is a new theme that was generated as literature states a LMS affords standardization but also presents challenges.

<table>
<thead>
<tr>
<th>Affordances of Schools</th>
<th>Data Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enabling avoidance of human and surface contact</td>
<td>We are wanting to avoid cross contamination for example with marking books, and we wanting to limit the interaction of standing near learners, and, or, you know, touching their book their stationery etc. (C1P1).</td>
</tr>
<tr>
<td>Enabling remote teaching when physical classes are not possible</td>
<td>It’s just, I mean, it (using a LMS) was the only way to teach (C2P2).</td>
</tr>
<tr>
<td>More efficient storage and retrieval</td>
<td>We don’t have to walk around with a planning file anymore. We don’t have to search for videos or work notes anymore. I mean, it’s right there (C4P4).</td>
</tr>
<tr>
<td>Helping improve teaching quality</td>
<td>We can kind of see what works … what does not work and what we can fine tune (C4P4).</td>
</tr>
<tr>
<td>Improving Communication</td>
<td>It (Google Classroom) became the only avenue of disseminating information so it became a vital part of our teaching and learning (C3P3).</td>
</tr>
<tr>
<td>Satisfying parent needs</td>
<td>Yes, it was actually very, very helpful, especially for the parent (C5P5).</td>
</tr>
<tr>
<td>Accessible from different devices</td>
<td>We (teachers) access via our notebooks, we picked up that some learners do it by their phones (C4P4).</td>
</tr>
<tr>
<td>Ease of use</td>
<td>It’s (Google Classroom) user friendly (C3P3).</td>
</tr>
<tr>
<td>Providing a repository of information</td>
<td>It’s a storage place … your Google Classroom becomes your portfolio of what you do if you use it all the time (C3P3).</td>
</tr>
<tr>
<td>Allowing flexibility of usage</td>
<td>I think everyone in the school, every grade in the school uses [Google] Classroom in a different way… And I think the biggest challenge of that (using a LMS in different ways) was that not all of the grades in the school were using it the same way (C4P4).</td>
</tr>
</tbody>
</table>

Table 3. Data Evidence for Affordances of Schools

From the learner’s perspective, an easy learning curve reflects that a LMS caters for the demands of ‘Gen Z’ (Kraleva et al., 2020). Improvements in learning – an affordance of a LMS was consistent with the literature. Learners learning digital skills by using their LMS was noted in the literature.
Participants mentioned learners grasping concepts of responsibility and accountability – a new theme that was generated specific to primary school learners.

<table>
<thead>
<tr>
<th>Affordances of Learners</th>
<th>Data Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy learning curve</td>
<td>That's it's normal to them (learners… (C2P2).</td>
</tr>
<tr>
<td>Improving learning</td>
<td>And that kids actually learn… (C2P2).</td>
</tr>
<tr>
<td>Learning digital skills</td>
<td>[W]e are moving towards more of a digital age, the skills, the digital skills</td>
</tr>
<tr>
<td></td>
<td>that kids are learning (C3P3).</td>
</tr>
<tr>
<td>Learning responsibility and accountability</td>
<td>[Google Classroom] allow[s] the learner sometime after the work has been done,</td>
</tr>
<tr>
<td></td>
<td>they can go and mark at home or they could go and revise them … they quite</td>
</tr>
<tr>
<td></td>
<td>responsible now (C4P4).</td>
</tr>
</tbody>
</table>

Table 4. Data Evidence for Affordances of Learners

From the teacher’s perspective, the enabling of teaching and the saving of time by using a LMS were voiced by participants and noted in the literature. Motivating teachers to learn new technologies is a new theme that was generated since literature only refers to teachers learning digital skills. Having many features in their LMS afforded teachers to have everything in one place as noted in the literature.

<table>
<thead>
<tr>
<th>Affordances of Teachers</th>
<th>Data Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enabling teaching</td>
<td>Being able to still teach (C2P2).</td>
</tr>
<tr>
<td>Learning new technology</td>
<td>They (teachers) will just dive straight in and we're (teachers) very happy to</td>
</tr>
<tr>
<td></td>
<td>use it (Google Classroom) (C3P3).</td>
</tr>
<tr>
<td>Saving time</td>
<td>So, learners can check their work, which obviously saves us (teachers) time</td>
</tr>
<tr>
<td></td>
<td>(C1P1).</td>
</tr>
<tr>
<td>Having many features available in one</td>
<td>The organization and having everything in one place (C2P2).</td>
</tr>
<tr>
<td>software application</td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Data Evidence for Affordances of Teachers

4.2. Constraints of LMS Usage

Constraints have been classified as financial (Table 6), technological (Table 7), school (Table 8), learner (Table 9) and teacher (Table 10) constraints and are now described.

The financial constraints were costs incurred when using a LMS. These constraints applied to all users. The assumption was that all participants disclosed costs they were aware of – since all participants are teachers, the financial position of their schools is not their expertise. Several costs mentioned by participants such as devices, internet, licensing, support, and training were in line with the literature. C3P3 stated their school used the free version of Google Classroom as noted in the literature – enterprise versions have more capabilities and are usually not preferred by educational institutions. Increased printing costs was generated as a new theme contradicting a LMS’s paperless affordance but remaining consistent with literature’s stance on a LMS’s potential not being fully realized.

<table>
<thead>
<tr>
<th>Financial Constraints</th>
<th>Data Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device Costs</td>
<td>[A]ll educators at home had the school's notebook… (C4P4). I use my cell phone</td>
</tr>
<tr>
<td></td>
<td>or my laptop… (C5P5).</td>
</tr>
<tr>
<td>Internet Costs</td>
<td>So, my package, at home, is about 600 rand or just under, per month. And that's</td>
</tr>
<tr>
<td></td>
<td>for high speed fibre (C1P1). We had a learner in my class, he says he spent</td>
</tr>
<tr>
<td></td>
<td>about 300 Rand a week on data… (C4P4).</td>
</tr>
<tr>
<td>License Costs</td>
<td>I'm not sure what the license fee is to register for the number of staff we</td>
</tr>
<tr>
<td></td>
<td>have using Google education (C1P1). The school has set that up for us (C4P4).</td>
</tr>
<tr>
<td></td>
<td>For teaching well G Suite is a free education platform. So, that's the beauty</td>
</tr>
<tr>
<td></td>
<td>of it, there are no costs involved (C3P3).</td>
</tr>
</tbody>
</table>
Table 6. Data Evidence for Financial Constraints

There were several constraints of the LMS technology experienced across all user groups. C1’s LMS was unavailable for a period – a new theme that was generated to an extent of contradicting the availability affordance of an LMS but being consistent with constraints of any technology. Insufficient features in a LMS and poorly developed features remain consistent with literature as LMSs are built in developed countries. Educational institutions opt for free versions which come with limited capabilities too. C1P1 faced constraints in using other tools along with their LMS due to no integration capabilities – a new theme that was generated as literature states integration is an affordance of an LMS. Not being able to use a LMS offline limited students’ access – a new theme that was generated requiring accessing a LMS without internet connection. A LMS requires an internet connection for accessibility, highlighting the effects of using LMS built in developed countries.

Table 7. Data Evidence for Technological Constraints

There were many constraints that schools experienced with respect to LMS usage. The digital divide in South Africa was evident in the primary schools, responses from different schools varied, C1 stopped using their LMS while C3 was subsidizing internet costs for some students. C3P3’s surprise at seeing their colleagues use WhatsApp groups instead of Google Classroom highlighted the digital divide – consistent with the literature. C2P2 mentioned lacking support from management, a new theme, that was generated although lacking support from management is a general constraint for any technology being introduced (Ismail, 2018). C4P4 noted timing constraints in setting up their LMS for ERT (a school without an existing LMS) – a new theme that was generated as the scope of this research did not include reviewing implementations of a LMS. Training users was time consuming, consistent with the literature. Some participants did not track usage of their LMS, an affordance of a LMS, due to having other priorities while others had their own strategy of tracking users – both reasons being consistent with literature as it takes time to train users and teachers to use a LMS to its full potential.
Table 8. Data Evidence for Organizational Constraints

In terms of constraints learners experienced, inadequate access to data and devices to use their LMS was referred to often, as noted in the literature. For this reason, C4P4 faced difficulty in introducing learners to their LMS. A new theme was generated, C4 rushed their introduction to their LMS leaving learners confused. Parents were unable to assist primary school students as they were lacking literacy skills – a new theme that was generated specific to primary school students while reiterating the effects of the digital divide. Even after contacting parents, C2P2 was struggling to ensure all students use their LMS highlighting a new theme contradicting the ‘Gen-Z’-friendly image of a LMS in the literature.

Table 9. Data Evidence for Learner Constraints

Teachers had poor connectivity which could have been resolved by upgrading their internet package – reflecting the digital divide (infrastructure) and financial constraints mentioned in literature. Consistent with the literature, teachers resisted using a LMS – some even went for training but never applied the concepts taught to them. Some teachers had inadequate technological skills – also an effect of the digital divide in South Africa.
5. DISCUSSION
The findings highlighted several themes consistent with literature. This section focuses on themes which were generated as affordances or constraints to the LMS enabled teaching system and were not evident in the literature. For affordances, a new affordance, specific to the COVID-19 context emerged as a LMS enabled avoidance of human and surface contact. In the same context, a LMS became the only way of teaching highlighting the role it played in increasing resilience in the teaching process in schools. Schools used a LMS to send announcements, extending the usage of a LMS for communication found in the literature. Flexibility in using a LMS, opposing standardization, brought its own challenges. Students learned accountability and gained responsibility indicating how a LMS may be used to increase resilience in students. LMSs motivated teachers to learn new technologies demonstrating the role LMS play in increasing resilience in teachers.

For constraints, printing costs were generated as a new theme but are captured as a LMS not being used to its potential. Constraints relating to support from management are general technological constraints. Learners faced constraints in using a LMS due to the rushed introduction to a LMS while their parents’ technological literacy, a contribution specific to primary learners, constrained parental support to learners at home. Most constraints revolved around the existing digital divide in South Africa which was exacerbated by the pandemic. LMSs are advertised as ‘Gen Z’ friendly in contrast to findings of this research. This highlights the need for further research on LMS from the ‘Gen Z’ learner’s perspective. The technological constraint of integration with a LMS was raised. This contradicts the affordance of a LMS and was due to varied brands being used for integration.

The themes that were generated in this research contributed to literature. From a practical perspective, schools’ management may learn about the affordances and constraints of using an LMS and use the information for decision making, strategy planning and possibly undertaking internal research to see how they are using their LMS. This research provides a basis of understanding a LMS in the context of South Africa specifically for primary schools.

6. CONCLUSION
With the abrupt shift to remote teaching during ERT, the usage of a LMS in schools increased. As lockdown began, schools shut down and teaching moved online. An opportunity rose to study affordances and constraints faced when using a LMS for remote teaching, specifically for primary school learners (‘Gen Z’) – a largely ignored area of research as ‘Gen Z’ learners require new teaching methodologies to keep them engaged with content.

Several themes were generated for both affordances and constraints. Affordances were classified in relation to schools, learners, and teachers. Noteworthy affordances included using LMSs as notice boards and satisfying parents – the key stakeholders. Constraints were classified into financial, organizational, learner, teachers and technological. The digital divide in South Africa was a recurring theme while device and data costs were consistently a challenge.

From a practical perspective, this research will be useful to any primary school looking at introducing a LMS as part of their teaching. Existing users of a LMS will be able to learn from the experiences of other schools. For example, management of primary schools will understand the constraints their students may or already face and try to influence school policy or create mitigation strategies to counter constraints.

The research has limitations, the main one being that it is from a teachers’ perspective only. There are several stakeholders in a school’s setting that haven’t contributed to this research such as students, parents, government and NGOs. Secondary sources while analysed were not presented here. Most of the schools used one brand of LMS thus adding an element of bias to the answers.
Some of the affordances and constraints raised are difficult to generalize as the researcher was unable to understand if they were due to the specific brand of LMS.

To help understand more and bring more light on ‘Gen Z’ learners and LMSs, future work needs to be conducted from perspectives of other stakeholders involved in a school setting to understand the affordances and constraints faced. Lastly, researchers must include schools that use different LMSs to be able to generalize across technologies.

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Abstract: A number of studies in Information and Communication Technologies for Development (ICT4D) focus on projects’ sustainability and resilience. Over the years, scholars have identified many elements to enable achievement of these goals. Nevertheless, barriers to achieving them are still a common reality in the field. In this paper, we propose that special attention should be paid to communities’ relationships, self-organizing, and social capital—and the people’s networks that enable them—within ICT4D scholarship and practice, as a way to achieve sustainability and resilience. Building on Green’s work (2016) on social change as a force that cannot be understood without focusing on systems and power, we claim that ICT4D would benefit from intentionally growing social capital and fostering networks within its systems. We propose “network weaving” (Holley, 2013) as a practical approach, and we explore its potential to complement and advance existing ICT4D frameworks and practices, including the sense of community of the researchers themselves.

Keywords: network weaving, sustainability, resilience, social capital, ICT4D

1. INTRODUCTION

1.1 The scope of sustainability and resilience inquiry

Over the years, scholarship in Information and Digital Technologies for Development (ICT4D) has extensively engaged with issues of projects sustainability and resilience, defined jointly as the ability of systems to withstand, recover from, adapt to, transform, and endure amid external stressors and over time (Heeks & Ospina 2019). Both barriers to achieving them and ways forward for the field have been identified, generating theoretical and methodological frameworks.

In this research, we consider some of the ways sustainability and resilience have been addressed in the ICT4D literature, and we propose a way to complement existing frameworks by focusing on particular fundamental values applied to growth of social capital and fostering of networks. We maintain that the focus of research should shift from the - often temporary - project level to a more systemic level, which considers communities in all their contextual complexities and is designed to contribute to sustainable development processes. The next section, thus, deals with two scopes of inquiry, the project level and the community-in-context level.

2. THE SCOPE OF SUSTAINABILITY AND RESILIENCE INQUIRY

2.1. Project-level sustainability

Project-level sustainability is the context in which the different value systems of ICT4D key role players have an immediate and major influence on sustainability, and ultimately resilience. Despite the extensive research uncovering how to make ICT4D projects sustainable and resilient, there are still many obstacles to realize the desired change we want to bring, and many projects still fail...
Network Weaving to Foster Resilience and Sustainability (Fierbaugh, 2017; World Bank, 2011). Research on ICT4D failures is quite extensive, with a large focus on sustainability-connected issues. From “design-reality gaps” (Heeks, 2002) and the need to promote a stronger emphasis on local dynamics and socio-cultural factors, to the need to analyze power dynamics and the role of researchers (e.g. Avgerou & Walsham, 2000; Unwin, 2009; Tedre, Sutinen, Kähkönen, et al., 2013; Brunello, 2015), through employing participatory approaches to ensure projects are socially sustainable and empowering for communities (e.g. Gómez, 2013; Heeks, 2008, 2010), a considerable amount of work has also looked at viable approaches to successful projects.

For example, participatory methods have been used to promote community empowerment and ownership, thus increasing the probability of project sustainability (Bentley, Nemer, & Vannini, 2017; David et al., 2013; Vannini, Rega, Sala, et al., 2015). Participatory work has also been promoted as a way to engage as equal partners and develop local capabilities and resilience. A number of studies guided by strong and explicit value systems identified that respecting local traditions, engaging in longer partnerships, co-designing at all levels, and promoting mutual ownership and shared decision-making, are key to achieve sustainable outcomes (Bidwell, 2020; Rey-Moreno, Roro, & Tucker, et al., 2013; Winschiers-Theophilus, Chivuno-Kuria, Kapuire, et al., 2010). The concept of participation per se has also been questioned. Researchers have been questioning what and whose voices and knowledges are eventually heard, and which ones are lost along the way (Halabi, Sabiescu, David, et al., 2015; Russ, 2021). The relationships between researchers and communities have also been examined in terms of power dynamics, and frameworks were offered to rethink mismatching expectations when dealing with intercultural contexts (Brunello, 2015; Vannini, Nemer, Halabi, et al., 2017). This shows progress towards respect and sensitivity towards differences in value systems.

Sustainability, as bottom-up alignment of communities’ interests enabled by building social resources and social capital, has a rich tradition in development and ICT4D research. Marais (2016) provides a comprehensive overview of social capital in ICT4D. Renken and Heeks (2018) review the role of Social Network Analysis. Social capital was described in terms of networks of relationships based on trust by Farr (2004). Sein, Thapa, Hatakka, et al. (2019) propose three groups of theory underpinning the ICT, D, and ‘4’ in ICT4D, including theories of Social Capital and Actor-Network theory (ANT). The importance given to the role of social capital here shows how social interactions enable action through the enhancement of alignment, trust, and acceptance. Trust is considered pivotal, as it is rooted in different value systems, and open and equal engagement is required for mutual trust. This is where the work of June Holley, which we will introduce in section 3, is relevant to the enduring problems in ICT4D.

The integrative concept of ‘sustainable livelihood security’ by the World Commission on Environment and Development (WCED) reflects the connections between basic needs, secure resource ownership, and long-term resource productivity (WCED, 1987). Chambers & Conway (1992) include social resources and capabilities (Sen, 1984) in their definition of sustainable livelihoods. Social capital became embedded in the systemic perspectives on sustainable development partly due to its prominence in the World Bank-based research development policies (Woolcock & Narayan, 2000) and the linkages between sustainable development approaches and the Choice Framework (CF) of Kleine (2010; see also Grunfeld, Pin & Hak, 2011).

The social capital of a community is grown by local individuals who can fulfil many important roles. Examples include: local champions who facilitate interaction with development initiatives (Renken & Heeks, 2019), intelligent intermediaries (Gopakumar, 2007), infomediaries (Mukerji, 2008), or social connectors (Díaz Andrade & Urquhart, 2010). These individuals are vital for success in ICT4D projects, particularly for promoting access to information and adopting and fostering innovation and use of social capital (Madon, 2007; Sey & Fellows, 2009; Gómez, Fawcett, & Turner, 2012; Marais, 2016).
However, complex challenges remain inherent to current development funding schemes. Recent research has underlined the ethical dilemma between designing for participation and respecting the constraints of funders, who usually budget for short-term projects that don’t allow for the continuity needed in development. The derogatory phrase often used in the literature is that of “parachuting” into a community followed by a quick departure (Holeman & Barrett, 2017, p.920; Unwin, 2014, Raftree, 2011, 2018). Clearly, this is a particular type of value system in action.

2.2. Community-in-context sustainability

In a recent report addressing the drivers of change in human development, Knox Clark claims that decision-making in the sector is still mainly not guided by evidence, despite supporting data being provided. This is attributed either to decision-makers being affected by a number of other considerations - e.g., politics, resource availability, security - or to decision-making not considering evidence as an important component of their processes (Knox Clarke, 2017). For example, many donors seem to prefer funding project-based initiatives, while evidence shows the greater value of core and long-lasting funding to organizations. ICT4D itself is often operated in under-resourced systems where long-term projects are not the norm.

Green’s work (2016) suggests that social change cannot be understood without focusing on systems and power. Social change progresses must address both how power is distributed and how it is possible to re-distribute it within and between social groups. Power and systems are always situated, affected by and affecting complex social contexts (Green, 2016). For example, ICT4D processes are often directed or funded by the North, and it is rare that local or South-South collaborations are enabled and amplified (Walsham, 2020). Funding for collaboration in ICT4D between the Global North and the Global South has been scoped by UN agencies such as USAID, or science foundations such as the UK ESRC or the Swiss DEZA as creating shared ownership and equal partnerships. In practice, though, funded projects are often directed by the Global North expertise, while countries in the Global South are mainly labelled as beneficiaries. When South-leading collaborations are enacted, partners are sometimes not considered as equally contributing (van Stam, 2020), which reflects a judgment that may be based on a value system. Under these circumstances, project sustainability is hardly enabled. Short-term funds will often ignore the hidden running costs that maintaining systems long-term will require, and North-enabled projects will often present structural power dynamics that are hard to discern and overcome.

As mentioned in Section 2.1, individuals play many necessary roles, but these roles can be misused as well, or divide communities due to patronage issues. The reliance on individuals as infomediaries or local champions to ensure sustainability, resilience, and community ownership may also have unwanted consequences. First of all, local champions might not be easy to find in any given community. Secondly, they have characteristics such as being innovative, natural leaders, dynamic, strategic, propensity to take risks (Renken & Heeks, 2019) that could potentially lead them to leave their communities for better opportunities elsewhere. Thirdly, a too great emphasis on champions’ responsibility reinforces the narrative of “the genius” extraordinary. This might be problematic as it tends to over-burden the individual with the responsibility to create change instead of focusing on more systemic power imbalances. Also, the concept intrinsically bears individualistic values (of “the” champion) that are not necessarily the most appropriate for work with more collectivist non-Western cultures (Arora, 2019; Jimenez & Roberts, 2019; Oliveira, Muller, Andrade, et al., 2018).

This illustrates a difference in value systems that prioritize the individual’s actualization versus the loyalty towards being part of a community. A shift to a more collective idea of championship would be more fitting for the kind of work ICT4D is pursuing.

In this paper, we argue that more attention should be given not only to the family of approaches that follow bottom-up, participatory strategies in ICT4D, but also to possible differences in value systems and frameworks that leverage on communities’ self-organising, and that build on existing relationships within and between communities, without relying on single individuals only. These existing relationships may already have (and usually already have) led to innovation, development,
and social change in their communities. They might be more resilient and sustainable in time, as they are based on existing and enhanced social capital as enabled by shared value systems.

We propose a network approach that builds on existing experiences and scales up community level development already led by a number of actors, including community champions and people less on the spotlight, as well as Non-Governmental Organizations (NGOs), Faith-Based Organizations (FBOs) and Community-Based Organizations (CBOs). Intentionally enabling networks within the systems in which ICT4D projects operate requires adopting a relationship and social capital framework as one of the foundations for sustainable development. This could be done in the context of periodic external interventions (e.g. projects relying on external funding for development frameworks), which contribute to long-term, sustainable development, but are hardly the main drivers for it. We propose the practice of “network weaving” (Holley, 2013) and the value system on which it is built, and we explore its potential to complement and advance existing ICT4D frameworks.

3. NETWORK WEAVING AND ITS POTENTIAL FOR ICT4D

In this section, we talk about what network weaving is and how it addresses change through situated, transformational responses to systemic power structures. Finally, we identify how this approach can bring forward ICT4D research.

3.1. What is Network Weaving?

The concept and practice of “network weaving” was started by June Holley (2013) to help low-income entrepreneurs in the Appalachian region in Ohio, one of the poorest regions of the U.S., create networks that would bring opportunities and change to their communities.

According to Holley (2013), networks are complex sets of relationships among people and communities that have the ability to address power imbalances by 1) encouraging intentional peer relationships which recognize the value and contribution that individuals can make; 2) considering every individual to be a leader, who has the ability to connect and initiate collaborations. In this way, “power is distributed, not concentrated” (ibid., p.10); and 3) including all stakeholders’ voices in the process of generating change. This is a summary of the elements of this value system.

Networks are at the basis of societal systems. The status quo is held in place by old networks, and exposing them, according to Holley, is paramount to change. Societies and communities also consist of unconnected or loosely connected people. Holley claims that, to shift systems and rebalance power, it is important for people to understand the old networks and subsequently foster new networks that can reposition peoples that have been historically relegated at the margins of networks to their centre. This re-positioning of and within networks, together with the attention to enable grassroot networks to emerge and thrive, can effectively transform systems and enable change (ibid.).

Networks can be of four different kinds, at time co-existing, but especially interlocking and complementing one another so that a network can function (see Fig. 1). First, they have to be intentional, meaning they have to have the same goal or share the same vision. These networks can be formally organized or not. Second, they have to establish relationships. Intentional and relationship networks are connected to one another. Holley (ibid.) identifies the lack of attention to relationships as the main cause for network failures, as it can lead to issues such as lack of trust or lack of support. As argued previously by the authors, trust involves in-depth engagement with value systems. Third, they have to be action-oriented and self-organizing. Fourth, they have to have systems in place to provide support and foster accountability for their work.
Figure 1. The four Interlocking Networks, adapted from Holley, 2013

Network weaving indicates being intentional about networks and fostering them. This can be done by “connecting people strategically where there’s potential for mutual benefit, and serving as a catalyst for self-organizing groups” (ibid., p.24). Figure 2 summarizes the four different roles Network Weavers can have as identified by Holley: two are concerned with fostering the network (Connector Catalyst and Guardian), and two are action-oriented (Self-organized Project Coordinator and Facilitator). Also, Connector Catalyst and Project Coordinator tend to operate on the micro-level, e.g. strengthening ties that are only loosely connected or seeing opportunities for a network, while Network Guardian and Facilitator tend to work on the macro-level, e.g. improving networks’ systems or helping people see the benefits of a network approach.

Figure 2. Network Weaver Roles, adapted from Holley, 2013.

In network weaving, leadership is distributed and everyone can be a leader (or, in ICT4D terms, a champion) because everyone is believed to manifest leadership abilities. These abilities can also be learned, improved, and leveraged upon. The self-organizing nature of network weaving is what encourages people to take initiative, ultimately fostering ownership and leading to transformation. As everyone is a leader, the success of a network depends on each and every participant into the network, and on how leaders are supported.
3.2. Network Weaving’s value for implementing sustainability and resilience in ICT4D

Several characteristics of network weaving make it a suitable addition to existing frameworks addressing ICT4D projects sustainability and resilience. In this section, we underline the existing linkages between them and ICT4D theorized best practices.

First, network weaving focuses on co-creation processes and on all stakeholders’ participation. Networks include diverse stakeholders, with their different approaches and perspectives. Stakeholders are all nodes of the networks, organized in a non-hierarchical way. A network mindset implies decentralized decision-making and collective action - i.e. it would require that local communities participate in development strategy decisions that are usually made by Government, NGOs and International Development Organizations. Living Labs (LLs) are a similar development strategy, which describes the Finnish Triple Helix models of collaboration between industry, government and citizens (Følstad, 2008), where product development shifts from the laboratory to the real-life context of citizens (the “living lab”) at home and at work, where co-creation of innovations can emerge. In ICT4D Finnish development aid has assisted the development of ICT-enabled rural LLs in South Africa (SA) (Stillman, Herselman, Marais, et al, 2012). A network mindset requires contextual development strategies where the diversity of interests is represented, and the space is held for multiple ways of achieving outcomes, in which indigenous knowledges, various value systems and so-called expert knowledge can interact and evolve. The approach also responds to the need of developing adaptive capabilities, which can innovate and respond to the complexity of our planet transformations.

Second, network weaving builds on existing literature on the importance of intermediaries, infomediaries and champions. By saying that everybody can be a network weaver, the focus on leadership is shifted to a shared, collective idea of “championship”, which is more inclusive, more attuned to collective dynamics and value systems that are usually more common in non-Western communities, and possibly more sustainable in the long term. This different idea of leadership is especially relevant when it comes to focusing on women’s participation in development leadership. Women as leaders and champions are often hidden. For example, schools in SA depend largely on women teachers, but School Principals are mostly male (Skosana, 2018). Activities related to care work are predominately performed by women and are often devalued and made invisible in the information field, including in spaces such as community centers and access to information venues where this kind of caring work is paramount (Sweeney and Rhinesmith, 2017). Despite the centrality of their work, including their reproductive labour, women are hardly recognized in society capitalist production (Federici, 2012; Stillman, Sarrica, Anwar, et al., 2020). Also, women in resource-constrained contexts form very strong relationships, usually out of necessity, and they are more likely to use their social capital to survive because of their position in society (Stillman et al., 2020). Women’s positions and positionality, then, makes them natural networks weavers. A focus on networks is relevant because it recognizes different ways of leading and it might help emphasise women’s leadership and the values that are often associated with women’s roles.

Third, this approach is empowering for communities, not only as they have more access to decision-making and to leading the change they want to see, but also because it enables them to be aware of the networks they are embedded in and of the power they have to shape decisions. This awareness also brings with it more exposure to a plurality of ideas, and more peer learning.

Finally, the approach speaks to ICT4D scholarship’s focus on transparency as a way to achieve social justice (Smith, 2014). A network approach encourages sharing by default, including not only sharing outcomes and approaches from different projects, but also sharing networks themselves, so they can grow and evolve. Networks are intrinsically flexible: they often have no clear boundaries, which ensures they have a great potential for expansion. This natural evolution of networks is beneficial to ensure best practices’ dissemination: while projects can come and go, and academic findings rarely reach communities outside of researchers’ own influence sphere, networks learning exchanges at the community level can self-sustain as new members become involved.
In each of these categories, trust relationships are the foundation of community development and social change. This is in line with Toyama’s view (2010) that “technology—no matter how well designed—is only a magnifier of human intent and capacity.”

The network weaving approach that we are hereby proposing is the distillation of many years of experience in communities and implementation of a value system (Holley, 2013). Holley’s work provides practical advice and clear guidelines on how to operationalize the practices at the micro and macro levels, including how to recognize, support, and deploy networks into a project. Also, this approach fits in with the way that people are used to develop and assist each other in informal and formal ways, especially within the kinds of resource-constraint contexts where ICT4D operates.

4. APPLICATIONS IN CONTEXT

This section addresses how aspects of network weaving have already been applied in the ICT4D sector. Two examples are provided to show benefits and challenges of the approach as connected to Holley’s work.

4.1. Rural entrepreneurs in Southern Africa

Twenty years of experience of the challenges in ICT4D and “technology for development” implementations in Southern Africa is distilled in a paper by Van Rensburg, du Buisson, Cronje, et. al. (2014). Their challenge is achieving a direct linkage between ICT4D application and adoption to the process of scalable socio-economic development, which are elements that directly connect to sustainability and resilience. The largest resource for local development remains the local, regional (provincial), and the national government. The autonomous nature of these three spheres of government is highly dependent on excellent collaboration, which is problematic. This leads to a top-down development approach, where the richest consultations are at local government level, as mandated by law. In reaction to the lack of real collaboration between community and government, the authors create a development perspective that is founded in participatory processes during which both the individual and communal asset-base is improved, while making it part of a bottom-up process of developing a shared vision. This is integral to this value system. The major shift in focus of rural enterprise and economic development (REED), when compared to ICT4D, is the focus on people-centred network development. This focus is rooted in a rethinking of African development with a respect for the traditional African context and culture and the “African communal relationships of mutual responsibility that was once finely tuned to respond to the needs of the African community, climate and its environment” (Sparks 1990 as cited in Van Rensburg, et. al., 2014, p.2). The respect for African value systems is clear.

The people-centred network development corresponds to the intentional kind of network described in network weaving (see Fig. 1), in which people have a shared focus, or vision, and the basis is relationship-based, such as established communal relationships and the development of new relationship networks. Infopreneur® networks, as discussed below, correspond to the action-oriented kind of network that enables self-organizing. The support and accountability systems that complete the four inter-locking and complementary networks described by Holley are used as a value within the African communal relationships of mutual responsibility. These relationships are currently mostly augmented by the more formal structures, processes and relationships of development practitioners that have relationships with communities, governments and funding sources.

Infopreneur® networks play a more specific role than the other types of actors described previously, namely: intermediaries, infomediaries, or social connectors. Their focus is to improve the reach and nature of the extension services as normally delivered by government departments, in order to “support new scalable and sustainable micro-enterprises within the local contexts (ibid, p.1).” They interact directly with the community via “knowledge economy services” to foster the five main community assets: “human, physical, financial, natural and social.” (ibid.).
A typical example is the development of a geo-located database of small businesses for a municipality that needs to know the businesses that are to be served by their Local Economic Development (LED) plan executed by their LED office. This plan gets funding via the Provincial government, which requires good data to inform plans, budgets and to execute monitoring and evaluation. Rural (agricultural) schools are also brought into the network to assist in the revitalisation of neglected irrigation schemes and small-holder agricultural activities (ibid.). And interesting point for our study is that Infopreneur® networks are seen as “a network of change agents which are micro enterprises within their communal contexts” (ibid., p.5). Hence, a “micro-franchise or micro-license” model was developed so that everyone could run their own businesses while aligning to the Infopreneur® network goals. Therefore, the basic approach is “development through enterprise” (ibid.), in which participants contribute to the network and also benefit from their membership. It. This is a large element in the REED values system.

The Infopreneur® networks can be mapped to the four different roles of Network Weavers (Holley, 2013). For example, via the building of community assets, the network combines elements of the Connector Catalyst role, by growing social assets, and the Self-organized Project Coordinator role, by coordinating the knowledge economy services. These two roles are mostly at the micro-level scale of communities in fostering networks and coordinating project level actions.

The Infopreneur® networks are supported by a Regional Infopreneur®, a business minded person with good networking and change management skills, who plays a vital role to connect and create bridges between communities’ agendas, Infopreneurs®, and researchers (Van Rensburg, et. al., 2014). The Regional Infopreneur® is connected to a formal organisation providing the support systems for these networks and helping Infopreneurs® to build their own network to be more explicit and focused.

The Regional Infopreneur® provides mentoring and support to the Infopreneurs® and assists them to internalise the values of the network via the use of change management tools and processes. The value of being part of a mutually supportive network is vital in the REED values system. The change in ingrained mindsets (with the associated value systems) regarding community development is the biggest challenge they face, as they run against competing interests. For example, local officials are driven by quick turnarounds of outputs, to avoid having their yearly budgets cut by Provincial and National Treasury. This leads to quick-win projects with rapid delivery of tangible outputs, which are prone to corruption and against the principles of collaboration (versus competition) and the time required when building support networks (Marais, 2016).

This brief summary shows how the REED approach, with its focus on mapping Small, Medium and Micro Enterprise development and networks, does share commonalities with network weaving and its focus on community change, value systems and sustainable development.

In the next section we discuss the discovery of local support networks in an ICT for Education project.

4.2. Education in rural South Africa

SA has one of the most unequal school systems in the world with the widest gap between the test scores of the top 20% of schools and the rest (Amnesty International, 2020). The Council of Science and Industrial Research (CSIR) in Pretoria, SA, executed a three-year project from the Department of Rural Development and Land Reform (DRDLR) for implementing the DRDLR ICT for Education Project (ICT4E) (Herselman, Botha, Dlamini, et al., 2019). Teachers at 24 schools in seven of the nine provinces in SA were trained over a period of a year and a half to integrate mobile technology to support their teaching and learning. The aim was to integrate mobile technology into schools in order to facilitate improvement in the quality of teaching and learning. Thus, the scope of the project included a focus on providing Teacher Professional Development through accredited training materials (Botha & Herselman, 2018).
The focus of the project was resource-constrained rural schools characterized by lack of internet, remote geographical locations, unreliable electricity, low digital literacy and limited local funding sources, e.g., parents. (Botha and Herselman, 2016). During a project training session, the attendees were asked to tell us who are the types of people in their town that assists them with problems regarding devices, e.g., cell-phone, tablet or computer, or services such as emailing, internet searches and photocopying. The results are presented in Figure 3.

![Figure 3. The different types of relationships of school teachers at an ICT4E school (Marais, 2019).](image)

As the legend of the relationship map done in https://kumu.io shows, the four teachers of a school are represented in red circles. Businesses are shown in light blue, children in yellow, friends in green, family members in brown, and colleagues in orange. Technical support service relationships for devices are shown green and service relationships in grey. Two of the teachers had nine relationships, two teachers had eight and the remaining teacher had six relationships. Relationships with their school were not counted.

In Lerato’s case, her nine relationships consisted of one relationship with a business, one with a Technical and Vocational Education and Training (TVET) college, two with teacher colleagues, two with her children, and three with friends. The direction of the arrows indicate that she provided support services in seven relationships: a relationship with one of her teacher colleagues, her children, three friends and the TVET college. In turn, she received support from another teacher colleague and a business.

The map indicates to teachers that they have many existing support relationships, including important peer-to-peer relationships. This value of helping each other is a key element for sustainability. Four technical support sources exist of which two are businesses and two were friends. Technical support services are thus balanced between businesses and social relationships with friends. Three of the teachers had technical support from a shared friend, which indicates the
many shared relationships. This can be seen as the initial phase of network weaving where local champions are identified.

4.3. Discussion and Way Forward

In this paper, we presented a brief reflection on sustainability and resilience frameworks and discussion in ICT4D scholarship. Among others, we emphasized the value of approaches that focus on social capital and the way in which differing value systems are engaged with. We introduce network weaving as a possible fruitful addition to our scholarship’s current efforts focusing on a strong value system of each person being a leader.

In our analysis, we show the characteristics of network weaving that makes it not only suitable for the field, but also a valuable addition to the frameworks that currently inform ICT4D’s best practices. A network approach is participatory, co-creative, and empowering; it focuses on awareness raising, distributed leadership, and transparency. These characteristics speak to bringing change within and beyond single projects, by addressing the power structures that often prevent change from happening, as theorized by Green (2016) and the underlying value systems emphasised in this work.

Furthermore, network weaving is transformational. It is not focused on individual successes and heroic efforts, but on the possibility for everyone to be a leader responsible for the change they want to see. This resonates with ICT4D’s aspirations to find more collective-oriented frameworks, especially when working in the Global South, as well as to the need to highlight the work that women often perform in these contexts (Sweeney and Rhinesmith, 2017). Also, a focus on networks underlines the importance of social capital, values, and relationships in ICT4D.

We argue that a focus on enabling and weaving networks should be included as an integral part of ICT4D thinking and as a component of ICT4D’s projects. Building networks that can operate to build resources and capabilities, that can lobby for change, where people trust each other, are supported, and that can be sustained in the long-term will initially require intentional project design from day one.

We invite the broader ICT4D community to join us in representing ourselves as a network in ourselves, which may be used to add value to the attractiveness of the domain, by illustrating the diversity of the research agendas, disciplines and existing partnerships. In this kind of multidisciplinary research domain, it is difficult for newcomers, students, and local partners to get a grasp of what the reach and scope of this domain entails, and network relationship mapping will enable us to ease the introduction of new entrants and for existing members to develop new partnership opportunities. In addition, researchers have referred to the “significant amount of reinvention of the wheel in ICT4D” (Zheng, Hatakka, Sahay, et al., 2018, p.9) that may be reduced, as new entrants to the field tend to neglect earlier research since technologies change rapidly. We are convinced that the spirit of network weaving and the value base of a distributed leadership can enhance our relationships and transform our values, often still focused on individualistic Western perspectives, into more collective-oriented perspectives reflecting the diversity of challenges in our increasingly complex world.

While we believe network thinking and its underlying value systems provide a valuable addition to existing ICT4D’s scholarship, we are aware of the limitations of our work and of the need to further explore and validate this approach. We have based our analysis on an exploration of past work in the field, where different characteristics of network weaving have emerged, but were not necessarily applied systematically. At the same time, we are aware that network weaving was first created within a Western context and, although it was developed and applied exactly to empower resource-constrained communities and redistribute power, communities in the Global South might receive it differently. We encourage more collective research to embrace this approach and document it in ICT4D, both in Global North and Global South contexts.
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TOWARDS AN INTEGRATED KNOWLEDGE MANAGEMENT AND INFORMATION AND COMMUNICATION TECHNOLOGY FRAMEWORK FOR IMPROVING DISASTER RESPONSE IN A DEVELOPING COUNTRY CONTEXT

Teurai Matekenya, Cape Peninsula University of Technology and University of Zimbabwe, teuraimtkn@gmail.com
Ephias Ruhode, Cape Peninsula University of Technology, RuhodeE@cput.ac.za

Abstract: This paper is part of an ongoing project that seeks to address a gap in disaster information coordination and collaboration in Zimbabwe. There is lack of coordinated information and knowledge in natural disaster and emergency situations in Zimbabwe. This results in weak collaboration links among the various organizations that respond to emergencies, leading to slow decision making processes and long response times. This negatively affects the affected communities, exacerbating poverty in Zimbabwe. This has been evidenced in the recent catastrophic cyclone Idai where many people were left dead, infrastructure destroyed and some people marooned. To address this, the research seeks to develop an integrated Knowledge Management and ICT framework that aid in coordination and collaboration among the various crisis responders. This will be achieved through a case study approach using Zimbabwe’s Civil Protection Unit. PAR within DSRM will be used to gather data from CPU as well as with NGO respondents, traditional leaders and disaster response experts. Findings will be compared and contrasted with secondary data gathered in literature, this, with collected data will be used in developing a home grown coordination and collaboration solution. Qualitative approach to data collection will be adopted using interviews, visioning workshops and document analysis.

Keywords: Knowledge; Knowledge Management; Knowledge Management Framework; Information Communication Technology; Disaster; Disaster Response; Crisis Response, Emergency Response, Coordination; Collaboration; Design Science Research; Participatory Action Research.

1. INTRODUCTION

Each year the world is struck by natural disasters which threaten human security and welfare (Oktari et al., 2020). Responding to such crisis involves a high demand for a critical mass of individuals and organisations who have different stakes in disaster recovery programs (LESLP, 2015). For effective disaster response, it is important that there be effective coordination and collaboration amongst these responders (Bjerge et al., 2016). This allows disaster responders to quickly and effectively respond to disaster, ultimately maximizing a nation’s response capacity (Usada, 2017). However, coordination and inter-organisational collaboration in a disaster is complex (Kapucu, 2010) and responding effectively to disaster is a big challenge to most nations (Wang, 2013). According to Bjerge et al., (2016), a barrier to organized information sharing in disaster management is the availability of vast amounts of information which is sometimes not the relevant information that the stakeholder requires at that time. Bjerge et al., (2016) observed a gap in information coordination and sharing among responders which usually leads to overlapping initiatives, extensive resource mismanagement which ultimately leads to loss of lives and livelihoods (Provitolo, 2012). Alexander (2020) called for an urgent need for close coordination and collaboration among crises responders
as crises such as the Corona virus, has pushed for effective information sharing within and across jurisdictional borders.

This paper is scoped empirically to examine the case of Zimbabwe, which has suffered natural disasters in recent years. In 2000, alongside Mozambique and South Africa, Zimbabwe was hit by Cyclone Eline. Reports indicated that 90 people died and over 250,000 marooned and approximately US$7.5 million in economic losses were experienced in Zimbabwe (Shumba, 2000). In March 2019, Zimbabwe, Mozambique and Malawi were hit by Cyclone Idai, which was characterised by heavy rains, mudslides and flooding. Cyclone Idai left hundreds of people dead, thousands marooned and infrastructure destroyed, with hundreds unaccounted for. The cyclone also left the governments overwhelmed with little resources to respond to the crisis. The Zimbabwean government activated its crisis coordinating organ, The Civil Protection Unit (CPU), to coordinate the emergency response. Unfortunately, CPU was incapacitated to coordinate such a catastrophic cyclone. A major challenge identified in Cyclone Idai was access to information to define the type of assistance required. A number of individuals, humanitarian actors, organisations that entered the affected provinces could not get timely information from CPU to assist them respond effectively to the emergency. It is therefore apparent that there is a lack of coordinated information and knowledge in natural disaster and emergency situations in Zimbabwe. This results in weak collaboration links among the various organizations that respond to emergencies, leading to slow decision making processes and long response times. This negatively affects the affected communities, exacerbating poverty in the country.

Under the above background, this paper seeks to answer the following question: What are the key elements of a KM and ICT Framework that improves coordination and collaboration among emergency responders to natural disasters in Zimbabwe?

The paper is structured as follows: the next section is a review of literature and theoretical framework. The section that follows presents the methodology which involves data collection methods and techniques and the DSR used to design the rudimentary framework. The section that follows presents the expected outcome followed by a section on implications to theory and practice and lastly a summary.

2. LITERATURE REVIEW

2.1 Natural Disaster Management

Natural disasters destroy the people’s common forms of survival such as health, food security, education as well as other related humanity aspects. No one organization, can succeed in Disaster Management (Singh, 2006). There is need for a number of organisations with different roles and expertise who partner and collaborate. The 1999 Odisha Cyclone in India resulted in increased Government-NGO collaboration (Singh, 2006) through regular coordination meetings, combined knowledge sharing, planning and vision construction (Ababe et al., 2008).

2.2 ICTs for Disaster Management

ICTs play a very pivotal role in information coordination and collaboration in all stages of the disaster management (Xue, 2017; Raymond et al., 2015). Despite their significant role, ICTs in disaster response has the following drawbacks among others: the disaster can result in power failure, hampering the use of ICT tools hence service delivery and communication systems can be oversubscribed resulting in communication difficulties. According to Comfort et al., (2004) there is need for creation of a flexible information infrastructure that manages the dynamic information exchange among the various emergency responders. For this system to be effective, it must ensure that relevant information gets to the right party timeously and in the right format to support prompt

It is argued in this paper, that both KM and ICTs have the potential to provide for reliable interconnectedness of various organisations which are responsible for disaster response. KM focuses on systematic approach for searching and using knowledge with the overall aim of value making (Mráček & Mucha, 2015). Seneviratne et al., (2012) describe KM within the DM context as focusing on availing the correct knowledge to the right people in the exact place at the correct time.

2.3 Theoretical Framework

This paper recognizes the existence of many KM frameworks in literature. According to Holsapple and Joshi (1999), prominent frameworks include:

- Framework of Knowledge Management Pillars;
- Framework of Core Capabilities and Knowledge Building;
- Model of Organizational Knowledge Management;
- Framework of the Knowledge Organization; and
- Framework of Knowledge Management Stages

While the rest of the frameworks focus on KM in one organisation, it is worthwhile to emphasise that the ICT/KM framework to be developed in this study can be expanded to conceptualise KM not just in one organisation. Thus it seeks to aid coordination and collaboration among disparate emergency responders and not just one organisation. In this paper, the Framework of KM Pillars shall be coalesced with the coordination theory (Malone, 1990) as shown in the next two subsections.

2.3.1 Framework of Knowledge Management Pillars

Stankosky et al., (2003) developed the Four Pillars of KM framework that organisations intending to embark on KM initiatives should consider for effective management of knowledge. The four pillars are Leadership, Organisation, Technology and Learning (Figure 1). The Leadership pillar focuses on strategically aligning KM initiatives with business objectives. The Organisation pillar focuses on redesigning and aligning of processes and procedures. The Technology pillar focuses on setting up an enabling technological infrastructure to support the KM initiative. The Learning pillar focuses on ways in which the organization creates a learning community (Stankosky et al., 2003).
2.3.2 Coordination Theory

Coordination is the act of working together harmoniously (Malone and Crowston, 1990). There is little known or coherent theory of coordination in the Information System domain. There are however numerous disjointed theories from various disciplines such as sociology, organizational theory, social psychology and many other disciplines. In all these various fields, there appears a common problem of coordination regardless of discipline which centers around how resources can be allocated effectively among different actors. Of importance to this study is “how information can be shared effectively with the different actors”. According to Malone (1990), there are some processes underlying coordination (Table 1).

Table 1: Processes underlying coordination (Malone, 1990)

<table>
<thead>
<tr>
<th>Process Level</th>
<th>Components</th>
<th>Examples of generic process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination</td>
<td>Goals, activities, actors, resources,</td>
<td>Identifying goals, ordering activities, assigning activities to</td>
</tr>
<tr>
<td></td>
<td>interdependencies</td>
<td>actors, allocating resources, synchronizing activities</td>
</tr>
<tr>
<td>Group decision</td>
<td>Goals, actors, alternatives, evaluations</td>
<td>Proposing alternatives, evaluating alternatives, making choices,</td>
</tr>
<tr>
<td>making</td>
<td>choices</td>
<td>(e.g., by authority, voting or consensus)</td>
</tr>
<tr>
<td>Communication</td>
<td>Senders, receivers, messages, languages</td>
<td>Establishing common language, selecting receiver (routings),</td>
</tr>
<tr>
<td></td>
<td></td>
<td>transporting message (delivering)</td>
</tr>
<tr>
<td>Perception of</td>
<td>Actors, objects</td>
<td>Seeing same physical object, accessing shared databases.</td>
</tr>
<tr>
<td>common object</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

In the context of Zimbabwe, Table 2 shows the activities in the processes of disaster coordination as they relate to the Framework of Four Pillars of KM.

Table 2: Coordination Theory Processes in the Four Pillars of Knowledge Management Leadership

<table>
<thead>
<tr>
<th>Process Level</th>
<th>Leadership</th>
<th>Organizational</th>
<th>Technology</th>
<th>Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordination</td>
<td>Disaster coordination goals, disaster responders involved. Establish and implement KM strategy.</td>
<td>Structures that manage actor interdependence. Operational processes aligned to the KM strategy.</td>
<td>For creation, capturing, storing, searching, retrieving, sending only relevant information to</td>
<td>Increased internal and external communication, reports, developing institutional memory, lessons learnt database, promoting cross-functional teams, creating a learning community, Interagency discussions</td>
</tr>
<tr>
<td></td>
<td>Nourish the climate and culture for KM strategy implementation</td>
<td>Redesigning the organization introducing change managers’ KM champions on the organizational</td>
<td>each responder, sharing fostering collaboration among responders, recommending solutions.</td>
<td></td>
</tr>
<tr>
<td>Group decision</td>
<td>Mapping goals to activities, deciding on who does what, to whom and when. KM strategy formulation and Advocacy for humanitarian principles.</td>
<td>Reporting structure, nature and frequency of meetings, Compliance measures/codes of conduct, member</td>
<td>Decision Support Systems, collaborative technologies, mobile communication applications, e.g.</td>
<td></td>
</tr>
<tr>
<td>making</td>
<td></td>
<td>complaints mechanism</td>
<td>WhatsApp, Slack</td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td>Negotiating access to affected populations. Communication to the media.</td>
<td>Mechanisms for collecting data from disaster population and for passing information to the various</td>
<td>Knowledge Dashboard, E-Mail, Business Intelligence, Analytical Processing.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>responders</td>
<td>Through Virtual Teams, sharing results, exchange forums.</td>
<td></td>
</tr>
<tr>
<td>Perception of</td>
<td>Shared database for situational updates, collate needs assessments</td>
<td>Shared database for disaster information</td>
<td>Training of members/interagency through a standardized training curricula.</td>
<td></td>
</tr>
<tr>
<td>common object</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
CPU leadership should identify the disaster coordination goals, the disaster response actors, create a group of disaster response leadership with representative from NGOs or cluster leaders who will be involved in group decisions such as goal decomposition-who does what, to whom and where. This group should agree on the communication and KM strategy. Leadership should cultivate a culture of disaster information sharing so that responders have a common perception of the disaster situation.

**Organisation**

To support the leadership pillar, a number of organisational changes should be effected and managed. CPU’s organisational structure, operational processes, staff, skills, systems should support the various disaster responders in accessing the right information at the right time in the right format. This should include setting up structures to manage actor interdependence, upgrade personnel skills to manage disaster information and knowledge, a KM champion on the organogram to drive the disaster KM initiative. Some group decisions should be made such as deciding and agreeing on the governance mechanism, reporting structure, frequency of meetings etc.

**Technology**

While organisational and cultural changes as highlighted in Pillars above are vital, a lack of a proper technology infrastructure leads to failure of KM initiative hence ineffective disaster coordination. There is need for IT tools that capture data, store, search and retrieve, send the relevant data to the various responders in a format appropriate to the responder, share the information and foster collaboration amongst the various responders, solve and provide recommendations to the responders for prompt decision making. The group should agree on the kind of tools and mechanism appropriate for effective collaboration.

**Learning**

For effective use of the technologies and implementation of the agreed KM strategy, CPU should create a conducive environment for learning. Organisational learning, using approaches such as promoting cross functional teams, building institutional memory, lessons learnt, group discussions, experience sharing as well as training should be adopted. The group should agree on the learning approach.

3. METHODOLOGY

A case study approach using Zimbabwe’s disaster coordinating agency-(CPU) will be adopted as it helps in acquiring in-depth understanding of how CPU carries out the coordinating role. Cohen et al., (2007) argues that case studies provide distinctive examples of genuine people in real situations. Design Science Research (DSR) will be most appropriate in this study as it is a practical research method that produces a technology based solution. According to Baskerville et al (2015), one mandate of DSR is to produce practical solutions to teething problems by bringing change through improving existing systems. According to Peffers et al (2007), DSR includes the following six steps: 1. Problem identification; 2. Defining the research objectives; 3. Designing and developing the artefacts; 4. Demonstrating; 5. evaluating the solution by matching the objectives and the observed results from the use of the artefacts and 6. Communicating the problem, the artefact, its usefulness and effectiveness to other practitioners and researchers.

3.1 Data collection Methods and techniques

In order to answer the main research question, two sub questions will be asked. These are “What are the current coordination and collaboration practices employed by CPU? and “What are the
emergency responders’ service expectations from CPU? PAR will be used within the DSRM to get an understanding of Zimbabwe’s CPU. Futures visioning workshopping shall be the dominant method for data collection. Visioning is a participatory approach that brings a group of stakeholders together and supports them in developing a shared vision of the future. To answer the three questions, data collection will be done in stages as follows:

**Stage 1: Current realities assessment**

This involves collecting data from CPU through interviews with Key Informants (KI), document analysis and extensive literature search to understand how other countries are coordinating emergency response. The aim of this stage will be to better understand CPU’s current coordination mechanism. Specific information to be collected include CPU’s vision, workflow, current technologies and others as shown in Table 3 below. This will be the first step towards PAR, involving Ministry KI in defining the problem so as to solve it (Avison et al., 2001). Findings from this will be used to feed into stage 2.

**Stage 2: Future’s visioning**

Data will be collected through a future’s visioning workshop that will be attended by respondents from NGO and CPU. Respondents will highlight aspects of the past and present they think are the most important elements to include in a future vision of CPU. The purpose of this exercise will be to identify what CPU’s stakeholders consider as important for effective coordination and collaboration. The goal of this phase will be to arrive at a vision that reflects the thinking of diverse stakeholders and not majority opinion.

**Stage 3: Identifying mechanisms to support the envisioned future**

Participants will form into new smaller groups and members will be asked to brainstorm the changes that should take place at CPU in order to ensure effective coordination and collaboration. The facilitator will introduce the 7s Mckinsey, a model for organisational effectiveness to assist the participants in coming up with changes/adjustments that should support the envisioned future. The model postulates that there are seven factors that need to be in alignment for an organisation to be successful. The identified changes will be used to develop the integrated ICT/KM Framework.

**3.2 Data analysis**

Data collected from the three stages will be collated and analysed thematically and manually. Thematic analysis identifies, analyses and reports themes/patterns within data (Braun & Clarke, 2006). The four pillars of KM coalesced with the coordination theory (Leadership, Organisation, Technology and Learning) will form the themes. This will be used in the development of the integrated KM and ICT framework that will ensure effective coordination and collaboration among the emergency responders. Table 3 shows a summary of data collection and analysis.
3.3 Framework development and validation

Based on the extensive literature search and data collected, the key elements to the framework will be identified. The proposed framework will be validated by demonstrating its viability and suitability to the identified problem through a two-day workshop. The workshop participants will include those that would have been engaged in problem awareness stage of the DSR approach. The participants will discuss the applicability of the tools, techniques and procedures proposed in the framework and evaluate the extent to which the framework addresses the problem.

4. EXPECTED OUTCOME: DISASTER RESPONSE FRAMEWORK (DRF)

The DSR iterative process will lead to a participatory design outcome, which is the disaster response framework (DRF) which will be informed by ICT and KM concepts. The envisaged DRF will be guided by the four pillars of KM which in this research, have been adapted and applied to the disaster response empirical context (Figure 2).

Table 3: Data collection and analysis summary

<table>
<thead>
<tr>
<th>Research question to be answered</th>
<th>Method for data collection</th>
<th>Information to be collected</th>
<th>Data analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>What are the current coordination mechanisms and collaboration practices employed by CPU?</td>
<td>Key informant interviews with CPU representatives</td>
<td>Coordinating agency’s vision, workflow, its challenges in coordinating emergency response, current technologies facilitating coordination and collaboration, the strength, weaknesses, opportunities and threats as well as agency’s needs. Technical questions - current system architecture, type of data being collected, volumes of data and how they are being used in the current collected data.</td>
<td>Data collected will be analysed thematically according to the four pillars of KM.</td>
</tr>
<tr>
<td>What are the emergency responders’ service expectations from CPU?</td>
<td>Through a future’s visioning workshop</td>
<td>Aspects of the past and present respondents think are most important to include in a future vision of the coordinating organ.</td>
<td>Data will be analysed by the whole group as the workshop goes and the researcher will group the findings according to the four pillars of KM.</td>
</tr>
<tr>
<td>What are the key elements of a KM and ICT Framework that improves coordination and collaboration among emergency responders to natural disaster in Zimbabwe?</td>
<td>Through the future’s visioning workshop 7c McKinsey model to assist the participants in coming up with changes/adjustments that should support the envisioned future</td>
<td>Changes that should take place at CPU in order to get to the future. This will be grouped according to the four pillars of KM (Leadership, Organisation, Technology and Learning)</td>
<td>Data collected from the three stages at each of the cases will be collated and analysed thematically and manually according to the four pillars.</td>
</tr>
</tbody>
</table>
5. IMPLICATIONS TO THEORY AND PRACTICE

*Theoretically:* Findings from the empirical study will be used to extend and complements earlier theories by providing a novel Zimbabwean country perspective on disaster coordination and collaboration.

*Practically:* An implementable integrated KM and ICT framework for improving coordination and collaboration will be developed.

*Methodologically:* This research uses a combination of DSR, PAR, collaboration theory and Framework of KM Pillars in exploring the current coordination and collaboration problems at CPU and in devising the solution. This is the first research in developing country context that has used these methodologies specifically in improving emergency response.

6. SUMMARY

The paper has presented part of an ongoing project that seeks to address a gap in disaster information coordination and collaboration in Zimbabwe. Literature has revealed that ICTs and KM has the potential of addressing the gap hence the review of theories on KM and coordination which will be coalesced to develop the DRF. The paper proposes the use of PAR’s visioning workshopping within the DSRM in coming up with the envisioned DRF.
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**DIGITAL RESILIENCE TO COVID-19: A MODEL FOR NATIONAL DIGITAL HEALTH SYSTEMS TO BOUNCE FORWARD FROM THE SHOCK OF A GLOBAL PANDEMIC**

Scott Russpatrick, University of Oslo, scottmr@ifi.uio.no

Johan Sæbø, University of Oslo, johansa@ifi.uio.no

Eric Monteiro, NTNU, eric.monteiro@ntnu.no

Brian Nicholson, University of Manchester, brian.nicholson@manchester.ac.uk

Terje Sanner, University of Oslo, terjeasa@ifi.uio.no

**Abstract:** COVID-19 represented a major shock to global health systems, not the least to resource-challenged regions in the Global South. We report on a case of digital, information system resilience in the response to data needs from the COVID-19 pandemic in two countries in the Global South. In contrast to dominant perspectives where digital resilience enables bounce back or maintenance of a status quo, we identify five bounce forward resilience preconditions (i) distributed training, (ii) local expertise (iii) local autonomy and ownership (iv) local infrastructure and (v) platform design infrastructure. These preconditions enable an elevated degree of resilience that in the face of an external shock such as COVID-19 can deliver a bounce forward or strengthening of the information system beyond its pre-shock state.

**Keywords:** COVID-19, Resilience, Bounce forward, ICT4D, Information Systems, Models, Adapt, Change.

1. **INTRODUCTION**

COVID-19 is an exogenous shock disrupting health care systems, business, economies, societies across the entire world [1]. The United Nations defines an exogenous shock as an “unexpected or unpredictable events that occur outside an industry or country but can have a dramatic effect on the performance or markets within an industry or country.” [2]. Minimizing the population impact and maximizing vaccine update of COVID-19 is dependent on national disease surveillance systems [3]. Considering the increased focus and dependency on disease surveillance information systems, there is a need to further understand their digital resilience [4]. A helpful starting point is Heeks and Ospina’s definition of digital resilience in the context of ICT4D as “the ability of a system to withstand, recover from, and adapt to short-term shocks and longer-term change” [5].

The development agenda, however, calls for information systems to grow and strengthen rather maintain a static state [5]. Marais points out that there is a real concern that resilience of information systems could equate to a stagnation or an approach toward preservation of the status quo [6]. Observed from the prior shocks Ebola and the great East Japan earthquake of 2011, Sakuai and Chughtai state that, “a recovery as returning to the pre-disaster state was not enough; resilience requires going beyond rebound, and must encourage adapting to the existing crisis and then transforming.” [7]. Therefore, models and drivers of resilience that results in change needs to be
explored. Here we refer to the phenomenon of an information system strengthening, improving, or developing in response to an exogenous shock as a “bounce forward”. In essence it is a progression past the pre-shock state to a stronger, more developed, and/or scaled state [5].

We examine the use of the free and open source District Health Information System 2 (DHIS2) platform for COVID-19 surveillance. Some 67 mainly low- and middle-income countries have adopted DHIS2 as their central digital platform for their health system [8]. Within the comprehensive DHIS2 ecosystem, we selectively zoom in on the efforts of two countries’ Covid 19 responses, viz. Sri Lanka and Sierra Leone. These two countries are sampled for their ability to respond to the pandemic beyond mere “recovering”.

In this research we propose the following research question: What are the enabling preconditions of a resilient information system to experience a bounce-forward when confronted with an exogenous shock?

The paper is organised as follows. First, we define our grounded methodology of data coding, identification of the preconditions, and model development. Next, we present a detailed description of each case-study. From there, we present our findings of the preconditions and bounce forward resilience models, and finally we provide a brief discussion and reflection on these findings.

2. CONCEPTUALIZING DIGITAL RESILIENCE

This paper views digital resilience through ICT4D perspective, where the long-term notion about resilience is change or adaptation rather than solely the short-term notion which is more simply stability in the face of a change or shock [9, 10]. Through the ICT4D perspective we, view resilience as system properties [5, 11]. Many have introduced the concept of system properties that equate towards resilience al be it by different names; system attributes, qualitative, sub properties, and characteristics [5, 11, 12, 13, 14]. Each of these studies and others introduce resilience attributes which some redundancy but little consolidation [5, 11, 15, 16].

Taking all existing IS literature on resilience into account and drawing from the broader disciplines of ecology, engineering, and psychology, Heeks and Ospina introduce foundational resilience attributes that enable an information system to be able to bounce back or return unaffected by a shock. These are:

- Robustness - “Ability of the system to maintain its characteristics and performance in the face of contextual shocks and fluctuations.”
- Self-organization - “Ability of the system to independently rearrange its functions and processes in the face of an external disturbance, without being forced by the influence of other external drivers.”
- Learning - “Capacity of the system to generate feedback with which to gain or create knowledge and strengthen skills and capacities necessary to experiment and innovate.”

Heeks and Ospina also define attributes that enable these foundational attributes as, redundancy, rapidity, scale, diversity and flexibility, and equality [5].

However, again drawing on an ICT4D perspective and acknowledged by Heeks and Ospina, there is an added need for an understanding of resilience as longer-term change or adaption [5, 7]. To that point, only a handful of model of IS resilience exist, none of which incorporate change or adaption / “bounce forward” [5, 11, 16]. Some argue, that the perspective for additional resilience model
creation and theory refinements should best be derived from rich interpretative, empirical investigations which there is a paucity of in the existing IS or ICT4D literature [5, 7, 13]. Schryen argues that analysis of rich empirics should be the primary vehicle that IS researcher use to decipher the complexity and dependencies inherent in such a model [17].

Therefore, this paper responds to three gaps in the IS resilience literature. First, we identify specific system properties, that we refer to as preconditions, that enable a bounce forward of the information system. Secondly, we then present a new theoretical resilience model that illustrates the complexities and the dependencies of the information system to be able to bounce forward from an exogenous shock such as COVID-19. Finally, we supply a rich empirical investigation of two longitudinal case-studies in two countries developing and implementing COVID-19 surveillance information systems [4, 5, 7, 17]

3. METHODS AND CASE CONTEXT

The context of this study is the ongoing implementation and use of DHIS2. DHIS2 is a free and open source District Health Information System 2 (DHIS2) platform serving 67 low- and middle-income countries in the Global South. DHIS2 has a core database, a suite of generic applications that cover data entry, analysis, and system administration, and an application programming interface (API) which are developed and maintained by the Health Information System Project (HISP) headquartered at the University of Oslo. Beyond the core is a continuously increasing number of third-party developed applications that are developed with little or no involvement from the core development team in Oslo. These periphery, generic applications are by nature more reusable across countries and contexts and increase the value of the platform as a whole to all users [18]. Our research design is informed by theoretically sampling of two out of 67 countries in the DHIS2 ecosystem that demonstrates vividly the preconditions and strategies of digital resilience beyond “bouncing back”.

The methods use grounded theory as it allows for natural theory evolution during the research process [19]. Specifically, a grounded theory based methodology enables the researcher to deductively process the interviews, observations, and other data into categories, or distinct units of meaning, which can then evolve into inductive a-priori theory generation that is grounded in empirical observation [20, 21].

For our data we conducted two longitudinal, interpretive case studies [22]. We followed from their beginning the implementation of DHIS2 for COVID-19 monitoring in Sri Lanka and Sierra Leone. Data was collected through four key informant interviews, text analysis from four publicly available case descriptions, presentations of the use-cases during six webinars, and direct observations from communication and activities between the implementation teams in the country and the implementation support staff based at UiO. Direct observations took place between February 2020 and March 2021. Data from direct observation was gathered from 13 meetings between the UiO COVID-19 implementation team and Sri Lanka and 4 between Sierra Leone and the UiO team. The goal of these meetings were to get an update on the progress of the implementation, identify issues, provide technical guidance, and capture any software issues. Running, detailed notes from these meeting were kept for each case-study. These notes include direct quotes from both UiO and country implementers, status of each implementation at the time of the meeting, future plans, any encountered issues, points of success, etc. Key informants were identified through the communication between UiO implementation support staff and the implementation teams in the country. The first round of semi-structured, key informant interviews was in early October 2020,
one informant from both cases. Those key informants were asked who else they recommended be interviewed which led to another round of key informant interviews in late October again with one interview from each case. Each interview was 1-1.5 hours long and transcribed.

We then applied a four-step grounded, interactive process to derive five pre-conditions that resulted in resilience attributes that enabled the information systems to improve or bounce forward from exposure to the shock of COVID-19. First, the data was tabulated into chronological order so that it could be coherently analysed. For example, observation notes were broken into the case study timeline so that quotes from the interviews, webinars, and text from use-case descriptions could be placed into the same chronology to build a coherent sequence of key events. Second, we applied line-by-line open coding to our data to group them into distinct, labelled concepts [23]. Next, we employed axial coding to cluster the concepts to derive the preconditions which were iteratively refined until they offered sufficient explanatory power over the observed phenomenon [20, 21, 24].

Finally, we used selective coding as a reductive approach of refining a theory by identifying ‘core’ categories which our identified concepts and precondition can be coded against. Selective coding further refines the categories and lays a foundation that additional theory can be built upon [20, 21].

We used the Heeks and Ospina foundational resilience attributes, as previously defined, as our core categories to which we coded concepts and the preconditions [5]. Note that we did not code against the Heeks and Ospina enabling conditions as we pursued to identify novel drives of the bounce forward phenomenon in accordance with our research question. Through selective coding we reductively organized our identified categories into the corresponding resilience attributes. From there, we were able to trace our preconditions to the resilience attributes (figure 2). This approach allowed us to recognize the complex interplay between the pre-conditions, the resilience attributes, the COVID-19 shock, and the observed bounce-forward outcomes thus leading us to a model of bounce-forward information system resilience.

4. CASE DESCRIPTION

4.1. Sierra Leone

While Sierra Leone has used DHIS2 since 2008, the use of the software for disease surveillance is relatively recent, following the West African ebola virus outbreak. The electronic Case Base Disease Surveillance (eCBS) was set up for both weekly reporting of aggregate cases for 26 diseases, and for handling individual cases for 20-22 of these (malaria for instance would be too many cases to make sense to have case-based). A prominent group of diseases is Acute Respiratory Infections (ARI), which typically give symptoms similar to flu, and includes diseases like SARS and MERS. Patients with acute respiratory syndromes (ARS) will be registered as unconfirmed ARS until a lab confirmation. All these diseases have a quite standardized set of information collected for standardized stages, including lab request, lab result, and split stages depending on the disease. Given the similarity of ARIs, it was a relatively easy task to adjust it to have the additional needed variables for Covid-19. In early February 2020 it took just a couple of days for the lead system architect to set up case-based disease surveillance for COVID-19. The relative knowledge deficiency in the early period of the disease meant that some of the variables were never used, like “have you been to the animal market lately”. There have subsequently been minor changes to the variables collected.

The usage of the existing case-based surveillance system was not a given in the early period of the pandemic. A different government directorate was pushing for new technologies and apps. The high level of uncertainty, an international sense of panic, and the strong influence of external actors such
as aid agencies, many of whom are supporting their own technologies, also contribute to an environment where new technologies can be seen as more favourable. However, the past experience of the Ebola outbreak was decisive in uniting key actors to build on their current system.

“One key experience from the ebola epidemic 2014-15 remains in force: Strengthen existing systems during an outbreak!”

“the last thing you do in a crisis situation is start from scratch” [...]”what was lucky for us, the eCBS had already been institutionalized. If we hadn't been there, there would have been a free-for-all situation", an app for this, an app for that”

Once established as the primary COVID-19 reporting system and quickly configured, the eCBS was able to scale rapidly to the whole country.

“But the benefit is now that we were only active in four out of 16 districts in January before COVID, February when we started COVID we rolled that rapidly to all districts and now we were then following up with all the other diseases, et cetera, to those districts. So again, we can benefit from all the work that has been done.”

Prior to COVID-19 pandemic the eCBS was operating in only four districts, but with the rapid need for COVID-19 surveillance the scale of the system was fast tracked and rapidly scaled to all 16 districts in the country.

“And as I said, that the benefit here is that all the efforts being put into COVID-19 and setting up the systems and contact tracing, and all of that it's very easy to expand it to the other diseases. You basically almost get that for free. The training now is about is very much anything, pick the detail for each disease exactly, what they data you're capturing, how do you handle each disease, et cetera.” [...] “We didn't have capacity to obviously train everybody at the same time, but it was over two or three months.”

By rapidly scaling the eCBS driven by the need for COVID-19 surveillance, disease surveillance for all diseases correspondingly scaled to the whole country. The focus became training, which was done incrementally using a training-of-trainers model from February through May. First district health medical technicians were trained then the district staff trained the facility staff. The training includes data capture and surveillance for all diseases, not just COVID-19. In Sierra Leone COVID-19 acted as a catalyst for galvanization around an existing disease surveillance system, rapid configuration of that system to accommodate COVID-19, and the rapid scale of the system expanding all disease surveillance to the whole country. Additionally, a virtual training was provided by external DHIS2 administration experts in March 2020 to the core DHIS2 country administration team on DHIS2 design, management, and database scripting.

The utility of the expanded eCBS has already been tested with a localized outbreak of Ebola in the border regions with Guinea in mid-late February 2021. While the data is very fresh, indications are that the eCBS is performing nominally in this area of concern and providing near real-time information on the current evolving situation.

4.2. Sri Lanka

DHIS2 was first introduced in Sri Lanka in 2011 by a group of enthusiastic master’s students in the Biomedical Informatics program at the University of Colombo. The first implementations were small for local NGOs, but over time these grew into national program systems owned by the Ministry of Health (MoH). In 2017, in response to the need for more DHIS2 support for the various MoH
programs, HISP Sri Lanka was established as a company specializing in supporting DHIS2 implementations throughout the country.

On the 20th of January 2020 top digital health doctors in the MoH met to discuss the need to collect data on and screen travellers arriving to Sri Lanka from areas with a high prevalence of COVID-19. The first case of COVID-19 was reported in Sri Lanka on 27 January 2020. Within two days of that, a DHIS2 implementation group that supports the MoH, HISP Sri Lanka, had developed a new DHIS2 instance to register all travellers arriving into the country through airports.

“So the major concern was to get this tourist register, then now, then to have follow them up at the level. Because we were kind of very competent in DHIS2, so we could quickly set up something in two to three days time.”

The epidemiology unit within the MoH as well as the Director of Health Information Unit urged the Director General of Health Services to swiftly approve the system. With the approval, infrastructure, government database cloud hosting, and hardware were rapidly identified through the government ICT Department. The ICT Department was already experienced hosting DHIS2 instances due to the many that are already deployed in the country. Initially a small team of three DHIS2 experts at HISP Sri Lanka were able to do the inceptive configuration of the information system, but more human resources were needed to implement it in the quarantine centres and ports of entry. This was addressed by drawing on the large, distributed pool of medical doctors what had completed a government sponsored master’s in information systems at the University of Colombo. In 2009 the University of Colombo launched a master’s in information systems program to train Medical doctors to be Medical Officers in Health Informatics in the Ministry of Health. Over the last decade, this program has produced a large cadre of medical professions that are able to support the digitization and implementation of information systems.

“So with regard to human resources, we needed people to implement and train the end users. So for that one, we had around another like six other doctors who are already there in the Ministry of Health, some of them who are based in different districts. [...] So of course, the public health staff who at field level, they were kind of familiar with the DHIS2, so training them was kind of not that difficult. But the point of entry staff who were at the airport and the quarantined unit of Ministry of Health, they did not know DHIS2, they had not used DHIS2 before. So for them, the training was like it was a bit time consuming. But that part was mainly taken care of these five or six doctors who were attached to Ministry of Health.”

By early February the port-of-entry travel screen system was fully implemented at all airports in Sri Lanka. However, it quickly became apparent that to be able to follow-up with travellers and their contacts throughout the country's existing health infrastructure was required. This necessitated a broader active COVID-19 surveillance system that could record all cases and their contacts across the entire country. Again, HISP Sri Lanka was called on to develop this system.

“So but what happens is this process things (defining and developing a new system) takes longer time. And this is the usual scenario. But when it comes to COVID, we had to be a child, because now people were also panicking, say, for example, they had their deliverables, like people wanted data, and they wanted some visualizations. And when we try to go for a compromise, this was sometimes not possible (for COVID-19).”

HISP Sri Lanka reached out to the core DHIS2 development leads to enquire if their COVID-19 surveillance requirements were possible within the existing feature sets in DHIS2, which they were not. Specifically, Sri Lanka needed to be able to transfer patients between and from site to site and visualize the index and contact cases in a network graph. HISP Sri Lanka, utilizing DHIS2’s open source components and API, decided to build new applications to satisfy these requirements.
Russpatrick et al.  

Bounce Forward Digital Resilience Model

time HISP Sri Lanka did not have the necessary developers internally, so they communicated with the ICT Department which were able to lend a few developers. However, this was still not sufficient to be able to build the applications quickly as was required, so the ICT Department director posted an open invitation for volunteer developers via Twitter and organized a hackathon. Within twenty-four hours twenty-five additional developers were identified. Most of these developers were ethnically Sri Lankan, but they were distributed globally. UiO also made available a lead core developer to assist in the utilization of core components and resources. Starting with a hackathon on March 14-15, in the course of two weeks a new port-of-entry and contact tracing data capture application, a COVID-19 case relationships analytics application, and integration with the Sri Lankan immigration system were developed by this pool of volunteer developers, ICT department developers, HISP Sri Lanka implementation manager, and a UiO core developer working collaboratively.

Prior to COVID-19 Sri Lanka has developed siloed disease or program specific information system. Most of these utilize DHIS2, but there is not a single DHIS2 instance that integrates data across all programs.

“ [...] because of the way we could interact with the stakeholders, and we showed that integrations are possible, we recently received a call from the ministry to have a discussion about setting up a central HMIS so that that is going to be on DHIS2. So we will have a one HMIS with all the dashboards. What we talk about in most of the countries, now, we are seeing that becoming a reality, mainly due to what has happened during the COVID-19 times. So there are good mostly good aspects of whatever we did during that time, which has helped us.”

The unilateral focus to implement the COVID-19 surveillance system also spurred deeper connections and collaborations between departments. Prior to the COVID-19 response the Ministry of Health did not have proper access to the ICT Department due to some internal resistance and politics. The ICT Department provides ICT services for all other departments except for the Ministry of Health. During the COVID-19 response the Ministry of Health needed to cooperate with the ICT Department for cloud hosting the scaling COVID-19 surveillance system as well as assistance with developing of the new applications.

“And now, they're (Ministry of Health) also getting more inputs from the ICT agency about the systems that they're implementing. So that way, the collaborations that really took place during the COVID-19 has actually contributed positively and they are still ongoing.”

Sri Lanka was the first country to develop such an extensive surveillance system including new data capture and analytics tools specifically designed for COVID-19. They felt the need to provide this back to the global community of DHIS2 implementers and countries.

“Yeah, that is because this was the major opportunity we got to share back because we have been using whatever developed by other HISPs so for example, this data importer, the tracker data importer from Uganda, it's app that we have been using more frequently and also this HISP Tanzania DHIS2 touch application. Initially, the Android capture was not supporting aggregate data and we use the touch application developed by HISP Tanzania.”

HISP Sri Lanka also felt compelled to share the meta-data configuration of their COVID-19 surveillance system.

“So we felt I come in rather than people trying to do something, I mean, in reinventing the wheel, we can just share it. So it is an opportunity for us to share back to the community. And it's good for them to waste time on doing it over and over again. Now you can they can just use what they have developed. So I think that was the reason why we felt like sharing.”

HISP Sri Lanka’s meta-data configuration for port-of-entry screening was shared with the UiO which then shared it immediately through webinars, the DHIS2 website, and the DHIS2 community of practice with dozens of other countries. This happened in late January almost a full month before
the initial WHO interim technical guidelines were published on 28 February 2020. Sri Lanka’s port-of-entry meta-data configuration became the initial point of reference for fifty-five countries using DHIS2 for COVID-19 Surveillance as of December 2020.

On January 28, 2021 Sri Lanka launched a further expansion of their COVID-19 surveillance system to track the entire Sri Lankan population through vaccination. This further expansion includes an electronic immunization registry, vaccine stock monitoring, dashboards, and custom features for vaccination certificates.

5. **ANALYSING DIGITAL RESILIENCE: PRECONDITIONS FOR BOUNCE FORWARD**

In our analysis we identified five preconditions that establish a foundation for a state of resilience that produces an improvement or bounce forward of the information system as opposed that is necessary for a return to a status quo in the event of an exogenous shock like COVID-19. We use the term preconditions instead of following the Heeks and Ospina approach of identifying “enabling attributes” because we feel it more accurately and practically describe our findings in that these conditions have long been pre-established in the country with intention from both the country and the platform owner (UiO). Conditionality also denotes a level of dependency that we also observed between the resilience attributes and the preconditions.

<table>
<thead>
<tr>
<th>Preconditions</th>
<th>Sri Lanka</th>
<th>Sierra Leone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Expertise</td>
<td>• Existing ICT department with the ability to host the DHIS2 instance.</td>
<td>• Existing eCBS servers running.</td>
</tr>
<tr>
<td></td>
<td>• HISP Sri Lanka and Medical informatics doctors available to respond.</td>
<td>• Existing DHIS2 technical experts in place from Ebola response</td>
</tr>
<tr>
<td></td>
<td>• Database configured and new apps developed rapidly</td>
<td>• COVID-19 added to existing eCBS with minimal effort</td>
</tr>
<tr>
<td>Platform configurability</td>
<td>• HISP Sri Lanka and Medical informatics doctors available to respond.</td>
<td>• COVID-19 added to existing eCBS with minimal effort</td>
</tr>
<tr>
<td></td>
<td>• Database configured and new apps developed rapidly</td>
<td>• External DHIS2 technical and disease surveillance experts able to consult on</td>
</tr>
<tr>
<td></td>
<td>• Hackaton and use of core DHIS2 developers at UiO</td>
<td>configuration and scaling of eCBS</td>
</tr>
<tr>
<td>Local platform infrastructure</td>
<td>• Existing ICT department with the ability to host the DHIS2 instance.</td>
<td>• Existing eCBS surveys running.</td>
</tr>
<tr>
<td></td>
<td>• ICT Department able to work with MoH for first time</td>
<td>• Previous experience from the Ebola response to galvanize actors around</td>
</tr>
<tr>
<td></td>
<td>• Key decision makers across multiple departments meeting quickly to approve the system</td>
<td>system</td>
</tr>
<tr>
<td></td>
<td>• Already institutionalized eCBS</td>
<td>• Already institutionalized eCBS</td>
</tr>
<tr>
<td>Local autonomy and ownership</td>
<td>• Database configured and new apps developed rapidly</td>
<td>• COVID-19 added to existing eCBS with minimal effort</td>
</tr>
</tbody>
</table>
Key decision makers across multiple departments meeting quickly to approve the system

Need for rapid establishment of port-of-entry screening

Already institutionalized eCBS

Build on existing system instead of establishing new

Distributed Training

Distributed informatics doctors able to quickly train users

Clinical staff in the field already familiar with DHIS2

ToT model from district level to facility

Facility and district medical staff already trained on DHIS2

<table>
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<th>Distributed Training</th>
<th>Distributed informatics doctors able to quickly train users</th>
<th>ToT model from district level to facility</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Clinical staff in the field already familiar with DHIS2</td>
<td>Facility and district medical staff already trained on DHIS2</td>
</tr>
</tbody>
</table>

Table 1: Data Table

Local expertise’s are held by several individuals in the country on adapting and configuring DHIS2 to multiple use-cases or requirements. They are incredibly proficient with all DHIS2 functionality, data models, and components. These individuals are then able to quickly translate disparate requirements from the field into the DHIS2 data model and suite of features and applications. In the case of Sierra Leone, we saw a small group of system architects able to quickly adapt the existing disease surveillance system to also cover COVID-19, and likewise in the case of Sri Lanka, we saw another small team of DHIS2 expert implementers able to quickly capture field requirements and configure a DHIS2 instance that was able to rapidly deploy for port-of-entry screening and patient tracking.

Platform configurability was observed to have key three aspects. The first two are that the DHIS2 platform is open source and application based. These two facts, working in concert, showed that new features and functionalities can be rapidly developed by local teams to address urgent situations that are not adequately covered by the generic applications developed by the UiO. We see in the case of Sri Lanka that by holding a hack-a-thon they were able to develop new applications that were necessary for COVID-19 surveillance. As was the case in Sierra Leone where the system administrators were able to expand and adapt existing applications to also cover COVID-19 case registration without the need for complex programming or application development.

Local platform infrastructure was observed to be critical. The governments of both case studies were not dependent on licenses, third-party hardware or software vendors, or international platform providers for system hosting or support. The countries have complete access and ownership of their server infrastructure and all the features and functionalities of their DHIS2 instances. This degree of country ownership allowed local DHIS2 system administrators to quickly make changes, update versions, and deploy new features/apps to their DHIS2 instances.

Local autonomy is regarding the management and implementation of the information without global support or dependencies on resources outside of the country. This country level ownership means that in our case studies the countries were able to manage and implement the information system as necessary and rapidly as required. They were able to directly respond to the swiftly evolving situation on the ground without immediate concern for additional global resources or oversight. In both cases there was a strong sense of ownership of the system, a mentality of self-reliance and pride.

Distributed Training was a key precondition in each case-study. The development, implementation and scale of their respective COVID-19 information systems was undoubtedly hastened by the countries having already trained DHIS2 end-user capacity at each level. The long-term investments
that the countries had placed in training up cadres of technical experts resulted in a pool of distributed health officers in both countries that could rapidly utilize the new COVID-19 tools and requirements. It also meant that they were quickly able to cascade training down to less proficient users at the lowest levels (facilities, testing centres, quarantine centres, or ports-of-entry).

The final output of our analysis is the development of a dynamic bounce-forward resilience model that illustrates how these identified pre-conditions can lay a foundation for resilience attributes that when exposed to an exogenous shock can result in a bounce forward. Our model (figure 2) shows

Figure 1: Data coding to preconditions.

The final output of our analysis is the development of a dynamic bounce-forward resilience model that illustrates how these identified pre-conditions can lay a foundation for resilience attributes that when exposed to an exogenous shock can result in a bounce forward. Our model (figure 2) shows
that there is a complex and interconnected relationship between the preconditions and the resilience attributes. In our data analysis we were not able to reduce a few-to-one or one-to-one relationship between the preconditions and the resilience attributes. We found that multiple preconditions may feed into a single resilience attribute and, while each precondition is unique in its properties, the effects generated by some can easily be seen to touch multiple. However, there are three dependencies that we did appreciate.

Figure 2: Bounce-forward Resilience Model

Bounce forward outcomes were observed in both case-studies, and indeed the goal of this research is to identify new resilience models that incorporate identified causal preconditions to this outcome. In the case of Sierra Leone, the utility of this is already being put to the test with an emerging Ebola outbreak, and in the case of Sri Lanka, it is being further expanded to cover COVID-19 vaccinations. In both cases we observed a swift galvanizing around pre-existing solutions and technologies.

6. IMPLICATIONS AND CONCLUSION

In this research we employ the Heeks and Ospina foundational resilience attributes as a framing for a new, dynamic model that illustrates concrete, operationalizable preconditions. These preconditions form the foundation of a potential for the information system to adapt and bounce forward from a crisis. Heeks and Ospina’s own data showed that operationalization of the attributes and markers skewed more toward a bounce-back or a return to normalcy from a crisis. Our research answers the call for the identification of real system properties that enable a long-term change and adaptations. It partially fills the gap in the ICT4D literature for a resilience perspective that is transformative and dynamic [5].
Our model shows that a state of resilience that can harness a crisis for growth is complex with many preconditions and dependencies. It is not so easily distilled down to a few mechanisms, and indeed upon additional observation additional attributes and preconditions would probably be identified. We attempted to focus our preconditions on elements that the country had control over, but certainly looking more broadly it can be appreciated that some preconditions may not be in the country's control.

In our findings, resilience is inherent in the broader system through the defined preconditions. In a time of stability this equates to the ability of the information system to handle day-to-day changes. In the event of an exogenous shock, the ensuing crisis in our cases was not so much the classical shocks of a pandemic, e.g. lack of human resources, overwhelmed health services, economic hardship, unpreparedness, etc. The shocks in our cases to the information system were the need for rapid adaptation, rapid scale, increased investment, intense focus, and the need for innovation. The resultant bounce forward outcomes of these cases point to the fact that, while in a time of stability the countries were at a steady state of resilience, in actuality the countries in time of stress were operating at a higher level of resilience that enabled the bounce-forward outcomes observed. We denote bounce-forward resilience as being distinct in terms of its pre-conditions and outcomes in the event of an exogenous shock like COVID-19. Bounce-forward resilient information systems can propel beyond their pre-shock state, develop, and expand in the event of an external shock as opposed to a resilient information system which would maintain or return to a status quo, seemingly unaffected by the shock.

A major limitation of this research is that this model has not yet been able to be applied to other case-study to test its generalizability. Further research must be conducted to address this gap.

CITATIONS

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A CLIMATE CHANGE VULNERABILITY ASSESSMENT FRAMEWORK: A SPATIAL APPROACH

Claudia Cáceres, Claremont Graduate University, Claremont, USA, claudia.caceres@cgu.edu
Yan Li, Claremont Graduate University, Claremont, USA
Brian Hilton, Claremont Graduate University, Claremont, USA

Abstract: Climate change is affecting every known society, especially for small farmers in Low-Income Countries because they depend heavily on rain, seasonality patterns, and known temperature ranges. To build climate change resilient communities among rural farmers, the first step is to understand the impact of climate change on the population. This paper proposes a Climate Change Vulnerability Assessment Framework (CCVAF) to assess climate change vulnerabilities among rural farmers. The CCVAF framework uses information and communication technology (ICT) to assess climate change vulnerabilities among rural farmers by integrating both community level and individual household level indicators. The CCVAF was instantiated into a GIS-based web application named THRIVE for different decision-makers to better assess how climate change is affecting rural farmers in Western Honduras. Qualitative evaluation of the THRIVE showed that it is an innovative and useful tool. The CCVAF contributes to not only the knowledge base of the climate change vulnerability assessment but also the design science literature by providing guidelines to design a class of climate change vulnerability assessment solutions.

Keywords: climate change vulnerability assessment, exposure, sensitivity, adaptive capacity, resilience, GIS

1. INTRODUCTION

According to the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report (AR5), climate change has a clear human influence with the highest anthropogenic greenhouse gas emissions (GHG) in history, diminishing snow levels and ice caps, rising sea levels, and warming atmosphere and oceans. Disadvantaged people, such as rural poor and smallholder producers in developing countries, are at a higher risk of climate change as the changes in climate patterns will impact crop yields and undermine food security, especially among subsistence farmers who generally produce low yields and are least able to cope with their effects (Altieri et al., 2015; Antle, 1995; FAO, 2017; IPCC, 2014; P. Jones & Thornton, 2003; Kang et al., 2009; Misra, 2014; Schmidhuber & Tubiello, 2007; UN, 2018; World Bank, 2013). Thus, they are a priority in climate change adaption plans (Holland et al., 2017; Morton, 2007).

Climate change adaptation focuses on strengthening resilience and reducing vulnerability (FAO, 2018). It should involve the local communities, civil society, international organizations, governments at the local, regional and national levels (Neil Adger et al., 2005). They need to assess these populations’ adaptive capacity and identify vulnerabilities (Bouroncle et al., 2017). Information is often limited due to the difficulty of obtaining data about these vulnerable populations, and their expected shocks and stresses, particularly those faced by marginal communities of small farmers in low-income countries (LICs). To help build climate change resilient communities among rural farmers, the first step is to understand the impact of climate change on the population, its land, and its agricultural practices. This research aims to use information, communication, and technology...
(ICT) to assess climate change vulnerabilities among rural farmers. To achieve this overall objective, this research seeks to answer two research questions:

1. What determinants and indicators are needed to assess climate change vulnerability?
2. How can these indicators be measured and integrated to assess climate change vulnerabilities among rural farmers?

The rest of the paper is organized as follows. Section 2 presents the literature review, followed by the research methodology in Section 3. Section 4 describes the CCVAF, and Section 5 presents a Geographic Information Systems (GIS)-based web application that instantiates the framework using a case study in Western Honduras. Section 6 evaluates the CCVAF framework, and its instantiation, and Section 7 concludes the paper.

2. LITERATURE REVIEW

The concept of Resilience has seen an evolution within the climate change and development community as the “capacity for adaptation, learning, and transformation” (L. Jones et al., 2019a). Resilience is how a system can absorb risk and react to hazard through time. Adaptive capacity is the adaptability of a system to reduce its vulnerability (IPCC & Edenhofer, 2014; McCarthy & IPCC, 2001). Adaptive capacity needs the evaluation and measure of different characteristics inherent in its system to identify possible solution paths and tools to mitigate and cope with risk. The adaptive capacity has been viewed as a part of a wider resilient model (L. Jones et al., 2019a). The three ways to build resiliency in communities are: a) reduce exposure, b) reduce sensitivity, and c) increase adaptive capacity (Meybeck et al., 2012).

Vulnerability describes the analysis to measure powerlessness, marginality, and how susceptible a group or individual can be to a harmful situation being caused by multiple stressors and pathways (Adger, 2006). It has become a central concept to climate change research as its effects are being widely observed and the development of vulnerability assessments are being used to raise awareness, develop policies, and monitor adaptation measures (GIZ, 2013, 2014; Hinkel, 2011). If one intends to create a vulnerability assessment (to encourage a change in a community or inform policymakers), one must determine the methodology to measure vulnerability. Empirical studies show the use of a variation of the basic formula to measure vulnerability: “Vulnerability = Risk + Response” or “Vulnerability= Baseline + Hazard + Response” (Moret, 2014).

Different approaches can be used to build vulnerability assessments as the three ontological approaches identified by (Below et al., 2012a): theory-driven, data-driven, and combination of empirical and theoretical. The theory-driven approach uses a literature review to select the variables being measured, but this approach provides a level of uncertainty as to whether the chosen variables can measure vulnerability. The data-driven approach selects the variables being measured through expert opinion or the correlation of past events, but this approach does not assess the variables through a benchmark but limits itself to expert opinion. The third approach is a response to the weaknesses of the other approaches. Two specific examples are the Livelihood Vulnerability Index proposed by (Hahn et al., 2009) and the Vulnerability assessment using an Indicator approach proposed by (Below et al., 2012b; Gbetibouo et al., 2010). The indicator approach uses specific indicators or a combination of them to measure vulnerability to compute indices or weighted averages (Gbetibouo et al., 2010). To the best of our knowledge, there is no vulnerability assessment approach towards climate change.

3. METHODOLOGY

To answer the research questions, this research targets the designing and development of a framework to integrate vulnerability indicators and their measure to assess climate change vulnerabilities among rural farmers. Thus, this research undertakes a design science research paradigm (Hevner et al., 2004; Hevner & Chatterjee, 2010), as it designs and implements innovative and useful artifacts to solve real-world problems.
The first artifact is a Climate Change Vulnerability Assessment Framework (CCVAF) using ICT, specifically GIS-based remote sensing. The design of CCVAF includes the understanding of the problem and then acquiring knowledge from the environment within its design to solve it. Thus, it is important to interact with the people and organizations where the CCVAF will be implemented (Hevner et al., 2004). Thus, the researchers maintained a close interaction for several months with the THRIVE (Transforming Household Resilience in Vulnerable Environments) team from World Vision (WV), a global humanitarian organization. Such a close interaction allowed the researchers to better understand the practitioners’ needs and processes on the vulnerability assessment based on the data collected. Their feedback was essential in the iterative development of the CCVAF.

As an abstract framework, its validation needs to be tested through its implementation (Hevner & Chatterjee, 2010; Nunamaker Jr. et al., 1990). To instantiate the proposed CCVAF, a web-based application named THRIVE was developed for the THRIVE team, focusing on Western Honduras, the Departments (i.e., regional governments) of Intibucá, Lempira, Ocotepeque, Copan, and Santa Barbara with a total area of 17,303.13 km² and 114 municipalities. Honduras, a small low-middle-income country with more than 60.9% of its population living in poverty and one out of five Hondurans from rural communities living in extreme poverty (i.e., less than US$2.00 per day)(Ben-Davies et al., 2014; World Bank, 2018).

Artifact evaluation is an important step to demonstrate its utility. THRIVE was evaluated through a qualitative approach to understanding its usefulness and ease of use. The qualitative method used semi-structured interviews as data collection methods and was conducted through Zoom and Teams.

### 4. FRAMEWORK

The Climate Change Vulnerability Assessment Framework (CCVAF) is shown in Figure 1. It includes four steps: 1) identify vulnerability indicators using a hierarchical approach, 2) Identify data sources and collection, including GIS-based remote sensing; 3) measure the vulnerability indicators through GIS-based data analysis and modeling approach, and 4) create an overall index for areas of interests and visualize the results.

![Figure 1: CCVAF and its detailed steps](image-url)
indicators were adapted from the research of (Banu et al., 2011; Below et al., 2012b; Caceres, 2011; Gbetibouo et al., 2010; Hahn et al., 2009; Hirschi et al., 2011; Jaiswal et al., 2002; Shah et al., 2013), including the methodology used by UNDP to measure Unsatisfied Basic Needs as developed in CEPAL & PNUD (1988b). Depending on the area of the study, the practitioners and researchers may only select a subset of these indicators that are relevant to their study objectives. For example, in the THRIVE app, indicators related to the economic capacity, financial and market access from the adaptive capacity determinant were not included due to the COVID-19 travel restrictions.

The second step focuses on how to collect and process data in a format for analysis and modeling. As shown in Table 2, many measurements for adaptive capacity are straightforward to process, while these related to the exposure and sensitivity rely heavily on GIS and remote sensing data that requires an additional process. These data have been extensively used to perform complex spatial analysis to mitigate climate change impacts, such as identifying fire risk zones (Jaiswal et al., 2002), measuring environmental degradation (Hassan et al., 2015), estimating crop productivity (Tan & Shibasaki, 2003), and developing climate adaptation model tools (Kunapo et al., 2016). The data pre-processing process may include enrichment, reprojection, and cleaning, and may require different tools such as Microsoft Excel, Power BI, and ArcGIS Pro.

The third step starts with the creation of a database to store geospatial data or geodatabase. It may include data selection, filtering, querying, creation, and export to a different format. For raster data, it may be necessary to create a mosaic for image classification. Raster data need to be converted to vector and vector data may need to be converted to raster for analysis. Tools for data analysis may include ESRI ModelBuilder, a visual programming language inside ArcGIS Pro to build geoprocessing workflows (ESRI, 2020). Short Arcade or Python scripts may also be used to perform calculations.

The last step follows the guidelines presented by (USAID (2), 2014) as best practices in the composite indices. The creation of the index includes three steps. First, based on the indicators for each subcomponent, an overall index for each subcomponent is calculated. The overall index uses:

\[ \text{Index} = \sum W_iX_i + \ldots + W_nX_n \]

where \( W_i \) = weight factor and \( X_i \) = indicator.

The second step will determine the weight for each component, and then calculate the overall index for each component using normalized subcomponent values. Finally, an overall index to calculate vulnerability using:

\[ VI = W_{si}I_{sl} + \ldots + W_{sn}I_{sn} \]

where \( W \) can be defined by the users based on their specific decision context.

We illustrate the development of the Fire Risk Index and the Vulnerability Index using the Western Honduras data. A Fire Risk Index integrates several variables: 1) topographic variables (slope, elevation, and aspect) 2) socioeconomic variables (settlements and roads), and 3) land cover. But through literature review and expert advice, it was determined some variables have a higher influence regarding fire risk. A schematic model was developed using the variables. The Fire Risk Index formula can be summarized as follows:

\[ \text{Fire Risk Index} = 1 + 75lc + 30sl + 10a + 5r + 5se + 2e \]
Where $lc$ is the Land Cover score, $sl$ is the Slope Layer score, $r$ is the proximity to Road score, $se$ is the proximity to settlements score, and $et$ is the elevation score.
## Table 1: Vulnerability Assessment Indicators, and related measurements and data source

<table>
<thead>
<tr>
<th>Vulnerability Determinant</th>
<th>Component</th>
<th>Sub-component</th>
<th>Indicator</th>
<th>Unit of Measurement</th>
<th>Data Source</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure</td>
<td>Extreme Climate Events</td>
<td>Droughts (Water Scarcity)</td>
<td>Frequency of Droughts</td>
<td>Number of Droughts</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Gbetibouo et al., 2010)</td>
</tr>
<tr>
<td></td>
<td>Flood</td>
<td>Frequency of Flood</td>
<td>Number of Floods</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Gbetibouo et al., 2010)</td>
<td></td>
</tr>
<tr>
<td>Change in Climate</td>
<td>Change in Temperature</td>
<td>Change in Temperature</td>
<td>Change in Temperature</td>
<td>Degrees Celsius Change</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Gbetibouo et al., 2010)</td>
</tr>
<tr>
<td></td>
<td>Change in Precipitation</td>
<td>Change in Precipitation</td>
<td>Change in Precipitation</td>
<td>mm Change</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Gbetibouo et al., 2010)</td>
</tr>
<tr>
<td>Forest Fires</td>
<td>Forest Fires</td>
<td>Forest Fire Risk</td>
<td>Area in Kilometers</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Caceres, 2011; Jaiswal et al., 2002)</td>
<td></td>
</tr>
<tr>
<td>Soil Moisture</td>
<td>Soil Moisture</td>
<td>Change in Soil Moisture</td>
<td>Area in Kilometers</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Hirschi et al., 2011; Kumar et al., 2018)</td>
<td></td>
</tr>
<tr>
<td>Soil Carbon</td>
<td>Soil Organic Carbon</td>
<td>Soil Organic Carbon</td>
<td>Area in Kilometers</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Angelopoulou et al., 2019; Bhunia et al., 2019; Wang et al., 2013)</td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Deforestation</td>
<td>Change in Land Cover</td>
<td>Change in Land Cover</td>
<td>Kilometers of Land Cover</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Lawrence &amp; Vandecar, 2015)</td>
</tr>
<tr>
<td>Land Degradation Index</td>
<td>Percentage of Land Degradation</td>
<td>Percentage of Area with High Land Degradation Index</td>
<td>No Units</td>
<td>GIS/Remote Sensing Analysis</td>
<td>(Gbetibouo et al., 2010)</td>
<td></td>
</tr>
<tr>
<td>% Irrigated Land</td>
<td>Percentage of Irrigated Land</td>
<td>Number of Farms with Irrigation Systems</td>
<td>Number of Farms</td>
<td>Does your farm have any type of irrigation system?</td>
<td>(Gbetibouo et al., 2010)</td>
<td></td>
</tr>
<tr>
<td>% Small-Scale Farming Operation</td>
<td>Percentage of Area with Higher Number of Small-Scale Farming Operations</td>
<td>Percentage</td>
<td>What is the area of your farm?</td>
<td>(Gbetibouo et al., 2010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crop Diversification Index</td>
<td>Number of Crop Types</td>
<td>Percentage</td>
<td>What are the crops on this farm?</td>
<td>(Gbetibouo et al., 2010)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptive Capacity</td>
<td>Socioeconomic</td>
<td>Economic Capacity</td>
<td>Number of Household Members</td>
<td>Number of Members</td>
<td>How many members live in this household?</td>
<td></td>
</tr>
<tr>
<td>-------------------</td>
<td>--------------</td>
<td>-------------------</td>
<td>-----------------------------</td>
<td>------------------</td>
<td>-----------------------------------------</td>
<td></td>
</tr>
<tr>
<td>Number of Households where the Primary Adult is Female</td>
<td>Number of Households with Female Head</td>
<td>Number of Members who are employed</td>
<td></td>
<td></td>
<td></td>
<td>(Below, 2012a)</td>
</tr>
<tr>
<td>Number of Years the Head of Household Attended less than 3 Years of School</td>
<td>Years</td>
<td>Did you go to school? If yes, what was the last grade you attended?</td>
<td></td>
<td></td>
<td></td>
<td>(Shah, 2013)</td>
</tr>
<tr>
<td>Number of Heads of Household whose age is under 18 and over 45</td>
<td>Years</td>
<td>What is the age of the head of household?</td>
<td></td>
<td></td>
<td></td>
<td>(CEPAL &amp; PNUD, 1988)</td>
</tr>
<tr>
<td>Number of Members in the Household who are Employed</td>
<td>Number of Members</td>
<td>How many members of the household are currently employed? What is the type of occupation?</td>
<td></td>
<td></td>
<td></td>
<td>(CEPAL &amp; PNUD, 1988; Islam &amp; Winkel, 2017)</td>
</tr>
<tr>
<td>Number of Members Working outside the Community</td>
<td>Number of Members</td>
<td>How many members worked outside the community?</td>
<td></td>
<td></td>
<td></td>
<td>(Hahn, 2009)</td>
</tr>
<tr>
<td>Number of Households Receiving Remittances on a Regular Basis</td>
<td>Number of Households</td>
<td>Do you regularly receive remittances?</td>
<td></td>
<td></td>
<td></td>
<td>(Mochizuki et al., 2014; Rajan &amp; Bhagat, 2017)</td>
</tr>
<tr>
<td>Dependency</td>
<td>Population under 14 and over 60 Years of Age</td>
<td>Ratio of Number of Members</td>
<td>How many members are under 14 and over 60?</td>
<td></td>
<td></td>
<td>(Below, 2012a; Hahn, 2009)</td>
</tr>
<tr>
<td>Population with Physical or Mental Disability</td>
<td>Ratio of Number of Members</td>
<td>Is there a member of the household with physical or mental illness or disability? If yes, how many?</td>
<td></td>
<td></td>
<td></td>
<td>(Shah, 2013)</td>
</tr>
<tr>
<td>Number of Households with Orphans</td>
<td>Number of Members</td>
<td>Are there any children over 18 from other families living in this house because on or both of their parents died or moved to another country?</td>
<td></td>
<td></td>
<td></td>
<td>(Hahn, 2009)</td>
</tr>
<tr>
<td>Access to Basic Sanitary Service</td>
<td>Availability</td>
<td>Source of Water</td>
<td>Kilometers</td>
<td>What is the household's source of water? a) well b) river c) public service d) bottled water truck</td>
<td></td>
<td>(Below, 2012a; CEPAL &amp; PNUD, 1988)</td>
</tr>
<tr>
<td>Distance to the Source of Water</td>
<td>Kilometers</td>
<td>How long do you walk to the source of water? A) 0 b) 0.5 km c) 1 km d) 1.5 km e) 2 km f) more than 2 km</td>
<td></td>
<td></td>
<td></td>
<td>(Below, 2012a; CEPAL &amp; PNUD, 1988)</td>
</tr>
<tr>
<td>Sewage Disposal System</td>
<td>Type of Sewage Disposal System</td>
<td>Type of Sewage</td>
<td></td>
<td></td>
<td></td>
<td>(CEPAL &amp; PNUD, 1988)</td>
</tr>
<tr>
<td>Financial Access</td>
<td>Access to Credit</td>
<td>Number of Households with Access to Credit</td>
<td>Number of Households</td>
<td>Do you have access to credit? When was the last time you received credit?</td>
<td>(Gbetibouo et al., 2010)</td>
<td></td>
</tr>
<tr>
<td>--------------------------</td>
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<td>--------------------------------------------</td>
<td>----------------------</td>
<td>---------------------------------------------------------------------------</td>
<td>--------------------------</td>
<td></td>
</tr>
<tr>
<td>Market Access &amp; Analysis</td>
<td>Distance to Markets</td>
<td>Distance to Nearest Market</td>
<td>Minutes</td>
<td>How far is the nearest market?</td>
<td>(Below et al., 2012a)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Quality of Road</td>
<td>Quality of Road</td>
<td>Paved or Unpaved</td>
<td>GIS Analysis</td>
<td>(Gbetibouo et al., 2010)</td>
<td></td>
</tr>
<tr>
<td>Health</td>
<td>Chronic Illness</td>
<td>Number of Household Members with a Chronic Illness</td>
<td>Number of Members</td>
<td>How many household members suffer from a chronic illness?</td>
<td>(Hahn et al., 2009)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access to Health Service</td>
<td>Number of Households with at least a Basic Health Center in a 5 km radius</td>
<td>Number of Households</td>
<td>GIS Analysis</td>
<td>(Hahn et al., 2009)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dengue, Zika, Chikungunya exposure</td>
<td>Number of Household with Bed Nets</td>
<td>Number of Households</td>
<td>Do you have bed nets?</td>
<td>(Hahn et al., 2009)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Areas with a High Number of Cases</td>
<td>Area Km²</td>
<td>GIS Analysis</td>
<td>(Hahn et al., 2009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of Members who Experienced Dengue or Similar Episode in the Last Month</td>
<td>Number of Members</td>
<td>How many of your household members suffered from Dengue, etc.?</td>
<td>(Hahn et al., 2009)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knowledge and Information</td>
<td>Access to Knowledge and Information</td>
<td>Number of Households with Access to Information and Knowledge</td>
<td>Number of Households</td>
<td>Do you have access to a reliable system for climate, weather, land or market information?</td>
<td>(L. Jones et al., 2019b; Sorre et al., 2017b)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of Local Organizations and Community Leaders with Access to Information and Knowledge</td>
<td>Number of Local Organizations and Community Leaders</td>
<td>Number of Local Organizations and Community Leaders</td>
<td>Do you have access to a reliable system for climate, weather, land, or market information?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. **THRIVE APP**

The THRIVE web-based app is a GIS-based visualization and knowledge platform (see Figure 2) that aims to support decision-makers, such as NGOs, local government, or policymakers in assessing climate change vulnerabilities among rural farming communities. It includes information on how Climate Change is affecting the region, including forest fire risk zones, deforestation, access to health, and vulnerable areas. It allows users to explore, visualize and export information using the different tools provided.

The app included three determinants to calculate the Vulnerability Index: Exposure, Sensitivity, and Adaptive Capacity. The Exposure tab includes an Introduction Story Map, Hotspot Dashboard, Fire Risk Zones Dashboard, and the Soil Moisture Dashboard. The Sensitivity tab includes an Introduction Story Map, the forest loss and gain dashboard, the forest cover change app, and the agriculture dashboard. The Adaptive Capacity tab includes the Introduction Story Map, the Access to Health dashboard, Access to Basic Housing, Access to Basic Sanitary Services dashboard, and the Dependency Dashboard. The app also includes a tab to visualize the Vulnerability of the area by Department, Municipality, and Village. Several dashboards also include web apps with tools allowing users to print, measure, draw and export the layer table. Every section includes an introduction section to help the user understand the methodology used in the analysis and every dashboard includes a How-To section to help the user navigate throughout the app. The web app was developed using ESRI ArcGIS Online especially Web App Builder and Operation Dashboard.

![Figure 2. Initial screens introducing the THRIVE web app.](image)

6. **EVALUATION**

As described earlier, semi-structured interviews were used to evaluate the THRIVE web app, focusing on its ease of use and usefulness. An initial interview was conducted with the WV Development Officer, followed by six additional interviews with professionals outside World Vision, one located in Honduras and the rest located in the US but able to speak and read Spanish.

All participants considered the web-based app as innovative and useful, as shown below:
Participant 1, professional outside World Vision:

“If I were a local government or authority in the region, I would see this tool as extremely useful to identify where the population is living, under what conditions, and providing useful insights for decision making.”

Participant 2, World Vision staff:

“This tool will be extremely useful, for example in a project design, very soon we will start the process for the 2021 – 2026 strategy planning, and I believe this tool will play an important role during this process. I see us using it for the climate change transverse axis in our projects, specifically with climate change adaptation processes.”

In general, most of the participants considered the tool was easy to use with some exceptions from professionals who mentioned they were initially not sure where to start or what to do.

Participant 1, Professional outside World Vision mentioned:

“Initially I was very confused, and I didn’t know what to do. But once I got into the guide, it was very easy to use.”

Participant 2, World Vision staff mentioned:

“Something I like about this tool, is that it is very easy to use. And if needed the help sections in the left panels provide additional support on how to use it.”

Participant 8, World Vision staff mentioned:

“I consider this tool very user-friendly.”

During the evaluation, one of the most common themes was the recommendations from the participants to edit or change sections from the app. All the recommendations provided were used to improve the app. For example, Participant 1, stated:

“I think it is a little bit disorganized, and if you could organize it better maybe using the determinants used for the analysis. I think the Census tab seems a little bit outside the topic and I think should not be the first tab maybe change its order.”

7. CONCLUSIONS

This study proposes a Climate Change Vulnerability Assessment Framework (CCVAF) to better evaluate the different indicators for vulnerability assessment. The framework not only allows the assessment of the overall climate change vulnerability but also the understanding of how different vulnerability indicators would impact the overall vulnerability to support decision making in building climate change resilient in communities. A GIS-based web application, named THRIVE, was implemented to instantiate CCVAF. Although the THRIVE app is built specifically for Western Honduras, its design is based on the CCVAF framework and can be easily extended to different areas around the world.

Further research is needed to examine the exposure and sensitivity determinants along with adaptive capacity. For the exposure, several components could be analyzed using extreme climate events, change in climate and soil carbon. For the sensitivity, future research could include the percentage of irrigated land, crop diversification, and land degradation. For adaptive capacity, future research could include measurements of economic capacity and access to basic sanitary service at a household level, financial access, market access, and improved health access. Additionally, a research plan would be developed to include the expansion of THRIVE app to other areas of Honduras and in the Central American region.
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Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021

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A Climate Change Vulnerability Assessment Framework


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ROLE OF INFORMATION AND ICTS AS DETERMINANTS OF FARMER’S ADAPTIVE CAPACITY TO CLIMATE RISK: AN EMPIRICAL STUDY FROM HARYANA, INDIA

Priya Chetri, School of Public Policy IIT Delhi, chetripriya94@gmail.com
Upasna Sharma, School of Public Policy IIT Delhi, upasna@iitd.ac.in
P. Vigneswara Ilavarasan, Department of Management Studies IIT Delhi, vignes@iitd.ac.in

Abstract: Using the primary data collected for 463 farmers in six districts of Haryana, India, the present study attempts to understand the constituents of farmer’s adaptive capacity at local level and how it can be enhanced. We use path analysis technique using the lavaan package in RStudio to empirically test the role of information. We find that information is a direct and significant contributor to enhancing farmers’ adaptive capacity. However, even with exponential growth in use of technology, particularly information and communication technologies (ICTs), small farmers still lack access to information which hinders their capacity to respond to weather and climate risks. Thus, understanding the mechanism that can facilitate exchange and use of information by the farming community more effectively is important. We take an ensemble view of ICTs operationalized using ICT ecosystem and find significant interlinkages between information, technology and the ICT ecosystem that facilitate learning and information exchange and therefore contribute to enhancing farmers’ adaptive capacity and building resilience to climate shocks. We find that ICT ecosystem does facilitate access to information and also mediate the effect of farmer’s capability and willingness to use ICTs for agricultural purposes. Development of sound ICT ecosystem is likely to help farmers to better respond to changing climate in the future.

Keywords: Information, ICTs, ICT ecosystem, Adaptive Capacity, Resilience.

1. INTRODUCTION

About one-third of global crop yield variability of major crops like rice, wheat, maize is explained by variation in climate (Ray et al., 2015). Agricultural economies like India are expected to be highly impacted due to the increased variability in extreme weather events (Hoegh-Guldberg et al., 2018). Being resilient to such shocks is imperative to moderate the impact of such variability. Farm level resilience can be understood as the ability of farms to adapt to climatic, social, and market risk (Meuwissen et al., 2019). Enhancing adaptive capacity of an exposed unit is an important strategy for building resilience. Resources such as natural resources, financial and economic resources, human resources, technology, and information are considered significant contributors to build adaptive capacity (Brooks & Adger, 2005; Dillow, 2008; Jones et al., 2010). However, in the short time-span it is very difficult to alter the endowment set of some of these resources to enhance adaptive capacity. With a given endowment of resources, adequate information on risks and vulnerabilities helps in identifying adaptation needs$^1$ and options$^2$.

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$^1$ Adaptation needs refer to circumstances requiring information, resources, and action to ensure safety of population and surety of assets in response to climate impacts. (IPCC AR5, pp. 839)

$^2$ Adaptation options are defined as the array of strategies and measures available and appropriate to address adaptation needs (IPCC AR5, pp. 840).
Access to information is an important determinant of farmer’s adaptation strategies to climate variability both as a response to short term shocks and long term response to climate stressors (Alemayehu & Bewket, 2017; Deressa et al., 2009). Yet small farmers have limited access to information (FAO, 2019). Traditional sources of information such as extension services have limited outreach whereas information from local input vendors face issues related to reliability. Though ICTs have much broader outreach and are cost effective in terms of information dissemination, anecdotal evidences suggest that they do not ensure access to information. On the face of it, information seems accessible. However, constraints like mismatch in timing of TV/radio broadcast and farmer’s working hour, not carrying phones in the field to avoid losing them while working hinder farmer’s access to relevant information.

Thus, it is not just access to an underlying set of technologies (ICTs for example) but also the techniques for dissemination and exchange of information which are important to ensure information access to farmers. Various studies have demonstrated that even when individual farmer does not have access to modern ICTs, being connected to a social network where such technologies are accessed fill this space. Nesheim et al. (2017) found that farmers had less interest in accessing agri-met information themselves as they already receive it through their social networks. This entails the importance of local groups, neighbours, friends, relatives in serving the information needs of farmers (Kalusopa, 2005).

It helps in understanding how social networks and institutions interact with technology to facilitate the coping and adaption strategies of farmers to deal with the weather-climate uncertainty. ICT ecosystem is one such set of formal and informal institutions and networks that may influence the access to and use of technologies for dissemination, exchange, and use of information. Through spill-over mechanism yielded through social interactions, peer-effects, externalities and other types of interferences (Vazquez-Bare, 2017), ICT ecosystem can endorse technology and information use among farmers.

If adaptive capacity is about responding to risk better, then ICT ecosystems are particularly important to be studied and examined in the scholarship of any adaptation intervention (e.g., IMD’s agri-met advisories which provides information to farmers to respond to risk better). In this study we attempt to explore and unpack the inter-relationship between information (climate information in particular), technology (ICTs in particular) and institutions (farmer’s ICT ecosystems) and the effect that these have on the farmer’s adaptive capacity to take adaptation action in response to climate risk. In the next section we discuss the relevant literature and the theoretical framework to conceptualize farmer’s adaptive capacity at a local scale. The third section presents the methodology adopted in collection of data and operationalization of the variables. Section 4 presents the main findings of the statistical analysis. In the last section we discuss the findings and implications for policy research.

2. BACKGROUND LITERATURE

We draw from two broad strands of literature; one is the adaptive capacity to climate risk literature and the second is information and communication technology for development (ICT4D) literature. We see that in both these areas, the role of social relations is understudied. We attempt to bridge this gap by empirically studying the linkages between the role of social relations and technology (ICTs) in enhancing farmer’s capacity to adapt and being more resilient to climate shocks.

Within the adaptation literature, the broader understanding of adaptation corresponds to adjustments made by the exposed units to moderate the impacts pertaining to climate variability (IPCC, 2014, pp.838; Brooks, 2003; Ospina and Heeks, 2010). For instance, crop diversification is an adaptation practice followed by farmers as it implies change in farm practices (Billah et al., 2015). However,
there is lack of agreement about the determinants of adaptive capacity across different scales viz. national, community, or household level (Jones et al., 2010).

Context specific nature of adaptation influenced by social, political, economic, and institutional factors, social identity, and power relations mediating the impact of climate hazards (Brooks and Adger, 2005) and nature of hazard itself (Brooks, 2003) which require building of specific adaptive capacity make direct measurement of adaptive capacity difficult (Brooks and Adger, 2005; Jones et al., 2010). Therefore, we take a more generic approach to understand adaptive capacity as a set of resources and system’s ability and willingness to deploy these resources for achieving adaptation (Brooks and Adger, 2005). Studies include resources like natural resources, (e.g., land, water, raw materials, and biodiversity), human resources (e.g., labour, skills, knowledge and expertise), financial and economic resources, technology, social capital (e.g., strong institutions, transparent decision-making systems, formal and informal networks), institutions and networks, and equity (Brooks and Adger, 2005; Jones et al., 2010; Dillow, 2008).

Nonetheless, it is argued that tangible resources and infrastructure as determinants of adaptive capacity are given more importance while discounting the role of subjective human factors (Brown & Westaway, 2011). Although role of personal factors like entrepreneurship skills of farmers to take decisions is important, Kangogo et al. (2020) argue that interpersonal relations which can help in coping with the climate stressors require due attention. Cohen et al. (2016) argued that local social relations strongly explain the differences in the capacity to adapt or to cope with the change. Structural factors and ideology (informal institution) influence the choice of adaptation strategies that are feasible and are therefore important to take into account (Brooks & Adger, 2005). Learning outcomes through social interactions are likely to be more effective as people involved in the process share common interests and beliefs (Munasib & Jordan, 2011). Munasib & Jordan (2011) argued that associational membership promotes information sharing through increased interactions, exchange of ideas and knowledge sharing and promotes learning and informal training newer agricultural practices and thus positively influences farmer’s decision to adopt sustainable agricultural practices and also the extent of such adoption.

ICTs have potential to facilitate these interactions with more frequent exchange of knowledge information among the farmers. However, the role of ICTs particularly in area of climate change adaptation is not well explored especially in global south (Ospina & Heeks, 2010). Research in this area is mainly directed, one, to understand the influence of some common demographic indicators such as age, level of education, size of the household etc. Second, towards assessing the economic gain measured in terms of increased crop productivity in terms of increased yield (Casaburi et al., 2014; Cole and Fernando, 2016), reduced production and transaction cost (Mittal, 2012), access to better market price of produce (Goyal et. al., 2010), improved access to markets (Munyua et al., 2009).

We therefore propose to incorporate the ensemble view of ICTs which allows to consider that social and contextual aspects determine how ICT is conceived (Sein & Harindranath, 2004) and to assess whether this institutional framework facilitates access to and receipt of information by the farmers. The comprehensive definition of ICT ecosystem is as proposed by Diga & May (2016) a system that encompasses the policies, strategies, processes, information, technologies, applications and stakeholders that together make up a technology environment for a country, government or an enterprise and most importantly people – diverse individuals, who create, buy, sell, regulate, manage and use technology. Integrating ICT ecosystem is important because if socio-cultural factors are influencing the use of technology, there is need to investigate how social networks that mediate the access to ICTs and receipt of information by farmers can explain differential adaptation strategies of the farmers.
3. METHODOLOGY

The study was conducted in one of the major wheat producing states in India viz. Haryana. Within Haryana, data was collected from six districts which were Ambala, Panchkula, Jind, Hisar, Palwal, and Mewat (see figure 1). These districts were selected on the basis of three agri-climatic zones, rainfall and soil conditions. Data used in this study was collected for a randomized control trial (RCT) experimental study to study the effect of agri-met advisories sent to farmers through short message services (SMSs) on various farming outcomes. Data was collected for two consecutive rabi seasons (which starts around November and crop harvesting begins around April-May) in the year 2016-17 and 2017-18 for wheat crop. Data collected only for the baseline period 2016-17 is used in this study to avoid the bias in the intervention period data where all the farmers in treatment group received the information through SMSs.

To obtain a representative sample, from each district 10 villages were selected where SMS advisories were not received by farmers. It was ensured that a pair of similar villages located at some distance to each other and are not contiguous to villages that were already receiving SMS advisories were selected so as to avoid contamination during the intervention phase. For Panchkula district, data could be collected only for 8 villages. Thus, there are total 58 villages from where data was collected. Within each village, data was collected from a minimum of 10 farmers. Keeping in mind the possibility of attrition in the future, more than 10 farmers were contacted. The initial sample size was 640 farmers which reduced to 463 farmers by the end of data collection. Initial face-to-face contact with the farmer was established in the year 2016 and subsequent data collection was done through telephonic interview. Farmer’s consent was obtained before data collection. A farmer was contacted on an average 4-5 times during the entire season to collect information related to operational cost incurred on various farming operations, date of execution of such operations, ICT
related information. The tool for data collection was a comprehensive structured questionnaire which was tested in the field during the pilot survey. Questionnaire was designed to collect information pertaining to cost incurred on different agricultural operations (such as land preparation, sowing, irrigation, fertilizer application, weedicides and pesticides application, harvesting, marketing, and storage) and other relevant information like timing of these operations, inputs used, credit related information etc. Information related to use of ICTs and information was also collected. Unit of analysis in the study is individual farmer.

To study the linkages between ICTs, information, and adaptive capacity of farmers, we now discuss the variables used in this study. Table 1 discusses the dimensions of adaptation decisions used in the study with rationale behind including specific indicator variables for each dimension.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicators</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk mitigation through crop and input diversification</td>
<td>Crops grown other than wheat</td>
<td>Works as a hedge against the vulnerability present due to single crop production facing varied risks such as undesirable changes in weather, biological risk (pest attack), market risks etc.</td>
</tr>
<tr>
<td></td>
<td>Grown more than one seed variety</td>
<td>This could help the wheat crop withstand unforeseen changes in environmental conditions.</td>
</tr>
<tr>
<td>Followed land management strategies</td>
<td>Applied organic manure</td>
<td>Organic manure helps in keeping the soil moisture for long and also improves health of the soil.</td>
</tr>
<tr>
<td></td>
<td>Used fertilizers other than DAP and urea</td>
<td>This indicates that farmer is investing in keeping the nutrients in the soil and not just concerned about higher crop yield.</td>
</tr>
<tr>
<td></td>
<td>Grown multiple crops</td>
<td>Growing many crops helps in balancing the nutrients in the soil and at the same time may support the crops simultaneously grown crops.</td>
</tr>
<tr>
<td>Taking advantage of opportunities</td>
<td>Utilizing rainfall</td>
<td>Substituting rain water for ground water irrigation saves on economic cost of expending mechanical and human labor to extract scarce water resource, enhances crop growth especially when quality of ground water is moderate, and saves from the crop loss due to excessive water. This variable demonstrates farmer’s ability to take advantage of available opportunities.</td>
</tr>
<tr>
<td>Economic gains</td>
<td>Impact on yield per acre</td>
<td>Higher yield obtained per acre implies more revenue to the farmers which they can invest in enhancing their capacity to take more adaptation-oriented measures.</td>
</tr>
<tr>
<td></td>
<td>Impact on operational cost per acre</td>
<td>Cost is an important economic variable and lowering the cost of cultivation can support farmer economically to respond better to climate stressors.</td>
</tr>
</tbody>
</table>

Note: This is a work in progress and only the first dimension is analyzed.

**Table 1. Indicators of adaptation decisions**

Based on the literature, we have conceptualized adaptive capacity as access to different resources and farmer’s ability and willingness to use those resources to respond to the risk from variable
weather and climatic conditions. Figure 2 depicts the conceptualization and is further elaborated in table 2 with different indicator variables.

Figure 2. Determinants of adaptive capacity (adapted from Dillow (2008))
<table>
<thead>
<tr>
<th>Dimension</th>
<th>Indicators</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Resources</td>
<td>Own livestock</td>
<td>Provides farmers additional source of income, inputs for the crop in the form of manure, and also provides food items such as milk and milk products, eggs etc. that helps the community to reduce reliance on farming alone.</td>
</tr>
<tr>
<td></td>
<td>Able to use canal water</td>
<td>Whether a farmer was able to use canal water for irrigation (completely or partially). It is cheaper and its quality is considered as better than ground water, but available to only limited number of farmers.</td>
</tr>
<tr>
<td></td>
<td>Land (Is not a small farmer)</td>
<td>Land is an important resource to a farmer. Having access to a larger piece of land provides farmer option to experiment with different crops, inputs, technologies, etc. Since all the farmers own land, we have looked at the size of operational land holding.</td>
</tr>
<tr>
<td>Economic and Financial Resources</td>
<td>Engaged in two occupations</td>
<td>Reduces reliance on agriculture, expands farmer’s social network.</td>
</tr>
<tr>
<td></td>
<td>Bought either seed or fertilizers on credit</td>
<td>Specifically captures the use of credit money in the form of working capital to purchase inputs and not for any other non-agricultural purposes. Eases liquidity for undertaking farm operations by making funds available especially during lack of cash-in-hand.</td>
</tr>
<tr>
<td></td>
<td>Have a Kisan Credit Card (KCC)</td>
<td>It is a formal credit source, provides credit at a very low rate of interest to buy inputs which is often relaxed if paid back on time.</td>
</tr>
<tr>
<td></td>
<td>Have a bank account</td>
<td>Represents farmer’s access to formal sources of credit which provide credit at cheaper rates. Lower interest payments can lower farmer’s financial burden and thereby facilitate the process of adaptation.</td>
</tr>
<tr>
<td></td>
<td>Have a debit card</td>
<td>Simplifies cash withdrawal and purchase of material, saves time and efforts to access cash in bank accounts.</td>
</tr>
<tr>
<td>Human Capital</td>
<td>Education (Is literate)</td>
<td>Education in its own right is important for human development, further it may facilitate access to more information channels, enhanced ability to exploit technology, and adopt new methods of farming.</td>
</tr>
<tr>
<td></td>
<td>Adult-children ratio is greater than 1</td>
<td>Demonstrates availability of family labor to carry out farm operations taken in the form of whether the adult-children ratio is greater than 1 or not.</td>
</tr>
<tr>
<td></td>
<td>Use traditional methods to guess changes in weather</td>
<td>Such as using environmental cues like behaviour of birds and insects, direction of wind etc. belongs to specific area and community and therefore is salient. May help farmers in taking preparatory actions. Is considered important to be combined with modern scientific knowledge.</td>
</tr>
</tbody>
</table>
Table 2. Indicators of Resources as Constituents of Adaptive Capacity

Next, in table 3 we discuss the indicators used in the study to conceptualize farmers’ capability and willingness to use ICTs for productive purposes particularly for agricultural work

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Represents what?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can and does open and read SMS</td>
<td>Ability to do basic functions in mobile phone and access the agri-met advisories if delivered on the phone</td>
</tr>
<tr>
<td>Can use online mobile applications</td>
<td>Ability to use more complex mobile applications</td>
</tr>
<tr>
<td>Mobile banking</td>
<td>Ability to exploit formal banking services remotely and farmer’s willingness and openness to use of modern ICT channels viz. smartphone and internet to access banking services</td>
</tr>
<tr>
<td>Can and does use Debit card for ATM Transactions</td>
<td>Ability and willingness to access funds through other modes</td>
</tr>
<tr>
<td>Can and does use Debit card for Online Transactions</td>
<td></td>
</tr>
<tr>
<td>Use ICTs to search for market price of agricultural produce</td>
<td>These two types of uses indicate farmer’s awareness about use of ICTs for other agricultural purposes (other than just accessing weather information)</td>
</tr>
<tr>
<td>Use ICTs to get information about government support schemes for farmers</td>
<td></td>
</tr>
<tr>
<td>Call Kisan Call Centre</td>
<td>Indicates farmer’s willingness to use the available farm related advisory institutions to seek their advice</td>
</tr>
<tr>
<td>Seek weather information</td>
<td>Indicates farmer’s willingness to obtain weather information for making farm decisions</td>
</tr>
</tbody>
</table>

Table 3. Indicators of Ability and Willingness of Farmers to Use ICTs
Lastly, in table 4 we look at the indicators of farmer’s ICT ecosystem that explains how ICTs are incorporated in a farmer’s life and contribute to easy communication, increased interactions and exchange of knowledge and information.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Represents what?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of internet for communication by family members</td>
<td>Depicts frequent use of modern ICT tool and family environment of the farmer with respect to preference towards newer and modern technologies.</td>
</tr>
<tr>
<td>Use of internet for communication among friends</td>
<td>This shows the pervasiveness of internet usage not only within the family but also in the friend circle of the farmer. This wider use of internet increases the likelihood to obtain varied information.</td>
</tr>
<tr>
<td>Use of ICTs for productive interactions with others</td>
<td>Interacting with input suppliers to obtain information about prices, products and other miscellaneous market and related information</td>
</tr>
<tr>
<td></td>
<td>Connects with Agricultural universities or experts. This represent that instead of agricultural universities or expert, that are also infomediaries, reaching out to the farmers they themselves are contacting these experts through ICTs</td>
</tr>
<tr>
<td></td>
<td>Sharing useful information with fellow farmers demonstrating the importance of close links in information dissemination</td>
</tr>
</tbody>
</table>

| Table 4. Indicators of ICT Ecosystems at the Village Level |

4. RESULTS

We have reported the demographic profile of the farmers who participated in the present study in table 5. Majority of the farmers fall in the less than 50 years of age bracket. Average age of the farmers in the study is about 46 years. Only 17% of the farmers are illiterate. Half of the farmers have attained education till matriculate or above. Similarly, nearly half of the sample farmers belong to upper caste group. Average size of operational landholding of sample farmers is about 9 acres. The smallest farmers work on just half an acre of land. Operational landholding includes land owned and land leased in excluding the area leased out.

<table>
<thead>
<tr>
<th>Farmer Characteristics</th>
<th>Mean/Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Age:</strong></td>
<td></td>
</tr>
<tr>
<td>Mean, range, standard deviation</td>
<td>45.58 years, [18-80], 13.02</td>
</tr>
<tr>
<td>35 years or less</td>
<td>110 (24%)</td>
</tr>
<tr>
<td>36-50 years</td>
<td>195 (42%)</td>
</tr>
<tr>
<td>Above 50 years</td>
<td>158 (34%)</td>
</tr>
</tbody>
</table>

| **Education:**         |                |
| Illiterate & informally literate | 80 (17%) |
| Less than Primary to Middle   | 152 (33%) |
| Matriculate and above        | 231 (50%) |

| **Caste:**             |                |
| Upper Caste            | 227 (49%) |
| Other Backward Caste (OBC) | 210 (45%) |
Table 5. Description of Farmer Characteristics

Table 6 provides the descriptive statistics of the variables discussed in the methodology section and are used in the analysis. We see that penetration of traditional ICTs like TV is quite good whereas modern ICT channels which require skills to use them still have lower ownership. Similarly, we find that most of the farmers are capable of using basic feature like opening and reading SMS and seek relevant information. However, more complex tasks such as use of technology to get information or to carry out financial transactions still scores low frequency among the sample farmers. The use of ICT channels for communication and exchange of information is more with fellow farmers and family compared to input dealers and agricultural experts. Although nearly three-quarters of the farmers reported to have received information, the other indicators of information access such as frequency and multiplicity of information sources is still low. Ownership of basic technological inputs such as tractor and tube-well is moderate.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Response category</th>
<th>Mean, (SD), [Range]</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Index of Access to ICTs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TV ownership</td>
<td>Yes</td>
<td>1.09, (0.71), [0-3]</td>
<td>376 (81%)</td>
</tr>
<tr>
<td>Owned Smartphone</td>
<td>Yes</td>
<td></td>
<td>90 (19%)</td>
</tr>
<tr>
<td>Owned computer with or without Internet access</td>
<td>Yes</td>
<td></td>
<td>43 (9%)</td>
</tr>
<tr>
<td><strong>Index of Capability and willingness to use ICTs:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Can and does open and read SMS</td>
<td>Yes</td>
<td>3.09, (1.60), [0-8]</td>
<td>402 (87%)</td>
</tr>
<tr>
<td>Can use online mobile applications</td>
<td>Yes</td>
<td></td>
<td>129 (28%)</td>
</tr>
<tr>
<td>Mobile Banking</td>
<td>Yes</td>
<td></td>
<td>30 (6%)</td>
</tr>
<tr>
<td>Can and does use Debit card for ATM Transactions</td>
<td>Yes</td>
<td></td>
<td>178 (38%)</td>
</tr>
<tr>
<td>Can and does use Debit card for Online Transactions</td>
<td>Yes</td>
<td></td>
<td>37 (8%)</td>
</tr>
<tr>
<td>Use ICTs to get information about government support schemes for farmers</td>
<td>Yes</td>
<td></td>
<td>88 (19%)</td>
</tr>
<tr>
<td>Use ICTs to search for market price of agricultural produce</td>
<td>Yes</td>
<td></td>
<td>174 (37%)</td>
</tr>
<tr>
<td>Call Kisan call Centre (KCC)</td>
<td>Yes</td>
<td></td>
<td>8 (2%)</td>
</tr>
<tr>
<td>Seek weather information</td>
<td>Yes</td>
<td></td>
<td>388 (84%)</td>
</tr>
<tr>
<td><strong>Index of ICT social ecosystem:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Use of internet for communication by family members</td>
<td>Yes</td>
<td>2.24, (1.46), [0-5]</td>
<td>290 (62%)</td>
</tr>
<tr>
<td>Use of internet for communication among friends</td>
<td>Yes</td>
<td></td>
<td>288 (62%)</td>
</tr>
<tr>
<td>Use of ICTs for sharing information with fellow farmers</td>
<td>Yes</td>
<td></td>
<td>242 (52%)</td>
</tr>
<tr>
<td>Use ICTs to contact input suppliers</td>
<td>Yes</td>
<td></td>
<td>124 (26%)</td>
</tr>
<tr>
<td>Use ICTs to contact agricultural experts</td>
<td>Yes</td>
<td></td>
<td>96 (20%)</td>
</tr>
<tr>
<td><strong>Index of Information Access:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receive weather information</td>
<td>Yes</td>
<td>1.74, (1.20), [0-4]</td>
<td>338 (73%)</td>
</tr>
<tr>
<td>Receive weather information weekly or more frequently</td>
<td>Yes</td>
<td></td>
<td>209 (45%)</td>
</tr>
<tr>
<td>Receive weather information from more than 1 source</td>
<td>Yes</td>
<td></td>
<td>167 (36%)</td>
</tr>
<tr>
<td>Contact agricultural experts through ICTs</td>
<td>Yes</td>
<td></td>
<td>96 (20%)</td>
</tr>
</tbody>
</table>
Index of Agricultural Technology used by Farmer: 1.84, (1.16), [0-4]

<table>
<thead>
<tr>
<th>Technology</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own a tractor</td>
<td>218</td>
<td>47%</td>
</tr>
<tr>
<td>Own a tube-well</td>
<td>323</td>
<td>70%</td>
</tr>
<tr>
<td>Mechanized weeding</td>
<td>98</td>
<td>21%</td>
</tr>
<tr>
<td>Mechanized harvesting</td>
<td>213</td>
<td>46%</td>
</tr>
</tbody>
</table>

Index of Natural Resources: 1.68, (0.75), [0-3]

<table>
<thead>
<tr>
<th>Resource</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Own livestock</td>
<td>425</td>
<td>92%</td>
</tr>
<tr>
<td>Able to use canal water</td>
<td>126</td>
<td>27%</td>
</tr>
<tr>
<td>Is not a small farmer</td>
<td>229</td>
<td>49%</td>
</tr>
</tbody>
</table>

Index of Economic and Financial Resources: 2.56, (1.12), [0-5]

<table>
<thead>
<tr>
<th>Resource</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engaged in two occupations</td>
<td>116</td>
<td>25%</td>
</tr>
<tr>
<td>Bought either seed or fertilizers</td>
<td>218</td>
<td>47%</td>
</tr>
<tr>
<td>Have Kisan Credit Card</td>
<td>191</td>
<td>41%</td>
</tr>
<tr>
<td>Have a bank account</td>
<td>426</td>
<td>92%</td>
</tr>
<tr>
<td>Have a debit card</td>
<td>237</td>
<td>51%</td>
</tr>
</tbody>
</table>

Index of Human Capital: 1.92, (0.84), [0-3]

<table>
<thead>
<tr>
<th>Capabilities</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is literate</td>
<td>383</td>
<td>83%</td>
</tr>
<tr>
<td>Adult-children ratio is greater than 1</td>
<td>288</td>
<td>62%</td>
</tr>
<tr>
<td>Use traditional methods to guess changes in weather</td>
<td>218</td>
<td>47%</td>
</tr>
</tbody>
</table>

Risk Mitigation through Diversification 0.82, (0.74), [0-2]

<table>
<thead>
<tr>
<th>Crop Diversification</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crops grown other than wheat</td>
<td>219</td>
<td>47%</td>
</tr>
<tr>
<td>Grown more than one seed variety</td>
<td>163</td>
<td>35%</td>
</tr>
</tbody>
</table>

Table 6. Descriptive Statistics of Variables used in the Study

However, more use of machinery for weeding and harvesting is still low among the farmers. Over 90% of the farmers own livestock which provides income and nutritional support to farming households. Nonetheless, in terms of resource endowment we see that access to canal water which is a cheaper source of irrigation is quite low and about half of the farmer have smaller piece of land to work on. Only a quarter of farmers have secondary occupation. About 50% of the farmers buy seed and fertilizers on credit. Although over 90% of the farmers have a bank account, use of plastic money or debit card is still relatively low among the farmers. Majority of the farmers are literate and about half of the farmers still use old traditional techniques to predict changes in the weather. In nearly two-third farmer households the proportion of adult members is higher than children. About half of the farmers grow only wheat as a single crop and about two-third of the farmers use only one variety of seed to grow wheat.

To better understand the linkages between information, ICTs, and farmer’s adaptive capacity that contribute to building of resilience to climate stressors we use path analysis technique. Path analysis can be understood as a subset of structural equation modelling (SEM) used to estimate a system of equations. Path analysis allows us to estimate the effect of a set of variables on a specific outcome variable through multiple pathways. The advantage of this technique is that it allows to capture both direct and indirect effects of a variable by incorporating mediation analysis simultaneously. In the analysis only structural model is estimated using the observed variables with the assumption of multivariate normality. Some of the variables in our dataset do not satisfy the normality condition checked through Mardia test and univariate Q-Q plot. To account for multivariate non-normality, we have used the robust maximum likelihood estimator with Satorra-Bentler correction. The analysis was done using the lavaan package in RStudio. Figure 3 is the path diagram that depicts the relationships among the variables hypothesized and tested through path analysis. The straight-line with arrow head on one end shows the direct effect of one variable on another. The curved line with arrow head on both ends represents covariance between the two variables. The dotted lines represent that the path is not significant statistically.
Before discussing the model, it is important to check the overall fit of the model to establish its acceptance. To evaluate the model fit, we present the following fit indices in Table 7 along with their criterion value and robust estimates. Based on the criterion values, the model fit is good and acceptable.

### Table 7. Model Fit Indices

<table>
<thead>
<tr>
<th>Fit Indices</th>
<th>$X^2$*</th>
<th>DF</th>
<th>GFI</th>
<th>SRMR</th>
<th>RMSEA</th>
<th>AGFI</th>
<th>CFI</th>
<th>NFI</th>
<th>IFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criterion</td>
<td>-</td>
<td>-</td>
<td>&gt;0.90</td>
<td>&lt;0.08</td>
<td>&lt;0.08</td>
<td>&gt;0.90</td>
<td>&gt;0.90</td>
<td>&gt;0.90</td>
<td>&gt;0.90</td>
</tr>
<tr>
<td>Actual Value</td>
<td>46.92</td>
<td>14</td>
<td>0.978</td>
<td>0.056</td>
<td>0.071</td>
<td>0.930</td>
<td>0.930</td>
<td>0.907</td>
<td>0.933</td>
</tr>
<tr>
<td>(0.00)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robust Value</td>
<td>48.25</td>
<td>14</td>
<td>0.056</td>
<td>0.073</td>
<td>-</td>
<td>0.929</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>(0.00)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: * indicates the Satorra-Bentler chi-square value. Values in brackets indicate p-value.

### Table 8. Path Coefficients

Table 8 presents the standardized path coefficients. The level of significance guides whether the proposed hypotheses are supported or not as reported in the inference column.

<table>
<thead>
<tr>
<th>Path</th>
<th>Standardized Path Coefficients</th>
<th>Robust Std. Error</th>
<th>P-Value</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information $\rightarrow$ Risk_Mitigation</td>
<td>0.100**</td>
<td>0.028</td>
<td>0.028</td>
<td>Supported</td>
</tr>
</tbody>
</table>

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Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021

Chetri et al.

Information, ICT Ecosystem, and Farmer’s Adaptive Capacity

<table>
<thead>
<tr>
<th>Path Coefficient</th>
<th>t-Value</th>
<th>p-Value</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Econ_Fin_Resources → Risk_Mitigation</td>
<td>0.027</td>
<td>0.031</td>
<td>0.570</td>
</tr>
<tr>
<td>Ag_Technology → Risk_Mitigation</td>
<td>0.154***</td>
<td>0.032</td>
<td>0.002</td>
</tr>
<tr>
<td>Human_Capital → Risk_Mitigation</td>
<td>-0.009</td>
<td>0.042</td>
<td>0.844</td>
</tr>
<tr>
<td>Natural_Resources → Risk_Mitigation</td>
<td>0.178***</td>
<td>0.047</td>
<td>0.000</td>
</tr>
<tr>
<td>ICT_Access → Risk_Mitigation</td>
<td>-0.035</td>
<td>0.052</td>
<td>0.477</td>
</tr>
<tr>
<td>ICT_Ecosystem → Information</td>
<td>0.156***</td>
<td>0.041</td>
<td>0.002</td>
</tr>
<tr>
<td>Natural_Resources → Information</td>
<td>0.078*</td>
<td>0.069</td>
<td>0.070</td>
</tr>
<tr>
<td>Human_Capital → Information</td>
<td>0.039</td>
<td>0.063</td>
<td>0.379</td>
</tr>
<tr>
<td>ICT_Capability_Willingness → Information</td>
<td>0.105**</td>
<td>0.039</td>
<td>0.040</td>
</tr>
<tr>
<td>ICT_Access → Information</td>
<td>0.122***</td>
<td>0.077</td>
<td>0.008</td>
</tr>
<tr>
<td>Natural_Resources → Ag_Technology</td>
<td>0.280***</td>
<td>0.065</td>
<td>0.000</td>
</tr>
<tr>
<td>Econ_Fin_Resources → Ag_Technology</td>
<td>0.107***</td>
<td>0.042</td>
<td>0.008</td>
</tr>
<tr>
<td>Human_Capital → Ag_Technology</td>
<td>0.095**</td>
<td>0.055</td>
<td>0.020</td>
</tr>
<tr>
<td>ICT_Capability_Willingness → Information</td>
<td>0.292***</td>
<td>0.028</td>
<td>0.000</td>
</tr>
<tr>
<td>Econ_Fin_Resources → Econ_Fin_Resources</td>
<td>0.173***</td>
<td>0.069</td>
<td>0.000</td>
</tr>
<tr>
<td>Human_Capital → Econ_Fin_Resources</td>
<td>0.153***</td>
<td>0.055</td>
<td>0.000</td>
</tr>
<tr>
<td>Human_Capital → ICT_Ecosystem</td>
<td>-0.126***</td>
<td>0.068</td>
<td>0.001</td>
</tr>
<tr>
<td>ICT_Capability_Willingness → ICT_Ecosystem</td>
<td>0.486***</td>
<td>0.037</td>
<td>0.000</td>
</tr>
<tr>
<td>ICT_Access → ICT_Ecosystem</td>
<td>0.030</td>
<td>0.079</td>
<td>0.435</td>
</tr>
<tr>
<td>ICT_Access → ICT_Capability_Willingness</td>
<td>0.346***</td>
<td>0.101</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Note: *** indicates a significance level of 1%, ** indicates a significance level of 5%, and * indicates a significance level of 10%.

Table 8. Path Coefficients

We find that information is a significant contributor to farmer’s adaptive capacity. Farmers who have higher information index, indicating better information access, diversify their risk more (0.100). It is likely as getting relevant information particularly from a greater number of sources with higher frequency of receiving information and when expert’s advice is involved may help farmers to use variety of seeds and crops that works as hedge against the risk of crop failure. Ownership of technological inputs like tractor and tube-well and use of machinery to carry out agricultural operations makes it easier for farmers to diversify (0.154).

Natural resources also play significant role in enhancing farmer’s adaptive capacity by helping them to mitigate the risk through diversification (0.178). Having greater endowment of natural resources particularly land facilitate diversification. However, these results also indicate the likelihood of greater capacity to adapt for those who are richer or have higher resource endowment. As we argued at the beginning of the study, though other resources are necessary to undertake adaptation decisions, augmenting these resources especially in the short-term is a difficult task especially for the resource poor farmer. The significant linkages among capability and willingness to use ICTs for productive purposes, ICT ecosystem, and information implies that there is not only direct effect of information but there are other interlinked mechanisms that influence availability and use of information by the farmers and hence their capacity to adapt.

Indirect effect is the effect of one variable on another mediated by a third variable called mediating variable. Table 9 presents the indirect effects pertaining to dimensions of ICTs, information, and risk mitigation. In table 9 we see that farmers’ embeddedness into the ICT ecosystem significantly influence their ability to respond to risk by facilitating their access to information (IE1 in table 9). While we see that farmers’ capability and willingness to use ICTs for productive purposes play important role in ensuring information access directly (table 8), its indirect effect is, however, not
significant in risk mitigation through this channel (IE2 in table 9). On the other hand, when this linkage is mediated by ICT ecosystem, we see that capability and willingness also contribute to risk mitigation (IE3 in table 9). The role of ICTs in terms of having only physical access only is facilitating access to information (IE5 in table 9) and does not directly helps in risk mitigation (table 8). The indirect effects mediated through information suggest that enhancing farmer’s access to information can work as a catalyst for enhancing adaptive capacity of farmers. Thus, the role of information and ICT ecosystem that promotes exchange of information especially agricultural information becomes even more significant.

<table>
<thead>
<tr>
<th>Indirect Effect (IE)</th>
<th>Standardized Estimate</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>IE1: ICT_Ecosystem → Information → Risk_Mitigation</td>
<td>0.016*</td>
<td>0.065</td>
</tr>
<tr>
<td>IE2: ICT_Capability_willingness → Information → Risk_Mitigation</td>
<td>0.011</td>
<td>0.127</td>
</tr>
<tr>
<td>IE3: ICT_Capability_willingness → ICT_Ecosystem → Information → Risk_Mitigation</td>
<td>0.008*</td>
<td>0.067</td>
</tr>
<tr>
<td>IE4: ICT_Access → ICT_Capability_willingness → Information → Risk_Mitigation</td>
<td>0.004</td>
<td>0.136</td>
</tr>
<tr>
<td>IE5: ICT_Access → Information → Risk_Mitigation</td>
<td>0.012*</td>
<td>0.091</td>
</tr>
</tbody>
</table>

Note: *** indicates a significance level of 1%, ** indicates a significance level of 5%, and * indicates a significance level of 10%

Table 9. Indirect Effects

Thus, the present study not only propose to invest in skills to utilize available channels of information particularly ICTs but also draws attention to take a more systemic perspective to incorporate the use of ICTs within the farming community to enhance the adaptive capacity of farmers and hence make them more resilient to the climate stressors. Although developing a facilitating ICT ecosystem for the farmers requires time and dedicated efforts to understand the nuances of local social settings, our study suggests that it can help farmers to make important agricultural decisions even with the limited resources at their disposal.

5. DISCUSSION

The present study reveals that information is an important constituent of farmers’ adaptive capacity to climate risk. However, the linkages capability and willingness to use ICTs to access and use information and also the exchange of knowledge and information facilitated by ICT ecosystem are important to be exploited by any intervention that seek to facilitate adaptation through modern days technology (ICTs and IoTs: internet of things). In order to understand association between technology and social relations, it is important to understand how the introduction and use of technologies empower networked people vis-à-vis those who are not connected across different class, caste, gender and regions. For instance, Ali & Kumar (2011) discussed, even though information delivery through ICTs led to improvement in the quality of decision making of user farmers vis-à-vis non-user farmers, user farmers belonging to socially lower class had no difference in decision making compared to non-users of the same social class. We argue that adopting a more systemic approach allows to go beyond the access-capability enhancement dyad in the ICT domain and take
a more holistic view of access and use of information while looking at the engagement between social relations and technology.

Learning outcomes through social interactions are likely to be more effective as people involved in the process share common interests and beliefs (Munasib & Jordan, 2011). Thus, strengthening local ICT ecosystem of farmers could be a more sustainable and welcomed by the farmers. Encouraging farmers to participate in an ICT ecosystem may give them a sense of belongingness and therefore is more likely to be embraced by the farmers increasing their likelihood to be more adaptive and resilient to climate stress.

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Maps were created using the following sources: https://gramener.com/indiamap/, https://mapchart.net/india.html
BUILDING RESILIENT INFORMATION SYSTEMS FOR CHILD NUTRITION IN POST-CONFLICT SRI LANKA DURING COVID-19 PANDEMIC

Pamod Amarakoon, University of Colombo, Sri Lanka, pamodm@gmail.com
Jørn Braa, University of Oslo, Norway
Sundeep Sahay, University of Oslo, Norway
Lakmini Magodarathna, Ministry of Health, Colombo, Sri Lanka
Rajeev Moorthy, Ministry of Health, Colombo, Sri Lanka

Abstract: Post-conflict, low-resource settings are menaced with challenges related to low-resources, economic and social instability. The objective of the study is to understand the socio-technical determinants of resilience of routine information systems a backdrop of an implementation of a mobile-based nutrition information system in a post-conflict district in Sri Lanka. The longitudinal events in the study spans across several years into the period of COVID-19 pandemic and tries to understand the process of developing resilience of in a vulnerable district. The qualitative study deploys interviews, observations and document analysis for collection of empirical data. The case study reveals the long-standing capacity building, leadership and local governance, multisector collaboration, platform resilience and empowering of field health staff contribute in building resilience in everyday context. The empirical insights include the mechanisms in building resilience in routine system in low resource settings while promoting data quality and data use at field level.

Keywords: Resilience, dhis2, mHealth, mobile, health information systems, nutrition, Sri Lanka, COVID-19, pandemic, governance, platform.

1. INTRODUCTION

Low and middle-income countries (LMICs) are likely exposed to some degree of local or international conflicts at certain period during the last century. Wars or conflicts has a negative impact on country’s infrastructure which severely hampers the development of the country (Hoeffler, 1999). The low resource setting observed in post-conflict LMICs paralyses the health system which needs significant level of effort for revival. Childhood malnutrition is a generally a chronic condition observed due to failure of health and other sectors in a low-resource post-conflict context (“Study on the Impact of Armed Conflicts on the Nutritional Situation of Children,” n.d.). Some countries have attempted coordinated targeted interventions to malnourished children with multisector collaboration which has proven to be successful (“Multi-Sector Convergence Approach to Reducing Malnutrition in Lao PDR,” n.d.).

Preventive healthcare service is a major constituent of a health system of a country where provision of care is mainly community-based and provided through field health workers. Field health staff is conventionally assigned the task of gathering data of delivery of services and status of healthcare. However, the data collected and shared by field health staff is traditionally transmitted upward along the health administrative hierarchy without much supervision which can challenge the quality of the data on which public health indicators are based on (Mitsunaga et al., 2013). Another alarming situation in most of the low and middle-income countries is the lack of use of collected data at field level to enhance the healthcare delivery (Frontline Health Workers Coalition, 2016).
Digital health solutions are considered to be effective in providing transparency of data transmission and making data available to the stakeholders in a fast and efficient manner. Use of mobile technology in particular, has immensely contributed for real time data transfer between field level and healthcare managers and been increasingly implemented in low and middle-income country contexts (Tegegne et al., 2018). Cross-sector collaboration is increasingly observed across many fields and use of digital technologies has been a growing concern to make the process efficient (Lu, Zhang, & Meng, 2010). Implementation of mobile solutions for field health services has been generally challenging in the context of low- and middle-income countries that has raised increased concerns on careful planning and proper use of resources (Dharmayat et al., 2019). In addition, implementation of health information systems requires the systems to adapt to changes in the sociotechnical environment for it to operate smoothly (Yen, McAlearney, Sieck, Hefner, & Huerta, 2017). Establishment of such resilience in a vulnerable setting involves complex interplay between stakeholders and sociotechnical environment.

The study is motivated by a recent attempt of implementing a mobile based information system for nutrition monitoring at community level in Sri Lanka. The system was targeted at enhancing quality of data collected by field health staff and to enhance the data use at community level. The system was implemented in a low-resource post-conflict district of Jaffna in Northern Sri Lanka which was considered as a challenging context to establish an information system for routine use. The COVID-19 pandemic that struck the country in 2020 caused a major challenge to routine information flow in general. The study focusses at exploring deep into the broader research question of identifying socio-technical determinants of resilience of routine health information systems in a post-conflict setting. This is done through a longitudinal study of events took place in the implementation of the mobile-based information systems over a period of 3 years.

2. CONCEPTUAL FRAMING: VULNERABILITY & RESILIENCE

In this paper we try to focus on analyzing the factors involved in establishment of a m-Health solution in a post-conflict setting of a low and middle-income country in a manner in which it could sustain against existing and the new adverse conditions in which it is implemented. To achieve this, we contemplate on vulnerability and resilience to form the theoretical foundation.

2.1. Vulnerability

Vulnerability is defined as an internal risk factor of the subject or a system that is exposed to a hazard and corresponds to its intrinsic tendency to be affected, or susceptible to damage. It represents the physical, economic, social susceptibility or tendency of a community to damage in the case a threatening circumstance of natural or anthropogenic origin (Cardona, 2003; Emrich & Cutter, 2011). Vulnerability is a term which could not be confined to a specific domain or for specific group of people. It is a concept which could affect an individual or a group of people and can span across multiple domains from sociology, economics, geography, health and nutrition (Alwang, Siegel, & Jorgensen, 2001). There could be a central exposure which could make a context or society vulnerable. The degree and duration of vulnerability depends on the exposure (Kasperson, Kasperon, Turner, Hsieh, & Schiller, 2005). It is important to note that while sensitivity of a community or context to the ill-effects of an exposure suggest vulnerability, Adger defines social resilience as the ability to cope the stressors caused by changes in socio-political environment (Adger, 2000).

2.2. Resilience

Resilience could be broadly defined as a capacity of a system to cope with changes in its external environment (Heeks & Ospina, 2019a). In information system domain, resilience has been largely highlighted as a system property (Zhang & Lin, 2010). In certain instances resilience could be measured objectively by negative impact of an external stressor on system performance combined with time to recover to normal performance (Zobel & Khansa, 2012). Health system resilience is
defined as capacity of health actors, institutions, and populations to prepare for and effectively respond to crises; maintain core functions when a crisis hits; and, informed by lessons learned during the crisis, reorganize if conditions require it (Kruk, Myers, Varpilah, & Dahn, 2015). World Health Organization defines health information systems as one of the building blocks of a health system. Therefore, it is fair to assume that the definition applied for resilience of broader health system also impacts on the domain of health information systems (“WHO | Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies,” 2014). Heeks et. al highlights robustness, self-organizing and learning as foundational attributes of a resilient system while enabling attributes such as redundancy, rapidity, scale, equality, diversity and flexibility could support the establishment of resilience.

A health information system requires resilience of the health system as well as the resilience of the information system to function. Gilson et al highlights the role of routine governance structures in establishing everyday resilience of a district health system in African context. But highlights the necessity of leadership which is sensitive to district context in sustaining the resilience(Gilson et al., 2017). In the context of information systems, resilience has mainly been highlighted as a system property (Hollnagel, Woods, & Leveson, 2006). Heeks et al. identified the lack of operationalised conceptualization for resilience in the IS literature and develops a framework of foundational and enabling attributes with a set of markers for conceptualizing the resilience in a given context (Heeks & Ospina, 2019b).

While most of these studies focuses on general use of ICT in a community of an organizational context there is gaps in literature on how resilience could be established in routine information systems to promote data use in field health workers. Our study aims at identifying the gap in IS literature on this specific context which is essential for sustaining the health information flow of a country.

3. METHODS

We adopted case study methodology to explore the context prevailing within a district in Sri Lanka in the context of implementation of a mobile based nutrition information system. As highlighted by Yin, case study method facilitates empirical enquiry into the real-life scenario that happens with involvement of stakeholders at district, subdistrict and field health worker levels (Yin, 2014).

All authors of this paper were involved with the research context in multiple dimensions. One of the authors (PI) is a specialist in health informatics who was the lead health informatician in designing and implementing the mobile based nutrition information system in 4 districts of Sri Lanka. One of the authors was the Medical Officer of Maternal and Child Health (MO-MCH) of the Jaffna district who served at the managerial capacity of public health at district level. Another author is the Director of Nutrition Division of Ministry of Health (MoH) who provided oversight at national level. Two other authors are senior professors from University of Oslo, Norway who have closely been in contact with training specialists in health informatics in Sri Lanka and also was providing guidance in implementation of the project as well as physically attended field visits for qualitative research studies in Jaffna district.

As proposed by Yin, we devised multiple qualitative methods to explore the research questions of the study. As the first method we documented the lived experience of the implementers on the design and implementation in the Jaffna district which were included in the form of narratives for the study. Next qualitative method devised in the studies was in-depth interviews. These were conducted with 3 health informatics and public health experts at national level involved with implementation of the nutrition system, 3 district level administrators and public health experts, 1 provincial level public health expert of the Northern province, 2 members of Jaffna district core team implementing the system. Observations were made during the initial discussions on design and implementation within the Jaffna district, training programs conducted for end users, monthly meetings held at Medical Officer of Health (MOH) offices, a field level review conducted by national team and field visits.
done at field health clinics where the data capture took place. As the fourth qualitative data collection method documents and meeting notes of monthly meetings conducted in the district were analysed. In addition, 3 focus group discussions were conducted with the public health midwives who were the end-users of the system. The data collected from the above qualitative methods were documented and structured to formulate the case study presented in the next section.

4. CASE STUDY

4.1. Background

Sri Lanka is a country with a well-established public health system. Public health indicators of the country have outperformed many countries in the region and are comparable to levels of developed countries (World Health Organization, 2017). In spite of substantial performance in many aspects of preventive healthcare sector, indicators related to nutrition have failed to stay in par with others. Sri Lanka has significant percentages of malnourished children which has resulted in grave consequences to country’s development over the last few decades (Jayatissa, 2011). It has been well understood that one major cause of lack of proper intervention to malnutrition was the disconnect among is multisector stakeholders operating at field level to provide efficient interventions.

The presidential secretariat of Sri Lanka launched the multisector action plan for nutrition to provide targeted intervention for families of malnourished children with involvement of all sectors related to social services provision in addition to the health domain. The objective was to establish closer linkages between multisector stakeholders at district and subdistrict level to provide targeted nutrition interventions. It was also decided to design and implement a field level mobile nutrition data collection tool to quality of data collection and data use at field level. The system was designed on free and open-source platform DHIS2 as the backend solution which communicates with a custom-made mobile application. The information system was deployed in three districts in Sri Lanka during the pilot phase from year 2016 to 2018.

Jaffna district located in the northern province of Sri Lanka is an area heavily menaced by the conflicts that prevailed over three decades (“Sri Lanka’s northern province poorer, undeveloped after 26-year civil war with Tamil Tigers,” n.d.). The district, which is now in the post-conflict era was still having much issues related to infrastructure and technology in addition to a population living with memories of conflict era.

4.2. Capacity Building in Health Informatics

In the Ministry of Health Sri Lanka, numerous initiatives in administration and public health are driven by medical doctors specializing in the respected fields. Masters and doctorate programs in Community Medicine and Medical Administration are classic examples for this path. University of Colombo, Sri Lanka designed the Postgraduate Master’s program in Biomedical Informatics with the support of University of Oslo in 2009 to train medically qualified doctors in health informatics who were to be absorbed in to ministry of health operations once they were qualified to serve at national and regional level for expansion of information systems. Over the last decade, they have been serving at various levels in the ministry of health hierarchy supporting implementation of information systems and well as for building capacity. In fact, the design and implementation of mobile-based nutrition monitoring system was pioneered by a graduate of the master’s program.

The country also mastered in using generic platforms for designing health information systems over the years. The free and open-source health management information system platform DHIS2 is a classic example which is now being utilized by over 10 programs in the ministry of health at national level to streamline the health information management. The country has developed capacity on this platform at all levels to sustain major implementations and has kept close contacts with the DHIS2 core team at University of Oslo, Norway to ensure sustainability of support and deployment. The implementations ranges from standalone DHIS2 platform based systems to wide variety of integrations with existing solutions to establish an ecosystem of digital solutions in the country.
4.3. Digital Intervention

The medical officer of maternal and child health (MO-MCH) is the officer in charge at district level to implement and monitor maternal and child health activities including nutrition at district level. The principal investigator and his team in MoH designed a mobile based nutrition monitoring program based on DHIS2 as the platform. In late 2017 the MO-MCH of Jaffna district showed interest in implementing the system in the district to utilize mobile devices received for field health staff for another project. He raised the importance of strengthening multisector collaboration through the IS. In the initial discussions probable challenges for the implementation such as building capacity, supervision, infrastructure, resources for provision of support were identified as main challenges in post-conflict Jaffna districts. The MO-MCH discussed with the provincial and district health administrators, administrators of other sectors outside of the MoH at district level and the development partners such as UNICEF and World Food Program to obtain support and resources for the implementation within a short span of time. A major focus of the nutrition information system was to establish multi-sector collaboration of stakeholders operating at district level for addressing malnutrition. Therefore, he organized rounds of discussions with other government and non-government stakeholders to obtain the support. Tamil was the main language used in the Jaffna district which was posing a challenge to obtain trainers from National level who were mostly not fluent in Tamil. Therefore, he organized a training program for district core team with the help of the central implementation team to build training capacity at the district level. He and his team were able to conduct district level training programs to train the public health midwives (PHMs) on how to use the mobile data collection tool for nutrition within a period of two months followed by which the system was implemented in the entire district to collect data at field level. The team was also able to advocate the health administrators in the district and provinces to communicate the multisector collaborations on nutrition with the non-health sector government officials. The mobile application supported field health workers on their routine practice by providing snapshot idea of nutritional status of children under her care (Figure 1). The immediate supervisors of field health staff, the district and national level health managers could monitor the performance of the nutrition program using the system dashboards (Figure 2).

![Weight for Age graph of a child which provides snapshot idea of progress of weight in mobile app](image)

Figure 1: Weight for Age graph of a child which provides snapshot idea of progress of weight in mobile app
4.4. Post-implementation Phase

The lack of human resources for field health staff resulted in high turnover of health staff in low resource districts of Jaffna which necessitated conducting refresher trainings. The MO-MCH devised a formal training program at district level for newly joined field health staff prior to onboarding in field level services. The distance from the capital city and the language barrier were major challenges for conducting training and support for new users from central level. This led to significant frustration amongst end-users in the post-implementation phase. The district level team was sensitive to this growing issue and came up with a digital solution which in turn reused the mobile device provided to them. The team created a group chatroom using the instant messaging platform “Viber” for troubleshooting of end users who were requested to post their issues in Tamil language which were promptly answered by district team. They also included two members from the national team for advanced support if required. The use of instant messaging platform in turn provided peer education to the fellow end-users by learning from the issues encountered by others.

Couple of months following the initial implementation, the district team noted that the number of events of malnutrition which were recorded in the system were not up to the expected levels and also that there was considerable amount of data quality-related issues. The team analyzed the issue and attributed this development to the lack of supervision between the district and field level. To address this issue, the district team proposed to include discussion on findings from the system as an agenda item in the monthly supervisory conferences the medical officers in public health were conducting with the field health workers. Following this approach, the subdistrict team led by the...
medical officer of public health discussed the number of nutrition events captured as well as the quality of the data captured by the field health workers which essentially provided a feedback of data capture through the system. The field staff was also encouraged to use the dashboards in the monthly conferences which were generated based on the data collected at field level (Figure 3). This provided an instant feedback to the collected data as well as enhanced the culture of data use at field level.

Figure 3: Monthly conferences happening at subdistrict level

The District team took one step forward in assessing the use of the information system by obtaining an unbiased objective review by inviting a team of health informaticians from national level to conduct a review of the implementation. The national team included several medical officers in health informatics as well as an international expert in public health information system implementation from University of Oslo, Norway. Their supervisory visit included visits to district health offices, field weighing clinics and the regional director of health services office to observe the practices of data collection and use and provided their feedback to the staff at all levels.

4.5. Major Setbacks & Strategies Adopted

About two years following the initial implementation in the Jaffna district, there were complaints of non-functioning mobile devices reported from several areas. The issue led to not receiving data at all from several areas in the district. The reason was attributed to non-functioning devices following expiry of warranty period. In spite of attempting several modes of financial sources to replace the devices, Jaffna team could not obtain the sufficient funding for this purpose. This MO-MCH organized a round of discussions with public health doctors and the end-users of the subdistricts and advocated them on the value addition to the information flow by use of the nutrition system. They also observed that most of the end users owned smart mobile devices and proposed them to use personal devices for data collection. Significant number of end users accepted this suggestion and started collecting data from their personal devices. This ensured sustainability of the information system despite malfunctioning devices. The strategy was also promoted in other districts which was highly admired at national level.

4.6. COVID-19 Pandemic & Beyond

Sri Lanka experienced their first wave of COVID-19 outbreak in the country in March 2020. The government implemented countrywide curfew for a duration of almost 2 months. During this time only the essential services such as health care was functioning. However, this led to obstacles in
conducting field weighing sessions for nutrition monitoring which affected data entry at field level. Field health staff were also utilized for COVID prevention measures which significantly overburdened limited staff. On the other hand, lack of field interventions and the extended curfew adversely affected the nutrition of children. This imposed more pressure on requirement of a digital solution to make the routine nutrition monitoring efficient to function with less over-burdened staff striving for time. In spite of not being able to conduct the routine field health work during the curfew period the district staff took prompt measures to minimize the risk of the end-users losing their practice in data collection by constantly being active in the Viber group and discussing issues related to data entry and revising the system. In addition, they made it an opportunity to conduct review and supervision of entered data in the system by conducting data review programs in the monthly conferences even during the curfew. Another interesting fact to note is that the review meeting conducted by the MoH with the Jaffna district field staff was organized through Zoom platform during the pandemic.

Figure 4: Graph depicting number of nutrition monitoring events captured by field health staff in Jaffna district in year 2020 (Source: District Nutrition Monitoring System, MoH – Sri Lanka)

The (Figure 4) depicts the number of nutrition monitoring events during the year 2020 in Jaffna district. It is observed that there is lack of nutrition monitoring events in first half of year 2020 which is mostly observed during the period of the countrywide curfew. However, it is interesting to note that from June 2020 onwards the events have increased and come to a plateau which continued to remain the same during the next few months amidst field health staff being occupied with COVID-19 preventive measures.

Another interesting fact to note is that the champion behind the implementation, the MO-MCH was transferred to a different post at the end of 2020. However, he handed over his duties to his successor and build capacity in the team that continued to support implementation. He continued engaging in provision of technical and user support actively and chat support channels in the next three months. His void was filled by a Medical Officer in Health Informatics graduated from the Masters programme who was oriented in the system and had the capacity to provide leadership and expertise in sustaining the system. The success behind Jaffna district team inspired the national maternal and
child health program in the MoH to incorporate the remaining child health data collection fields into the mobile application to enhance the quality of child health service provision and monitoring and evaluation activities. Integration of the maternal and child health flow into the same mobile application was a major step to ease the burden duplicate data collection as well as ensuring the sustainability of the grassroots level digital data capturing process.

5. DISCUSSION

The paper revolves around a use case in post-conflict resource-limited district of Jaffna in Sri Lanka and how implementation of a mobile based health information system progressed amidst numerous challenges over a period of 2 years. Our analytical focus in this paper is on the relationship between the local operational mechanisms around the information system and how it contributed to the resilience of establishing a routine information system which supported enhancing data quality and use. The challenges we set out in this paper, are: “what it takes to build a resilient information system in a low-resource LMIC setting” and, within this overall case framework, we address 1) the process of building information system resilience, and 2) the bounce back-bounce forward duality of resilience, all in the context of establishing a digital IS in challenging times of COVID-19 pandemic.

The Jaffna district, in which the case study revolves around was in post-conflict stage after a 3 decade-long civil war which collapsed not only the infrastructure and livelihood, but also the general motivations and quality of life of people. Emrich and Cutter highlight that interaction of society with biophysical conditions caused by the vulnerability has significant impact on the way they adapt or build resilience in general (Emrich & Cutter, 2011). The vulnerability of economic domains led to lack of infrastructure and equipment while the vulnerability of psycho-social environment created a hostile environment for motivation and enthusiasm. Lack of capacity made the district furthermore vulnerable for embracing novelty or sustain it. This, in turn made the district vulnerable for long-term dependence for support from non-governmental organizations and development partners.

Sri Lanka envisioned about a decade ago the need of health informatics expertise and capacity to implement and sustain IS when establishing Masters program in Health Informatics. The approach of Sri Lanka on building capacity was slow and steady to build resilience against their vulnerability of capacity in implementing health information systems. The void of transfer of the champion doctor behind the implementation of IS was quickly filled by a medical doctor with expertise in health informatics which led to strengthening and continuity of building of resilience in the district.

Sri Lanka also built capacity around the DHIS2 platform steadily during the decade. The country had time to experiment with the platform and also to implement it at different scale while also developing capacity to expand the platform by designing complex, integrated mobile applications as in the case of the nutrition system. Best practices, implementation guidelines and governance mechanisms around the platform were established based on several use cases during the decade. Tiwana highlights the fact that aligning the governance with the platform’s architecture improves platforms resilience (Tiwana, 2014). Therefore, the case highlights how a LMIC accumulated platform resilience at a gradual pace which produced resilience within the country to sustain advanced IS.

When analyzing the case study, we identify that there were several instances where the system was severely challenged for its survival after the initial implementation. When the quality of data as well as use of data generated from the system was questioned at district level, the justification on resources spent for establishing the IS was threatened. When the user support mechanism was not properly established there was a risk of losing the use of the system at field level. These can be highlighted as examples of stressors to the routine functioning of the information system. The mechanisms operating at the field level were able to come up with strategies to overcome these stressors to bring back the system into normal use which could be referred to as “bouncing back” to normal. This is a general property of resilient IS (Heeks & Ospina, 2019a). However, the strategies that were devised by the district team such as introduction of reviewing system performance at
monthly conferences, introduction of “Viber” support group and moreover familiarizing the field staff to use an instant messaging platform for official purposes strengthened existence of nutrition system as well as contributed to creating a culture which could be reutilized in routine work. This strategy contributed to technology resilience during the times of COVID pandemic in addition to empowering end-users with a skill they can reuse for routine work. These are unique examples of systems transformation which pushed the exiting boundaries of Isa a step further than bouncing back. Müller et al. Refers to this as “bouncing forward” which could be defined as what strengthens the resilience of the system to face future stressors (Müller, Koslowski, & Accorsi, 2013).

Gilson et al. stresses the importance of everyday resilience for the sustainability of the health systems in low and middle-income countries (Gilson et al., 2017). They emphasize that having stable governance structures and adequate resources will not make the sustainability of the everyday resilience. They go on arguing that it is imperative to have new forms of leadership which empowers all levels while maintaining cordial relationship with other stakeholders to sustain the everyday resilience. Our case study highlights the initiatives undertook by the MO-MCH of the Jaffna district in introducing the information system into the low resource setting, interactions and advocacy he had with stakeholders at multiple levels across the domains and the initiatives he pioneered while empowering the district team as well as the field level staff. These steps were crucial to obtain the support of all stakeholders as well as laying a formidable foundation on which the system could establish in the district. The willingness of the maternal and child health programme of the MoH to incorporate the general MCH indicators into the existing mobile based nutrition information system provides sufficient evidence for the Ministry recognizing the prospects of this implementation to establish as a routine information system for everyday data requirements.

COVID-19 pandemic brought about major challenges to the health system as well as the frontline health staff. This is where the value of the system with everyday resilience becomes crucial. The nutrition system not only bounced back following previous stressors but bounced forward with modification such as incorporating supplementary digital solutions like instant messaging platforms. This resulted the ecosystem around the nutrition information system to further strengthen by means of conducting data quality reviews even though the field level data collection was not possible. The system empowered field health workers by having decision-making tools such growth charts at their fingertips as well as the dashboards for managerial staff. These methods brought about compliance as well as a sense of ownership to the end-users. They made the system a part of their daily work-routine which in turn consolidated the platform’s everyday resilience. The reduction of nutrition monitoring events during the period of country-wide curfew was the actual reflection of service delivery. But the fact that events reaching levels of pre-covid era just after pandemic and continuing to remain that levels highlight the fact that COVID pandemic has not crippled the use of the information system. The maternal and child health reviews were conducted by the ministry in times of the pandemic using the Zoom technology which also highlights the resilience developed in use of digital platforms and the digital transformation of health system in general.

Thus, through the case study we try to explore closely the interplay between vulnerability and resilience of routine health information system through on empirical lens.

6. CONCLUSION

Through this case study of implementation of a mobile based nutrition monitoring tool by field health staff, we try to capture the socio-technical determinants of information system resilience in a post-conflict LMIC setting. Long term capacity building, local governance mechanisms, platform resilience, multi-sector collaboration and empowering of end-users are crucial determinants in constructing resilience which can bounce back from routine stressors and bounce-forward to establish as a resilient routine system in the backdrop of COVID-19 pandemic.

The study contributes to the theoretical domain by understanding socio-technical determinants of resilience of routine IS and highlighting the importance of empowering field health staff for
achieving digital transformation in routine system. Empirically the study provides critical insights on the process of establishing resilience in routine IS in a post-conflict low resource setting and measures of enhancing data quality and data use at level of field health workers in such setting.

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EARTH OBSERVATION AND THE NEW AFRICAN RURAL DATASCAPES: DEFINING AN AGENDA FOR CRITICAL RESEARCH

Rose Pritchard, Global Development Institute, University of Manchester, rose.pritchard@manchester.ac.uk
Wilhelm Kiwango, University of Dodoma, wiaki2007@gmail.com
Andy Challinor, School of Earth and Environment, University of Leeds, a.j.challinor@leeds.ac.uk

Abstract: The increasing availability of Earth Observation data could transform the use and governance of African rural landscapes, with major implications for the livelihoods and wellbeing of people living in those landscapes. Recent years have seen a rapid increase in the development of EO data applications targeted at stakeholders in African agricultural systems. But there is still relatively little critical scholarship questioning how EO data are accessed, presented, disseminated and used in different socio-political contexts, or of whether this increases or decreases the wellbeing of poorer and marginalized peoples. We highlight three neglected areas in existing EO-for-development research: (i) the imaginaries of ‘ideal’ future landscapes informing deployments of EO data; (ii) how power relationships in larger EO-for-development networks shape the distribution of costs and benefits; and (iii) how these larger-scale political dynamics interact with local-scale inequalities to influence the resilience of marginalised peoples. We then propose a framework for critical EO-for-development research drawing on recent thinking in critical data studies, ICT4D and political ecology.

Keywords: Earth Observation; agriculture; power; inequality; Africa

1. INTRODUCTION
Recent years have seen a rapid increase in the availability of Earth Observation (EO) data, derived both via remote sensing and via ground-based sensors such as weather stations, river flow gauges and camera traps (Gabrys, 2016; Bakker & Ritts, 2018). Coupled with increased computational power, rapidly evolving analytical methods, and the increasing prevalence of ICTs to facilitate data analysis and information dissemination, these data are transforming monitoring and predictive capacities in global land systems (Bakker & Ritts, 2018; Lioutas et al., 2020).

Data availability has been highlighted as a barrier to sustainable development in African countries (Espey, 2019) and EO data can play a useful role in addressing data gaps. Specifically in the context of agriculture, a growing number of applications based on EO data are being developed to inform ‘data-driven’ agricultural policy and practice in African countries (Bégué et al., 2020; Nakalembe et al., 2021), from online platforms for national-scale decision-makers to mobile phone apps for individual farmers. EO data are celebrated as facilitating ‘better’ decisions which will lead to greater wellbeing and resilience among individuals and communities, particularly as climate change increases levels of uncertainty in agricultural systems (Jones et al., 2015; Dinku, 2020).

Questions remain, however, over the extent to which these claims are being realised. Technical methods papers vastly outweigh critical social science scholarship on datafication of rural landscapes in African countries (Adams, 2019; Rotz et al., 2019; Klerkx et al., 2019). Few studies question the politics of EO data themselves or pose critical questions over who can access, create, share, use or benefit from EO-derived information in different socio-political contexts (Taylor, 2017; Bakker & Ritts, 2018; Gabrys, 2020). Echoing a point made by Heeks and Shekhar (2019) regarding...
big data and development, and drawing a parallel with Shelton et al.’s (2015) work on Smart Cities, the academic literature contains many optimistic visions of what EO data could be used to achieve, but provides a patchy view of who gains or loses in ‘actually existing’ datafied agricultural systems.

Here we argue for more critical research into how increasing EO data availability could reshape rural landscapes and rural wellbeing in African countries, focusing particularly on agricultural applications. We begin by highlighting key issues underserved in current EO-for-development literature. We then outline a conceptual approach drawing on research in critical data studies, ICT4D and political ecology.

2. KEY OVERSIGHTS IN EO-FOR-DEVELOPMENT RESEARCH IN AFRICAN COUNTRIES

EO data can underpin diverse kinds of agriculture-related information, with examples including weather and climate forecasts, pest early warning and land degradation monitoring (Alexandridis et al., 2020). This information may be useful in itself or combined with other data sources to produce services such as famine early warning or index-based insurance (Baudoin et al., 2016; Ntukamazina et al., 2017). EO-derived information is being disseminated via diverse routes depending on the target users, including online platforms, bulletins, mobile phone apps, agricultural extension systems, and radio broadcasts (Hudson et al., 2017; Munthali et al., 2018).

We focus this piece on African rural contexts because decision-makers in many African countries have historically faced major challenges accessing quality ‘data-for-development’ (Jerven, 2013). EO, particularly satellite remote sensing, means that certain kinds of data are now becoming available at spatial and temporal resolutions which would have been logistically impossible with ‘traditional’ survey methods alone. This has triggered a rush of EO-for-development efforts focused on African agriculture, with information products targeted at stakeholders including government agencies, agribusinesses, non-governmental organisations and individual smallholder farmers.

But critical academic research on the datafication of agriculture is still skewed towards European and North American contexts, with less critical research in African countries (Rotz et al., 2019; Klerkx et al., 2019). This could be for a multitude of reasons, such as the comparative recency of the EO-for-development trend, challenges of access when some forms of EO data are privately owned, the continued dominance of ‘technical’ scientific knowledge in EO-for-development initiatives, or the fact that constrained project timelines leave little space for rigorous impact assessment (Tall et al., 2018). Whatever the cause, this results in important omissions in academic EO-for-development literature focused on African contexts. Here we outline three such omissions, while recognising that these are unlikely to be the only gaps. While we talk generally at time about ‘African rural contexts’, we recognise that there will be huge variation between and within African countries – which only makes the questions we pose here even more important.

2.1. Which development discourses shape the use of EO data?

Our first question is over the discourses of development shaping the ways that EO data are analysed, packaged, disseminated and used. African rural landscapes are contested spaces with many different possible futures, and this makes it essential to question the assumptions and beliefs over ‘ideal’ landscape futures which inform the design of EO data applications.

This recalls debates over digital agriculture and precision agriculture (summarised in Lajoie-O’Malley et al., 2020). Both of these have been critiqued as embedded in intensive agricultural paradigms which prioritise increased production while downplaying environmental harms. Proponents highlight the social goods arising from intensified agriculture over the last century as well as the benefits of increased production to individual farmers. Critics, in contrast, point out that
increased production does not necessarily translate to greater food security or wellbeing, and argue that productivist approaches are legitimised by flawed Neo-Malthusian claims around population growth and resource scarcity (Klerkx & Rose, 2020; Lajoie-O’Malley et al., 2020).

Similar productivist narratives – that EO-derived information can increase efficiency and therefore yields, so ensuring food security for a growing population – are clearly apparent in the rhetoric around EO data services in Africa (see e.g. Dinku, 2020). Less certain is the extent to which EO data are being operationalised to support the implementation of alternative agricultural visions, such as those centring principles of agroecology, food justice or food sovereignty (the latter discussed by Fraser, 2020).

### 2.2. How do power relationships shape – or become reshaped by – access to and use of EO data?

These different future imaginaries cannot be considered in isolation from the relationships of power structuring the networks involved in producing, analysing, disseminating and using EO data. The EO-for-development scene in African countries is messy and fragmented, involving complex assemblages of actors from both global North and South; Blundo-Canto et al. (2021) identified 161 organisations involved in scaling up climate services for Senegal alone. The changes in agricultural systems arising from EO data availability, and the distribution of costs and benefits, will be determined by the power of different actors to influence how EO data are accessed, packaged and used.

The changing availability and value of EO data will alter these power relationships in turn. In some cases, this could compound existing asymmetries, as in the case of precision agriculture and large agribusiness (Lioutas et al., 2020). In others it could create new asymmetries, as in the example of commercially valuable data held by meteorological departments (Nordling, 2019). And in some this could allow asymmetries to be challenged, as can be the case in counter-mapping initiatives (Peluso, 1995; although see Wainwright & Bryan, 2009).

Despite this, few studies explore power relationships in larger EO-for-development networks or consider the distribution of benefits and costs. This is true even in the case of weather and climate services, which are the longest-standing and thus best-studied kind of EO data service. Harvey et al. (2019) offer a rare example exploring the roles of NGOs in climate service delivery, and conclude with a call for greater research into the politics and power dynamics of climate service networks. Vogel et al. (2019) reach a similar conclusion that the political economy of climate services has been largely neglected. Several authors have now discussed the role of power dynamics in shaping climate service co-development approaches (e.g. Daly & Dilling, 2019; Vincent et al., 2020), but these studies are often reflections on individual projects rather than explorations of extended networks.

### 2.3. Who benefits from EO-derived information at local scales?

An incomplete engagement with how the costs and benefits of EO data applications are distributed is also apparent at local scales. A small number of studies have explored how characteristics such as age, gender or income shape ability to benefit from EO-derived information in African rural contexts, documenting access inequalities which will be familiar from the wider ICT4D literature (Muema et al., 2018; Gumucio et al., 2020). But as Nyantakyi-Frimpong (2019) observes, there are few studies in this literature which adopt an intersectional lens, despite the intersections of multiple characteristics being so important for shaping vulnerability and adaptive capacities (Turner et al., 2003; Erwin et al., 2021).

Current literature on local impacts of EO-derived information also emphasises benefits without much consideration of potential risks (echoing observations by Clarke, 2016; Barret and Rose, 2020).
Writing specifically on climate services, Nkiaka et al. (2019) found a substantial number of case studies focusing on individual-scale changes in yields and incomes, but there are less if any studies considering emergent impacts on community-scale dynamics in African contexts.

This is an important gap because it is widely recognised that the direct benefits of agricultural information services are less likely to accrue to the most vulnerable people in communities (Lemos & Dilling, 2007; Roudier et al., 2016). It remains unknown whether altered behaviour among the more advantaged will produce co-benefits, or whether it will further marginalise and disempower more vulnerable community members.

3. DEFINING A CRITICAL EO-FOR-DEVELOPMENT RESEARCH AGENDA

These three under-researched areas call to mind recent work by Eriksen et al. (2021), who found that adaptation interventions designed without reference to patterns of power and inequality often result in maladaptive outcomes for poorer and marginalized peoples. Now is a good time to evaluate whether these same issues are being reproduced in EO-for-development efforts, or conversely whether EO data applications are delivering the promised benefits. We propose to explore this using a conceptual framework drawing on research in critical data studies, political ecology and ICT4D (summarized in Figure 1).

We begin by characterizing EO data as forming landscape ‘data doubles’ – a term developed initially in surveillance research (Haggerty & Ericson, 2000), but here adapted to refer to the abstracted version of rural landscapes created through EO data. This full suite of available data goes through a series of filtering processes, firstly being reduced to what we term a ‘datascape’ – a simplified spatial representation of the landscape. The data double and datascape are neither neutral nor complete. As shown by research in critical cartography (e.g. Harris & Hazen, 2005), they are a function of the data available (which is itself politically determined) and the priorities of those creating the representation. But as Venot et al. (2021) demonstrate in their recent work on irrigation data, even flawed representations can have substantial influence.
These datascapes often form the basis for a range of information products. These products may be targeted directly at land managers such as farmers or may impact land and livelihoods indirectly by influencing policy and governance. Here theory from critical data studies is essential, emphasizing as it does the importance of power dynamics and political processes of negotiation and contestation among complex networks of actors (boyd & Crawford, 2012; Dalton & Thatcher, 2014; Jasanoff, 2017). Similar discussions of power and participation are common in the ICT4D literature (Daly & Dilling, 2019), which has particular relevance given that many information products are disseminated via online platform or mobile phone. Which actors are able to exert power over

Figure 1 A conceptual framework for exploring how increasing Earth Observation data availability could reshape land and livelihoods in rural African landscapes. We situate the local landscape within larger-scale networks of power relationships, which will determine the values and priorities shaping the production, packaging, dissemination and use of EO data. This in turn will influence the nature and distribution of costs and benefits both within rural landscapes and through the larger network.
decision-making processes, and the worldviews and values of these actors, will shape the nature and distribution of costs and benefits both at local scales and through the larger network.

Much of the research on Big Data focuses on the social impacts of datafication. We also propose to draw on political ecology, which shares similar themes to critical data studies in terms of emphasizing dynamics of power, but places more explicit focus on changes to land as well as livelihoods. There is a rich tradition of research in political ecology on how different views of ‘ideal’ rural landscapes come to be seen as valid and legitimate while others are sidelined, and how this can lead to both social and ecological harms (e.g. Fairhead & Leach, 1996; Asiyanbi, 2016). Research drawing on both critical data studies and political ecology is already providing useful insights in the field of natural resource governance. McCarthy and Thatcher (2019) use theories from both to explore the construction and potential impacts of World Bank resource maps, while Iordachescu (2021) discusses how the ways that Romanian landscapes are characterized based on remote sensing erases local people from landscape histories.

The kind of complex systems research proposed here poses interesting methodological challenges. One option is to focus on particular strands of EO data and track them through networks, as in Bates et al’s (2016) ‘data journeys’ approach. Another is to begin with impacts at the local landscape scale, as in the case studies reviewed by Nkiaka et al. (2019), and seek to reconstruct the processes leading to particular outcomes. A third is to focus on a particular stage in the data filtering process, as in the growing body of literature on the co-production of climate services (Vincent et al., 2018; Daly & Dilling, 2019). In practice, a combination of these approaches is likely to yield the greatest insights – particularly because the networks we reference here and the power relationships within them are dynamic, interacting with EO data sources which are also constantly evolving.

4. CONCLUSION

Our objective in this piece was to highlight the need for more critical research on how the growing ubiquity of EO data is reshaping African rural landscapes. EO data do open up exciting opportunities in data-sparse contexts, but equally raise new questions and challenges – particularly with regards to how the increasing availability of these data will interact with complex power relationships in EO-for-development networks and the consequences this will have for the people living in rural landscapes. We believe that research drawing on critical data studies and political ecology could provide valuable insights into the distribution of costs and benefits arising from EO data, and thereby help identify ways of realizing the potentials of EO data while minimizing the possible harms.

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MARKET DIGITALIZATION AND RESILIENCE IN CRISIS TIMES

Guillermo J. Larios-Hernandez, Universidad Anahuac Mexico, guillermo.lariosh@anahuac.mx

Abstract: Based on a conceptual framework that integrates three dimensions of digital transformation (DT), namely, the nature of the product, client interaction, and the level of coordination with industry players, this paper aims to explain the level of influence that contextual crisis factors may have played in organizational digitalization choices in search for resilience as part of adaptation strategies. In particular, this investigation would analyze digitalization choices as survival strategies for COVID-19 crisis in the case of Mexican enterprises. The selected country is of particular interest as research target in the Global South, in that public policy has offered little support to keep business organizations up and running, leaving entrepreneurs with no other option but to implement bottom-up resilience strategies, including digitalization. Qualitative Comparative Analysis (QCA) has been proposed to identify combinations of conditions to explain the role played by COVID crisis-related contextual factors that may have led to particular forms of digitalization. Semi-structured interviews with industry associations are also proposed to gain knowledge about group responses to the crisis.

Keywords: digital transformation, resilience, Mexico, COVID-19, ICT, QCA.

1. INTRODUCTION

We are living in a time of significant turmoil, especially considering that our world societies have been heavily hurt by the COVID-19 pandemic, leaving governments and the society at large with little action choices to what appears to be a significant systemic failure. Under these circumstances, many governmental regimes appear to prioritize short-term commitments but failed to assess the long-term consequences of their policy decision-making, suggesting the existence of a dichotomy between urgent demands of “situation” and sustainable recommended paths. As participants of a complex socioeconomic system, organizations need to confront contradictory institutional signals, triggering distributed social involvement when top-down institutional and market-based mechanisms seem ineffective to members in a given society.

On the other hand, characterized by complexity, uncertainty and appraising dimensions, scholars recognize that innovative solutions to grand challenges require collective action, whose systemic linkages are still to be understood (Ferraro et al, 2015). Given the upsurge of the digital economy as the dominant techno-economic paradigm of our time (Perez, 2003), innovation can be hardly appreciated without considering the role of information and communication technologies (ICT). The fact that COVID crisis has forced wide digitalization in practically all types of organizations (Klein & Todesco, 2021) is a clear exemplification of ICT having such an instrumental role, driving organizational change to what appears to be another level of business venture evolution, whose transformational impact would depend on the degree of technological integration that a given organization decides to accomplish in its development strategy. This form of digital upheaval is the so-called digital transformation (DT).

The promise of digital transformation has encouraged scholars and think tanks to derive explanatory models and theoretical frameworks that conceptualize DT’s core attributes and level of impact on several forms of organization (Andal-Ancion, Cartwright & Yip, 2003; Andriole, 2017; Gray, El...
Sawy, Asper, & Thordarson, 2013; Matt et al., 2015; Schwertner, 2017; Resca, Za, & Spagnoletti, 2013; Sanchez, 2017). However, while DT is about creating new value and more revenue that originate in digitalization (Singh and Hess, 2017), approaches to explain the concept diverge, posing several problems to determine the extent of DT and its ultimate business implications. Yet, several scholars coincide in identifying DT with digital product innovation and client experience (Andal et al., 2003; Sanchez, 2017; Schwetner, 2017; Sebastian, Ross, Beath, Mocker, Moloney, & Fonstad, 2017), with deep implications on the organization’s product portfolio and business model (Matt, Hess, & Benlian, 2015).

Hence, scholars continue to work on new research and case studies, each of which derives in academic contributions that offer aggregates of distinctive qualities to characterize DT from a particular perspective, defining different characters of DT that can be applied to change business organizations. But change can also drive organizational resilience and, though the principles of digital transformation usually encourage the business organization to drive both, cost down (optimization) and product differentiation up (innovation) (Sanchez, 2017), digitalization allows also for the development of new strategic alternatives to act upon external shocks and crisis, pointing to the necessity of determining the product portfolio suitability in the face of grand challenges, particularly in the case of COVID-19. Based on the three categories proposed by Andal-Ancion et al. (2003) to deploy a DT strategy, this paper aims to explain the level of influence that contextual factors may have played in organizations to digitalize, particularly, in terms of changing the nature of the product, client interaction, and the level of coordination with industry players, who seek to gain resilience as part of their adaptation strategies. The identification of such DT influencers has practical implications in that they may help scholars and practitioners in their pursuit to determine contextual factors in COVID crisis time that have led to certain DT resilience decisions.

Based on data gathered from the Mexican National Institute of Statistics (INEGI) and interviews with industry associations, this proposal aims to explain the level of influence that contextual factors may exert on the three categories that constitute DT. Mexico is particularly interesting as research target in the Global South, in that its current administration has provided little support to keep business organizations up and running. As of today, more than one million businesses have gone bankruptcy in the country and, considering that small and medium-sized enterprises (SMEs) tend to be the most vulnerable organizations in crisis situations – as a result of their limited financial resources and knowledge – (Klein & Todesco, 2021), market demand losses leave existing entrepreneurs with the sole alternative to adopt bottom-up strategies, including digitalization.

2. ANALYTICAL PERSPECTIVES OF DIGITAL TRANSFORMATION

Based on the previous discussion, we ought to acknowledge that the transformational effects on the business organization go well beyond the automation and optimization of business processes. To begin, the exploitation of the potential propounded by digital transformation is directly related to the type of product portfolio, which indicates those aspects on which a business organization must work to transform their business offering. Product portfolio digitalization determines to a greater extent the value proposition of the organization, which in turn shapes the strategic alternatives to implement DT. One of the key objectives of digital transformation is the embeddedness of digital technologies in products, services and business models in order to reach higher value-added in the portfolio. Additionally, digital solutions are suitable as relational interfaces that complement or substitute existing channels. These are common reasons to assimilate digitalization in business operations and new product development strategies. From a product portfolio perspective, however, Andal-Ancion et al. (2003) suggests that effective digital transformation depends on three main categories (object of impact): the nature of the product, the interaction with customers, and the level of collaboration with industry players, as shown in Figure 1.
Regarding the first category, that is, the inherent characteristics of a product or service, the business organization would need to assess the extent to which its product portfolio can be delivered electronically, the information intensity implicit in the products, potential for customization, and the implications of packaging products and services. The second category involves the interactions between the business organization and its customers, considering improvements to the client experience in attributes such as product portfolio’s search costs, real-time interface, and a decrease in the complexity of contracting or purchasing. In the end, a new customer experience is achieved particularly through multichannel interactions (Singh and Hess, 2017). Lastly, the third category considers interactions between the organization and its partners, which aim to generate greater network effects that lead to a larger client adoption rate, take advantage of the benefits of value chains through standardization or complement the lack of in-house skills through business alliances. Digital tools would allow for a more effective management of the organization’s value networks.

Coincidently, Rogers (2016) names value networks a key part of an organization’s business model. As a result of technology diffusion among the population, ICT efforts in organizations move away from the enterprise core (the center) to focus on digitizing customer interaction (the edge), taking advantage of the client’s digital connectivity to increase information exchange and transactions (Gray et al., 2013). Gray et al. (2013) also indicate that this customer interaction (the edge) has the potential to transform the enterprise core processes (the center) as clients can interact directly with the core because of a demand-pull trend. Thus, the analysis of digital transformation from a center-edge approach encourages the business organization to review existing ICT practices related to client interaction. Is the organization taking advantage of digital technologies to advance pull-mode interactions that start from what the client determines as valuable? Or is the ICT focus stagnant at the core, trying to push clients towards certain business ends?

However, the transformational value that can be obtained from DT (level of impact) depends not only on the functions of a generic technology, e.g. enabling digital technologies, but also on common organizational principles that imply a sociotechnical perspective, in that technology needs to be integrated into the various processes of the organization (Yunis, Tarhini, & Kassar, 2018), recognizing that technology cannot be simply technical or social, but the outcome of socio-material routines created through a process of interlacing the material nature of the innovation and the social practice. This perspective demands the business organization to carry out an in-depth analysis of what represents value for its clients, not from the ICT viewpoint but especially, from those responsible for the business results. This approach would allow business organizations to determine the structures that make sense to create a distinction in value proposition that dramatically

Figure 1. Product portfolio categories that define digital transformation. Based on Andal-Ancion et al. (2003)
supersedes the value offered by their competitors (Rogers, 2016), leading the business to a true digital transformation of the business model.

In coincidence with Andal-Ancion et al. (2003), Gray et al. (2013) bring our attention to three sources of strategic value in digital transformation: value chains to create new products and business processes, channels to transmit solutions to customer problems (client interaction), and networks for client-partner interaction through mediation technologies, i.e. platforms, consistent with the product portfolio perspective. All these sources involve digital interactions with external stakeholders (the edge), including clients. Based on the client value-generating interaction model that the business organization decides, impacts can range from operational processes and the organizational structure, to the transformation of the business model (Gray et al., 2013), both influencing the center and at the edge of the organization.

Without being comprehensive, typical digital transformation strategies that relate to product portfolio are two-fold, involving allegedly superior, even personalized, customer experience and the development of new products and services that are enriched or digitized (Sanchez, 2017). These strategies, according to the three categories proposed by Andal-Ancion et al. (2003), have the potential to increase resilience. In other words, resilience efforts can implicate the integration of digital technologies and use the framework shown in Figure 1 to determine actions that digitalize product portfolios and generate new value-added as part of a digital business model.

3. ORGANIZATIONAL RESILIENCE

The framework presented in Figure 1 aims to establish the actions that shape the development of digital transformation in a given organization. From a resilience perspective, digitalization would be expected to bring more client interaction alternatives, and lead to an update of processes and organizational structure, particularly among SMEs, which abound in sectors highly affected by COVID-19, such as retail and services (Gregurec, Tomicic Furjan, & Tomicic-Pupek, 2021). Eventually, digitalization for resilience would initiate the transformation of the business, involving product portfolio and client interactions, that is, the value proposition. However, to reach transformation, Gregurec et al. (2021) identified that organizational, financial, social and customer-driven changes are more relevant than technology. In other words, SMEs tend to use social media, platforms and mobile technology as a mean to reach customers and facilitate service delivery, which are easier to use and enable enhanced value propositions. Coincidentally, since SMEs still lack the necessary skills to cope with digital complexity, it has been observed that main responses among SMEs involve digital actions such as social media and online selling, e-banking usage, online community participation and home office work (Klein & Todesco, 2021).

Several models have tried to explain the main features of organizational resilience. For instance, Annarelli et al. (2020) identify static and dynamic characteristics that lead to organizational resilience, whose dimensions include adaptability, reliability, agility, effectiveness, flexibility and recovery. In contrast, Xiao & Cao (2017) conceptualizes resilience as a transition process, which starts at the individual level, whose aggregated characteristics are passed to the team, to eventually conform the organizational perception and behavior that define its resilience. Patriarca et al. (2018) propose a grid that combines learning, monitoring, responding and anticipating as key elements in organizational resilience. Similarly, Denyer (2017) has integrated a model that considers four organizational resilience tensions, namely, performance optimization (improving and exploiting), preventative control (monitoring and complying), mindful action (noticing and responding), and adaptive innovation (imagining and creating). All these models identify high-level attributes and actions that organizations should progressively adopt in order to gain resilience. Undoubtedly, resilience requires capabilities to predict scenarios and adapt, leading to short term responses and long term transformation (Miceli et al., 2021). However, little consideration has been granted to the identification of specific context-dependent triggers, which combine with pre-existing sociotechnical configurations (Tsoutsos & Stamboulis, 2005), to define digital transformation actions (object of impact) in order to gain such resilience. Additionally, digitalization allows for a
continuous connection of all stakeholders, both internally and externally, to maintain business processes in operation (Miceli et al., 2021). Thus, digital transformation requires the participation of a variety of players (Steward, 2012), including the ecosystem of stakeholders. The three categories of DT shown in Figure 1 constitute digital transformation actions that can be explained by contextual variables, this being the research problem that this paper aims to explore.

4. APPROACH/METHOD

Drawing from case-oriented techniques –Qualitative Comparative Analysis (QCA) – this paper aims to derive necessary and sufficient conditions of contextual variables related to COVID-19 crisis, namely layoffs, staff income and benefits reduction, shortages in the supply chain, income decline, demand losses, cash flow scarcity or limited access to financial services, that may have led to digital transformation actions, particularly online client interaction and new product development (see Figure 2 below). Based on set theory, QCA evaluates logical Boolean combinations of conditions (equivalent to dependent variables) to determine associations to a predetermined outcome (equivalent to independent variable) (Ragin, 1987). Additionally, standard multivariate statistics will be used to supplement QCA results and provide deeper explanatory power. Datasets will be taken from Mexico’s National Institute of Statistics (INEGI). Sample size is 1564 SMEs.

![Figure 2. Potential causal conditions and outcomes](image)

On the other hand, to gain knowledge about relations with the outside environment (communities, networks or ecosystems) that might lead collaborative actions in order to gain cluster resilience, information would be captured from interviews and questionnaires applied to selected industry associations in the country (to start in the Fall, 2021), which may provide a first glance of DT-resilience group implications.

5. VALUE/ IMPLICATIONS

This framework proposed is still a general model and its components can still be broken down in further constituents, according to the business characteristics and structure of a given organization. However, it invites scholars and the business organization to include causal thinking in the digital transformation design for organizational resilience, which may help also address some of the problems originated by COVID-19 in the Global South. As indicated by Klein & Todesco (2021), SMEs that expect to survive would need to adapt by bootstrapping immediate digital actions, learn and prepare for the expected new normal. Hence, this research aims to identify sufficient and/or necessary conditions that should be present for at least one of the DT dimensions to occur, posing theoretical questions about crisis conditions that encourage a particular form of DT initiative. Finally,
group actions may indicate the importance of clusters and networks to gain resilience in participating enterprises.

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DIGITAL RESILIENCE FOR WHAT? CASE STUDY OF SOUTH KOREA

Kyung Ryul Park, Korea Advanced Institute of Science and Technology, park.kr@kaist.ac.kr
Sundeep Sahay, University of Oslo, sundeepss@ifi.uio.no
Jørn Braa, University of Oslo, jbraa@ifi.uio.no
Pamod Amarakoon, University of Colombo, pamod@pgim.cmb.ac.lk

Abstract: Resilience has become an emerging topic in various fields of academic research. In spite of its widespread use, there remains conceptual confusion over what resilience means particularly in multi-disciplinary studies including the field of ICT and Development. With the potential of digital technology, research is needed to critically question what key socio-institutional values related to resilience are being strengthened, for what and for whom through the different conceptualizations of resilience. In this study, we conduct an interpretive case study on South Korea’s response to the pandemic and construct a chronological narrative to identify key aspects of digital resilience. We identify agility, diversity, and plurality - enabled by active roles of various stakeholders, including citizens, research communities, and private sector - as keys to digital resilience to the pandemic. Findings from the case of South Korea provide implications to ICT4D research while discussing how developing countries, where a national single window platform is typically implemented with greater level of homogeneity, achieve digital resilience with inclusive innovation with plurality of diverse platforms.

Keywords: COVID-19, pandemic, resilience, digital technology, agility, citizen engagement, public private partnership, R&D, governance, South Korea

1. INTRODUCTION

South Korea’s response to the COVID-19 pandemic has been considered by international authorities and media as one of the world’s most effective (World Health Organization, 2020). The Korean government comprehensively summarized how the country has taken various digital interventions to “flatten the curve” of COVID-19 (Ministry of Economy and Finance, 2020), including for the testing, tracing and treating of COVID-19 cases. The effectiveness of these interventions allowed the government to avoid a lockdown, like most countries did (D. Lee, Heo, & Seo, 2020). Conventional contact tracing methods involved exchange of documents with the National Police Agency with GPS locations acquired from telecommunication companies (MSIT, 2020). However, advanced digital technologies supported by new data governance models were harnessed to support the public-health response integrating surveillance, contact tracing, and information sharing with the public. This led to the government’s adaptive response and information sharing during the pandemic.

Lessons from the South Korea case provides important research and policy implications for digital resilience, including for building the following competencies: innovative and agile development of digital applications, efficient data governance, citizens’ active engagement and public-private partnership. We analyse these competencies from the perspective of digital resilience, drawing from the experience of the government’s information systems response to the pandemic and citizen’s participation and uptake of these responses. The rest of the paper is organized as follows. Section 2 identifies related conceptual issues. Section 3 presents research design, methods, and case
description of South Korea information systems response to the pandemic. Section 4 offers a chronological analysis of the case, followed by discussion in Section 5.

2. CONCEPTUAL FRAMEWORK

Resilience has become a popular concept used by enterprise, government and international organizations, and in research in many disciplines such as Ecology, Management, Disaster Studies, Development Studies and Information Systems. IS research has mostly studied resilience in the context of organizations, infrastructures and risk management, with a focus on identifying attributes of resilience such as agility, flexibility, adaptability, governance, and decreased vulnerability (Erol, Sauser, & Mansouri, 2010; Heeks & Ospina, 2019). In spite of its widespread discussion, there remains conceptual confusion over what resilience means particularly in the context of ICT for Development (ICT4D). Heeks and Ospina ask the question: ‘resilience of what? whether it is about the information systems as an object or the wider socio-institutional system as a target?’ Related relevant questions include ‘resilience for whom?’ and ‘resilience at which institutional level?’

The meaning of resilience varies at different institutional levels: such as i) mental and emotional resilience, e.g., trust, cognitive flexibility and diversity, at individual and community levels; ii) relational resilience, e.g., multidisciplinary teams, interaction and collaboration, at organizational level; and finally, iii) societal resilience, e.g., curative action/vaccine, across border solidarity and collaboration, at national and global levels. These three levels emphasize the inter-connections of aspects of trust, transparency, collaboration, networking, solidarity and institutional systems (Rawat, Boe, & Piotrowski, 2020) and also about regional innovation and networking (Bristow & Healy, 2014; Bristow & Healy, 2018).

In regional economy, the notion of complex adaptive systems provide insights into resilience and how the system rearranges its internal structure spontaneously in response to an external shock or to some internal or ‘self-organized criticality’ (Lansing, 2003). Building on this notion, Braa et. al. (2007) develop the lens of duality between ‘bounce back’ and ‘bounce forward’, and relate them to notions of adaptation and adaptability through their analysis of health data standardization and the role of attractors. While adaptation reflects a path-dependent process maintaining existing paths or primary functions of a system, adaptability refers to an adaptive ability, in pursuit of new path creation and structural change (Hu & Hassink, 2015).

Wilson (2012) provides a framework for community resilience understood as the intersection between economic, social and environmental components. The resilience vs vulnerability dichotomy can be expressed as a spectrum, where the extreme ends are easily conceptualized. Resilience is thus understood as an ideal end goal, whilst acknowledging that no community is totally resilient or vulnerable but will in most cases contain elements of both, raising the need to study it not as an outcome but as a process (Wilson, 2012).

Bruneau et al. (2003) conceptualize resilience along four interrelated dimensions of technical, organizational, social, and economic, with the following attributes: i) robustness, e.g., ability to withstand a given level of stress without suffering degradation or loss of function; ii) redundancy, e.g., the extent to which elements, systems, or other units of analysis exist that are substitutable; iii) resourcefulness, e.g., capacity and ability to mobilize resources; and, iv) rapidity, the speed of response. While Heeks and Ospina (Heeks & Ospina, 2019) emphasize additional attributes of self-organization, learning, equality, flexibility and scale, Erol et al (2010) adds increased adaptability and decreased vulnerability, representing process mechanisms in achieving resilience.

This conceptual review has shown that resilience means different notions to different research fields and there is the need to establish conceptual clarity and framework for transdisciplinary research such as ICT4D. In order to identify key attributes of resilience, we focus on the following key aspects: innovative applications of digital technologies, agility, efficient data governance, citizens’ active
engagement, public-private partnership (PPP), resourcefulness, and research and development (R&D) capacity.

3. METHODOLOGY

3.1. Data Collection

In this study, we develop a single embedded interpretive case study to understand digital response to the pandemic in the context of South Korea. Data collection involved conducting in-depth interviews with two government officers, one developer of a citizen-oriented application, and one health policy expert within Korean academia. These interviews were semi-structured and focused on understanding: i) the cases and details of ICT applications used in the context of the COVID-19 response; ii) government’s motivations for using the different digital solutions; iii) the challenges experienced in deploying the different digital solutions; and, iv) self-evaluation of the effectiveness of the ICT tools used. Their responses helped the reconstruction of the case narrative from an information systems perspective. With the exception of one in-person interview, the others took place online and over the telephone, and lasted between 45 minutes and one and a half hours. Two interviews (developer and health expert) were audio-recorded and transcribed in Korean, while permissions for recording the interviews with the two government officers were not granted. A variety of secondary publications were studied, including: i) official government reports; ii) open data portals and other citizen generated applications; iii) publications from conferences and journals; and, iv) media articles. A summary of some of the publications is provided in the table below.

Table 1. Summary of publications referred for case study in South Korea

<table>
<thead>
<tr>
<th>Citizens' generated applications</th>
<th>Corona Map: <a href="https://coronamap.site">https://coronamap.site</a></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Corona Live: <a href="https://www.coronalive.co.kr">https://www.coronalive.co.kr</a></td>
</tr>
</tbody>
</table>

The combinations of the primary and secondary data were consolidated and themes related to resilience were identified to develop more generalized insights for discussion.

3.2. Case Description

In late December 2019, there were reports of pneumonic patients arising in Wuhan, China. As a result, KCDC (Korea Center for Disease Control) enhanced the quarantine and screening measures for travelers entering from Wuhan at points of entry, with the cooperation of the World Health Organization (WHO) and the Chinese health authorities. The first patient confirmed as a case of COVID-19 in Korea was announced on January 20, 2020. The carrier arrived in Incheon International airport from Wuhan, China, and tested positive after being flagged for having high temperature at the entry screening using an infrared sensor. Korea was successfully able to control and mitigate the spread of the epidemic without the need for a lockdown or restrictions on movement. The Korean national crisis and emergency management system consists of four alert levels, on which the government raised the infectious disease alert levels to Blue (Level 1) on January 3rd, to Yellow (Level 2) on January 20th, to Orange (Level 3) on January 28th, to Red (Level 4) on February 23rd (MOHW, 2020), as summarized in Table 2.
<table>
<thead>
<tr>
<th>Month</th>
<th>Agile Adaptive Policy Decision</th>
<th>Information Systems Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jan</td>
<td>- Quarantine and Screening</td>
<td>- Immigration Screening</td>
</tr>
<tr>
<td></td>
<td>measures are enhanced</td>
<td>(January 8)</td>
</tr>
<tr>
<td></td>
<td>for inbounds</td>
<td></td>
</tr>
<tr>
<td></td>
<td>entering from Wuhan –</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Infectious Disease</td>
<td></td>
</tr>
<tr>
<td></td>
<td>alert category Blue</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Level 1) (January 3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Cooperation of KCDC,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ministry of Interior and</td>
<td></td>
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<tr>
<td></td>
<td>Safety (MOIS), and the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ministry of Justice (MOJ)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(January 8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- The Korean government</td>
<td></td>
</tr>
<tr>
<td></td>
<td>changes its Infectious</td>
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<tr>
<td></td>
<td>Disease alert category</td>
<td></td>
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<tr>
<td></td>
<td>Blue (Level 1) to Yellow</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(Level 2) (January 20)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- First positive COVID-19</td>
<td></td>
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<tr>
<td></td>
<td>patient in Korea (January</td>
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<td></td>
<td>20)</td>
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<tr>
<td></td>
<td>- KCDC extended the</td>
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<tr>
<td></td>
<td>definition/case of the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>novel coronavirus infected</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cases and strengthened</td>
<td></td>
</tr>
<tr>
<td></td>
<td>monitoring (January 26)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Infectious Disease</td>
<td></td>
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<tr>
<td></td>
<td>alert category from</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yellow (Level 2) to Orange</td>
<td>Orange (Level 3)</td>
</tr>
<tr>
<td></td>
<td>(Level 3) (January 28)</td>
<td></td>
</tr>
<tr>
<td>Feb</td>
<td>- MOHW denies entry of</td>
<td>- PCR test kits available</td>
</tr>
<tr>
<td></td>
<td>foreigners from Hubei</td>
<td>(Kogene Biotech) at</td>
</tr>
<tr>
<td></td>
<td>Region - Korean citizens</td>
<td>Incheon International</td>
</tr>
<tr>
<td></td>
<td>returning from Hubei</td>
<td>airport (February 4)</td>
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<tr>
<td></td>
<td>region or those who</td>
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<td></td>
<td>have been in contact</td>
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<tr>
<td></td>
<td>with positive tested</td>
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<td></td>
<td>patients must self-</td>
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<td></td>
<td>isolate for 14 days from</td>
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<tr>
<td></td>
<td>the date of entry (February 2)</td>
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<tr>
<td></td>
<td>- MOHW release</td>
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<td></td>
<td>guideline on</td>
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<tr>
<td></td>
<td>operation for group</td>
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</tr>
<tr>
<td></td>
<td>facilities</td>
<td></td>
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<tr>
<td></td>
<td>- Temporarily close if</td>
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<tr>
<td></td>
<td>any occupant is tested</td>
<td></td>
</tr>
<tr>
<td></td>
<td>positive for COVID-19</td>
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<tr>
<td></td>
<td>(February 3)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Public and Private</td>
<td></td>
</tr>
<tr>
<td></td>
<td>health facilities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>designated for additional</td>
<td></td>
</tr>
<tr>
<td></td>
<td>testing areas (February 7)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- KCDC announces</td>
<td></td>
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<tr>
<td></td>
<td>quarantine screening</td>
<td></td>
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<tr>
<td></td>
<td>and measures extended</td>
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<tr>
<td></td>
<td>to travellers from China,</td>
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</tr>
<tr>
<td></td>
<td>Hong Kong, and Macao</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(February 12)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- MOHW and KCDC dispatch</td>
<td></td>
</tr>
<tr>
<td></td>
<td>special task forces to</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Daegu region implement</td>
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</tr>
<tr>
<td></td>
<td>disease control measures</td>
<td></td>
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<tr>
<td></td>
<td>(February 19)</td>
<td></td>
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<td></td>
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</tbody>
</table>

**Note:** The text includes specific dates and actions taken by the Korean government and its agencies in response to the COVID-19 pandemic. The table summarizes the agile adaptive policy decisions and the corresponding information systems responses.
<table>
<thead>
<tr>
<th>Date</th>
<th>Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feb 23</td>
<td>Telemedicine initiation (February 23)</td>
</tr>
<tr>
<td>Feb 26</td>
<td>Social media and other platforms used for election campaigning (February 28)</td>
</tr>
<tr>
<td>Mar 2</td>
<td>Delayed new school year by 3 weeks (March 2)</td>
</tr>
<tr>
<td>Mar 5</td>
<td>Korean government supply mask on a 5-day rotation allowing two masks purchase per person (March 5)</td>
</tr>
<tr>
<td>Mar 11</td>
<td>Mask Map service started (March 11)</td>
</tr>
<tr>
<td>Mar 16</td>
<td>Entry restrictions for inbound from 76 countries (March 16)</td>
</tr>
<tr>
<td>Mar 26</td>
<td>K-Walk thru testing station set up outdoors at Incheon International airport (March 26)</td>
</tr>
<tr>
<td>Apr 5</td>
<td>MOHW announce a fine up to 10 million Korean won (~$8,000) or imprisonment for those who not comply to 14 days self-quarantine measures (April 5)</td>
</tr>
<tr>
<td>Apr 27</td>
<td>Introduction of Self-quarantine Safety Band (April 27)</td>
</tr>
<tr>
<td>May</td>
<td>MOLIT require all passengers to wear masks on flight and public transportation (May 25)</td>
</tr>
<tr>
<td>Jun 10</td>
<td>QR code-based registration at restaurants and entertainment facilities (June 10)</td>
</tr>
</tbody>
</table>

Table 2. Key milestones

With massive applications of digital technologies, Korea initiated quarantine measures and most significantly the testing for COVID-19 in the initial stages. People with history of contacts with proven cases were strictly quarantined, with digital monitoring of the quarantine. The effective response against a novel infectious disease required expertise knowledge in order to implement the

1 Korean English word similar in meaning to 'non-contact'; a newly coined word of "contact" with a negative prefix "un", referring to non-face-to-face social and economic activities facilitated by advanced information communications technology (ICT). See the explanation on Section 5.3.
required strict measures (Shaw et al., 2020). The Korean government had assembled the Central Disaster and Safety Countermeasure Headquarters which is headed by the Prime Minister to reinforce the government’s agile responses. In fact, specific roles and responsibilities were allocated such that the KCDC Headquarters served as the command center of the prevention and control effects, the MOHW, head of the Central Disaster Management Headquarters, assisted the KCDC. Meanwhile, the MOIS, head of Pan-government Countermeasures Support Headquarters, liaised and coordinated assistance between the central and local governments (MOIS, 2020). Nonetheless, the administered system and health policies were not possible without the help of digital technologies. Heo et al. (2020) argue that ICTs allowed the Korean government to endorse containment and mitigation strategies simultaneously such as warning alerts, epidemiological investigation, mask-wearing, quarantine contact, and social distancing. In late January, the KCDC introduced the ‘1339 Call Center’ which provides counselling and guidelines for suspected persons symptomatic of COVID-19 and also to check the closest screening station (MOHW, 2020). Furthermore, the Korean government was able to effectively equip itself with robust health and quarantine measures using the 3Ts modules, i.e., test, trace, and treat (Lee et al. 2020). The following section presents a chronological analysis of the case.

4. CASE ANALYSIS

In order to analyse the case, this section presents a narrative chronological account of the response to the COVID-19 and the roles of digital technologies. The case is embedded in the learning-based path dependence of government’s previous pandemic response. We turn to the government’s response, setting out briefly some of the historical environment that provides an opportunity to build adaptation and adaptability in Korean government.

Lessons from prior pandemics: Just as with any other crisis, pandemic response requires centralised leadership and a clear role in the chain of command. Korea became sensitive and adaptive to the dangers of similar viruses through its experience with prior pandemics of the Severe Acute Respiratory Syndrome (SARS) in 2003 and the Middle East Respiratory Syndrome (MERS) in 2015. The lack of emergency preparedness and response led to the rapid spread of MERS to patients, visitors, and healthcare workers at the hospitals, which also suffered from poor ventilation and lack of emergency training to healthcare workers (Ha, 2016). Consequently, the Korean government opted for non-transparency to avoid citizens’ panic, which caused friction between the central and local governments especially in the capital city of Seoul, where the latter wanted more transparency (Moon, 2020). Kim et al. (2020) also identified the issue of poor administrative and data coordination between the MOHW and the subordinate organisation of MOHW, KCDC, which contributed to the system failure of national disease control and to the slow response. The Minister of Public Safety and Security (MPSS, which later became Ministry of Interior and Safety, MOIS), being another important line ministry, did not implement specific response to prevent deaths (Ha, 2016). The painful failure in eradicating the MERS outbreak prompted the government to act expediently to build agile responses and commands during the outbreak of COVID-19 in early 2020, and paved a way to more resilient responses from the government.

Blue level alert (December 2019 – January 2020): In December 2019, the Korean government instructed the Blue Alert Level (the lowest level of alert in the national crisis management system) as the first case of novel Covid-19 was reported. The government assembled an emergency response team within a day that included the Central Disaster and Safety Countermeasure Headquarters headed by the Prime Minister, with the KCDC as the command centre, with the MOHW is close support. The MOIS liaised and coordinated assistance between the central and local governments (Ministry of Health & Welfare : News & Welfare Services, 2020). From the historical experiences of SARS and MERS, biotechnological companies were able to rapidly create reagents and kits for testing COVID-19. The real-time reverse transcription polymerase chain reaction (rRT-PCR) diagnostic sequencing method was shared by KCDC which partnered with the Korean Society for
Laboratory Medicine (KSLM) and the Korean Association for External Quality Assessment Service (KAEQAS) in January 2020 (You, 2020).

**Yellow Level – Containment (January 2020):** As soon as the first positive case was reported on January 20 at Incheon airport, the disease alert category was increased to Yellow (Level 2), and the focus shifted on ICT-based mass testing and the Central Discharge Countermeasures Headquarters (CDCHQs) was set up to initiate the 24-hour emergency response system. Quarantine and screening measures were set up for all individuals traveling to Korea within 14 days of visiting Wuhan, China, and were required to submit to the health questionnaire and report any fever or respiratory symptoms experienced. Symptoms of those entering Korea were monitored by using a self-quarantine safety app which registered quarantine location. The central and local governments established coordination structure to strengthen process to assess the situation, disclose information, provide transparency and built coordinated collective action.

**Orange Level – Contact Tracing (January 27-February 17):** On January 28, to strengthen community response, the level was raised to Orange (Level 3) and all incoming people were subject to 14 days of self-quarantine. The government endorsed public-private partnerships with advanced ICT and biotech companies (Kogene Biotech, Seegene, Solgent, SD Biosensor, and Bioseworm) to ramp up testing by developing COVID-19 diagnostic kits which were made available at airports on February 4th (The Government of Republic of Korea, 2020). As the number of cases started to increase, the central and local authorities proposed the deployment of a contact tracing application for all cases entering the country. The immediate response team would investigate on potential flareups at diverse locations to investigate traces of confirmed cases. Those confirmed was required to install the “Self-Diagnosis App” and “Self-Quarantine Safety Protection App” allowing users to monitor their health conditions and access readily available information on follow-up actions such as physical check-ups, and access to healthcare services using the 1399 line.

**Red Level – Epidemiological Investigation (February 18-):** On February 18th, patient 31 attended service at the Shincheonji Church, and as a result contributed to the cluster of COVID-19 cases in the days to follow, putting the country on Red Level Alert. The government implemented a 5-day rotation system allowing two masks to be purchased per person on designated days based on their birth year. In the efforts to minimize the spread of COVID-19 between healthcare workers and citizens, the government initiated new types of screening stations which are called Drive-thru and K-Walk-thru. Further, leveraging on the advanced ICTs, the MOLIT and the KCDC selected the Smart City data platform and jointly developed the Epidemic Investigation Support System (EISS) to provide an infographic mapping of those tested positive (who) and their routes of the infection (where), to estimate risks which were visualized by hot-spot analysis (Park et al., 2020). AI based medical imaging (including x-ray and CT scan) analysis devices were created to speedily detect major lung abnormalities (Ministry of Science & ICT - Republic of Korea, 2020).

**Global Pandemic Level – Citizen participation (March-):** Since March, the government has been making efforts in curbing the contagion through the Cellular Broadcasting Service (CBS) to inform the public of the movement routes taken by confirmed COVID-19 patients. The government used mass media and various channels to promote the level of awareness and encourage citizens’ participation and promote ‘untact’ behaviors such as ordering food remotely using delivery applications, and making online schooling available. Also on July 12th, public mask system was abolished and shifted to market supply system. There is also an institutional change in health governance. On September 12th, it was announced that the KCDC has underwent an institutional reform, providing itself the independent power over budget and personnel from MOHW.
Korea was one of the first countries to experience a COVID-19 case on 20th January 2020, after China (Shaw, Kim, & Hua, 2020). However, Korea was relatively successful to control the epidemic without the need for a lockdown or restrictions on movement (Lee & Lee, 2020). Although new confirmed cases increased up to 1,237 confirmed case per day during the Christmas season in 2020, overall daily new confirmed cases are around 600 in the last two months (April and May 2021). On February 26th, 2021, South Korea began vaccinating people aged 65 and older.

5. DISCUSSION

This section presents key enablers to digital resilience in the context of South Korea. We identify agility, diversity and plurality enabled by various digital actors’ engagement such as citizen participation, private public partnership (PPP) and R&D governance. This section consists of the following discussion: role of digital technologies and platforms, agility, citizen engagement, PPP and R&D capacity as below.

5.1. Utilization of Digital Technologies

The extensive use of digital innovations based on advanced ICTs was fundamental in shaping the response, implemented within a strong legal framework to maintain standards for privacy. ICTs were used to share and improve the inventory of mask supplies and for citizens to communicate with government authorities using mobile apps. MOLIT developed the Smart Management System (SMS) in collaboration with the KCDC and the MSIT (Ministry of Science & ICT - Republic of Korea, 2020). The SMS collects big data, such as mobile phone location, hot spot usage, CCTV recordings, and credit card usage within 10 minutes (Ministry of Health & Welfare : News & Welfare Services, 2020). Artificial Intelligence (AI) played a significant role in supporting the diagnosis and screening of patients, and develop thorough analysis of different situations. AI based medical imaging (including x-ray and CT scan) analysis devices were created to detect major lung abnormalities, and assist doctors in making quick diagnosis (Ministry of Science & ICT - Republic of Korea, 2020).

The EISS performed inter-institutional communication across the KCDC, police departments, and mobile network companies analysing real time data using GPS and mobile data and CCTV footage, which allowed tracking of patient routes (“KCDC,” 2020; Y. J. Park et al., 2020). The EISS is loaded on the cloud system TOAST G, providing access information of confirmed cases and the AI identifies any mismatched information such as location and time period of distant base stations (Y. Proceeding...
J. Park et al., 2020). Whereas the earlier system took 72 hours for contact tracing, the EISS could exchange information across 28 institutions in less than an hour (Y. J. Park et al., 2020). Moreover, the accuracy of epidemiological investigations was enhanced through data of patient’s travel and medical history, provided by the Korean Immigration Service and the Health Insurance Review and Assessment Service (Ministry of Science & ICT - Republic of Korea, 2020). To safeguard patient privacy, the EISS was equipped from hacking and log-in access protocol. To protect personal information, the EISS limited access of data to epidemiology investigators to identity routes of only positively tested cases who were promptly quarantined (Y. J. Park et al., 2020).

Existing hospital information systems were enhanced with dashboards, e-prescriptions and cloud-based image sharing. New mobile apps enabled efficient communications between healthcare workers and patients, and monitoring devices facilitated in effective patient management (Bae et al., 2020). Quarantined patients were monitored by using a self-quarantine safety app, which registered location and alerted authorities when patients went out of their location. Self-diagnostic apps were made mandatory to those entering the country (Ministry of Health & Welfare : News & Welfare Services, 2020), and patients were identified as moderate, severe, and extremely severe, and appropriately admitted to national designated treatment facilities. Asymptomatic but positively tested patients were isolated and placed in government-sponsored facilities called Living and Treatment Support Centers (LTSCs), which helped prevent shortages of hospital beds. Doctors engaged in telemedicine services to avoid group contagion and contain the spread of infection (Heo, Lee, Seo, & Choi, 2020).

5.2. Agility

Learning from the MERS outbreak, the government had significantly ramped up its testing capacity drawing upon all available resources and supported by advanced ICTs to geo-locate positive cases (Moon, 2020; Y. J. Park et al., 2020). The government enacted a policy on emergency use authorization which enabled the use of pre-approved diagnostic kits in conditions of emergency. The agility was built by the use of multiple apps for different purposes, each built through multiple actors and partnerships. Different forms of learnings contributed to providing the basis for agility in both target and object system responses, which were socio-technical in nature (Amarakoon, Braa, Sahay, & Hewapathirana, R. Siribaddana, 2020). Our study reinforces the contribution of socio-technical agility in innovation and adaptability during the period when there is the need for rapid institutional change. From this perspective, it is notable that each local government established a Local Disaster and Safety Management Headquarters to secure the capacity of healthcare services and beds (Ministry of Foreign Affairs- Republic of Korea, 2020). The government established drive-thru and walk-thru screening stations by late February which shortened testing time and scaled testing capacity nationally, without putting health workers at risk (S. M. Lee & Lee, 2020; Ministry of Health & Welfare, 2020; Moon, 2020). Tests lasted 10 mins on average, per person, whereas previous tests and registration lasted 30 mins (Ministry of Health and Welfare, 2020). Korea was capable of conducting over 23,000 diagnostic tests free of charge per day. Patients were identified as moderate, severe, and extremely severe, and admitted to national designated treatment facilities. Asymptomatic but positive cases were isolated and placed in government-sponsored facilities called LTSCs, where they received two check-ups a day and were immediately transferred to a hospital if symptoms are aggravated (Ministry of Foreign Affairs- Republic of Korea, 2020). The Information Management System provided status of patients and bed availability (Heo et al., 2020), and if countermeasures required excess local capacity, the central government supported necessary resources including supplies, beds and personnel (Ministry of Foreign Affairs- Republic of Korea, 2020). In-patient hospital care and testing costs was covered by the National Health Insurance (NHI) or government funding.
5.3. Citizens’ Engagement and Citizen-generated Apps

Leveraging on the existing digital infrastructure, the government was able to develop mobile applications which enabled ‘untact’ services and behaviour of citizens. “Untact” a combination of the prefix ‘un’ and the word ‘contact,’ describes the health-protective behaviour stemming from individuals in the perception of risk of infection (S. Y. Bae & Chang, 2020). The authors argue that the Health Belief Model (HBM) framework explains the individual’s health protective actions during COVID-19 pandemic. In fact, HBM have been successfully applied such as in vaccination in health-promoting behaviours. The fear of the unknown novel Corona virus, especially because patients are asymptomatic and the infection transmission rate are so rapid, has promoted untact behaviour in daily lives among Korean citizens, while minimizing the possible risk of infection. For instance, online purchasing and payment, working from home, and AI kiosks at restaurants have become more and more common (Lee & Lee, 2020). The Korean authorities also created low-contact testing such as drive through test stations, which minimized exposure to healthcare workers.

There were also citizen’s alternative digital responses to data sharing. A couple of notable Geographic Information System (GIS)-based applications and websites aimed to help people access and share information. Among them, ‘Corona Map’ and ‘Mask Map’ attracted many users as supplementary sources for information. After the first outbreak in Korea, the KCDC published the trajectory history of patients on its website. After 10 days of the first case, one college student developed a ‘Corona Map’ which shows the travel routes of confirmed cases on website map service that is accessible via mobile or web. It is based on open source called ‘Open Street Map’ (Ha, 2020a). The information on the map can be also found on the website provided by KCDC, but it is hard to be found and only written in texts. While the Corona Map has its advantage in intuitively displaying the information by visualization, its increasing use made the developer worry about the cost. However, on February 3rd, Amazon Web Service (AWS) contacted him for supporting all the costs rising from running the server. The following day, Naver gave free upgrade for Naver Map Application Programming Interface (API), and on February 6th, Kakao provided Kakao Destination Search API for free. Korea was not the first country to collaborate with citizen developers to provide mask availability information. However, the citizen generated Mask Map service is worth discussing. There was also a close partnership with IT service providers. When pharmacies inform Health Insurance Review & Assessment Service (HIRA) of the status of mask sales, the sales data is provided to National Information Society Agency (NIA) who reproduces the data in the form of Naver Map of Kakao Map API, so that it can be used in apps or the web (Ministry of Science and ICT Press Report, 2020). It is disclosed by cloud services to prevent delay of the data display and provide flexible services. The cloud alliance, comprised of Naver, KT, NHN, Koscom, offers free cloud service for two months. Other GIS-based applications were also actively developed in civic hacking communities in Korea. Understanding public participation and how this participation transforms knowledge, society and social orders is crucial for analysing the way people implement technoscience in solving social problems. Citizen participation can suggest implications for the data policy in public health crisis, such as voicing their opinions in the situation.

5.4. Public-Private Partnerships

PPP were effectively leveraged to support different interventions in an agile manner. While being important in the defence part of resilience, agility may be even more important in the bounce forward attack and innovative adaptability. A key intervention was the EISS, which enabled information sharing between the credit card company and mobile network companies. Park et al. (Y. J. Park et al., 2020) state that about 2,000 daily cases were tracked by mobile tracking applications, which reduced the time of epidemiological investigation to 10 mins, using information based on latitude and longitude, as well as of visit duration (Y. J. Park et al., 2020; You, 2020). The government collaborated with private agencies in the making of COVID-19 treatments and vaccines. On April
16th, 2020, The Coalition for Epidemic Preparedness Innovations (CEPI) granted funding of $6.9 million to INOVIO to work with The Korea National Institute of Health (KNIH), which functions under the KCDC, and the International Vaccine Institute (IVI) for the development and trial testing of INOVIO’s phase I/II INO-4800, a nucleic-acid based vaccine (IVI, 2020). The hyper-network environment comprising the government, businesses, and citizen’s digital contributed to the government ‘flattening the curve’ by following the 3T policy (test, trace, and treat). Within this framework, people with a history of contacts with proven cases were strictly quarantined, with digital monitoring of the quarantine. Braa et al. (2004) have emphasized the role of ‘networks of action’ in ICT4D research. While they don’t directly address the issue of resilience, they emphasize the heterogeneity of networks as an important determinant of building robustness and sustainability. From this perspective, the network in the case of Korea was relatively more formalized and in-country, coordinated by the MOHW, and built around the framework of PPPs. This networking was primarily in-country and place-based, as contrasted to the more global nature of developing countries where many international donors play roles. However, the case shows that networks are crucial in enabling adaptability in crisis and changing environments.

5.5. Research and Development Capacity

Another key aspect of the context relevant for the Covid-19 response was the government’s intensive funding for R&D in the health sector and in building effective PPP. Resilience requires building capacity at multiple institutional levels of the individuals, organizations, health system, and governance at national level. It also requires multi-faceted capacity relating to, for example, investments and science and technology policy that facilitated R&D for testing methods, leveraging on digital technologies, use of new technologies of AI and machine learning, emergency and disaster management, and various others. For the period of 2013-2017, the government invested KRW 1.14 trillion ($1,032 million) (Korea Pharmaceutical Bio-Association, 2020). MOHW, MSIT, the Ministry of Agriculture, Food and Rural Affairs, invested heavily on R&D with KRW 189 billion ($171 million) in total for vaccines, and a total of KRW 177 billion ($160 million) for diagnostic test kits (Korea Pharmaceutical Bio-Association, 2020). R&D was continuously funded, and efficient mechanisms were established to improve health emergency management, since MERS in 2015. For example, Kogene Biotech received a total of KRW 23.1 billion for the development of diagnostic technology using Multiple PCR, whilst SolGent and SD Biosensor got a total of KRW 20.5 billion and KRW 8.5 billion respectively for the development of diagnosis technology for Zika viruses based on PCR testing (Ministry of Science & ICT - Republic of Korea, 2020). The push for R&D investment is a crucial aspect of building successful diagnostic kits/drugs, which led to agile responses during the first impact of the COVID-19 outbreak. With this backdrop, the companies mentioned above managed to develop and supplied test kits to national and local governments by early March 2020, given the short time period (KMFDS, 2020). The development of these diagnostic reagents led to a significant reduction of time for diagnosis, enabling active response, enabled by the use of AI developed PCR reagents which supported accurate and rapid results from a single test (Ministry of Science & ICT - Republic of Korea, 2020). It is also notable that the KCDC used emergency procedures to fast-track the development and approval for the test kits during the early stage of the pandemic response.

6. CONCLUSION (280)

Although, the empirical findings derived from the single embedded case need to be used for general implications with caution, this study provides implications for digital innovation in developing countries. This study first broadly contribute to ICT4D literature and scholarly efforts to examine the role of information systems in developing countries (Park & Li, 2017; Walsham & Sahay, 2006). Our study may also be of interest to ICT practitioners and experts in health section, as it provides policy implications that highlight key attributes of digital resilience. In particular, in this study of
South Korea, agility, plurality and diversity in digital pandemic responses were crucial as key contributors to digital resilience. Numerous digital actors were involved and co-evolved through public private partnership as well as citizens’ coproduction to governance. In the case of South Korea, technological and economic strength combined with R&D and PPP were drivers of digital responses. On the other hand, in most developing countries, a parallel multitude in digital response to the pandemic are based on a national single window approach leading to the platform homogeneity and dilemma; should one go for one platform – or not. As Gawer (2014:1242) refer to this as the economies of scope in innovation explaining “the cost of jointly innovating on product A and B is lower than the cost of innovating on A independently of innovating B”. A recent study in Sri Lanka reveals that agility, plurality and diversity in digital responses were seen as key factors in responding to the pandemic as well (Amarakoon, 2020). But in this case, they are achieved to a large extent through one platform. It is crucial to investigate how developing countries overcome socio-institutional, technical and managerial challenges and enable innovation through a platform of multiple applications, agility, plurality and diversity for achieving digital resilience. Future research also can be conducted to further clarify the intrinsic characteristics associated with resilience during a pandemic from both an institutionalist view and comparative point of view.

REFERENCES AND CITATIONS


Appendix: List of Abbreviation

3T           Test, Trace, and Treat
AI           Artificial Intelligence
API          Application Programming Interface
CDCHQs       Central Discharge Countermeasures Headquarters
CEPI         Coalition for Epidemic Preparedness Innovations
COVID-19     Coronavirus Disease 2019
EISS         Epidemic Investigation Support System
GIS          Geographic Information System
GPS          Global Positioning System
HBM          Health Belief Model
HIRA         Health Insurance Review & Assessment Service
ICT          Information and Communications Technology
ICT4D        Information and Communications Technology for Development
IS           Information Systems
IVI          International Vaccine Institute IVI
KCDC         Korea Center for Disease Control
KNIH         Korea National Institute of Health KNIH
LTSCs        Living and Treatment Support Centers
MOEF         Ministry of Economy and Finance
MOHW         Ministry of Health and Welfare
MOJ          Ministry of Justice
MOIS         Ministry of the Interior and Safety
MOLIT        Ministry of Land, Infrastructure and Transport
MSIT         Ministry of Science and ICT
NIA          National Information Society Agency
RT-PCR       Real-Time Reverse Transcription Polymerase Chain Reaction
R&D          Research and Development
SMS          Smart Management System
WHO          World Health Organization
A RESILIENT ICT4D APPROACH TO ECO COUNTRIES’ EDUCATION RESPONSE DURING COVID-19 PANDEMIC

Azadeh Akbari, Political Geography Working Group, University of Münster, a.akbari@uni-muenster.de

Abstract: According to the United Nations, schools’ closures have impacted up to 99 per cent of the student population in low and lower-middle-income countries. This research-in-progress report introduces a project on Emergency Remote Teaching (ERT) measures in the ten member states of the Economic Cooperation Organization (ECO) with a focus on the application of Information and Communication Technologies (ICTs) in primary and secondary education levels. The project takes a comparative approach within a resilient ICT-for-Development (ICT4D) framework, where the coping, endurance, and return to pre-crisis functionalities in education systems are studied. The preliminary research demonstrates the impacts of the country’s general COVID-19 strategy, the education system in place, and digital infrastructure’s level of development on instigating distance-learning platforms. The paper further shows that in addition to access to stable internet connections and digital devices, other infrastructural factors such as access to food, electricity and health services play a significant role in education response planning and implementation. Human factors in the education system, such as teacher training for the usage of ICTs, digital literacy of students and parents, and already existing vulnerabilities in the education system pose challenges to crisis management in the education sector. Other socio-political factors such as attitudes towards girls’ education, level of corruption, institutional capacity, and international sanctions or available funds also make the education system less resilient.

Keywords: distance-learning, Emergency Remote Teaching (ERT), Online Distance Education (ODE), COVID-19 pandemic, educational platform, development, ICT4D, resilience

1. INTRODUCTION

The COVID-19 pandemic has caused the largest disruption of education systems in a historically unprecedented way, “affecting nearly 1.6 billion learners in more than 190 countries and all continents” (United Nations, 2020). Closures of schools have impacted up to 99 per cent of the student population in lower- and lower-middle-income countries (ibid.). Many countries have adopted emergency remote teaching (ERT) methods utilising information and communication technologies (ICTs), including educational platforms, radio and TV lessons, and social media channels. This research-in-progress report introduces a project on ERT measures in the member states of ECO with a focus on the application of ICTs in primary and secondary education levels. Economic Cooperation Organization (ECO) is an intergovernmental regional organization aiming for the sustainable economic development of its ten member states and the region. In addition to shared cultural and historical affinities, the member states use infrastructural and business links to achieve common goals. In March 2017, during ECO’s 13th Summit in Islamabad, “ECO Vision 2025” was endorsed (ECO, n.d.). One of the expected outcomes under ECO Vision 2025 in the area of social welfare and environment is the fulfilment of regional mechanisms/frameworks “to support education, training, vocational needs and other capacity enhancement requirements of the peoples/entities of the Member Countries” (ECO, 2017).
Despite such plans and the socio-cultural similarities, the crisis response in the education sector in these countries was not shaped through regional cooperation. It was extremely dependent on the country’s general COVID-19 strategy, the education system in place, and digital infrastructure’s level of development. The preliminary research of this paper shows that in addition to access to stable internet connections and digital devices, other infrastructural factors such as access to food, electricity and health services play a major role in education planning during the crisis. Human factors in the education system, such as teacher training for the usage of ICTs, digital literacy of students and parents, and already existing vulnerabilities in the education system pose challenges to crisis management in the education sector. Other socio-political factors such as attitudes towards girls’ education, level of corruption, institutional capacity, and international sanctions or available funds also complicate the design and implementation of ERT measures.

The research project studies the education and distance learning programmes of each ECO country during the COVID-19 pandemic with a comparative approach within a resilient ICT-for-Development (ICT4D) framework (Heeks & Ospina, 2019). Resilience is understood “as the ability of systems to cope with external shocks and trends” (ibid. p.71) and as a quality that enables not only survival but also endurance throughout the crisis and a return to planned functionalities before the crisis time. Consequently, the research scrutinises resilience attributes such as robustness, self-organisation, learning, redundancy, rapidity, scale, diversity and flexibility, and equality in education crisis responses of ECO countries and investigates the role of ICTs in building resilience through ERT programmes. In the following sections, the report introduces some of the preliminary research on each ECO country’s education response but does not provide concrete outcomes as the research is still underway as this paper is being written. The preliminary data is gathered mainly through desk research through media channels, teachers’ forums, policy plans, governmental and non-governmental reports, project reports, and especially through evaluations, funding and policy implementation reports of international organisations such as UNICEF, UNESCO, and Global Partnership for Education.

The research project has conducted a saturation review (Rennison & Hart, 2018, p.73) of the English-language literature on distance learning during COVID-19 pandemic until no relevant literature could be identified. From 112 publications (papers, conference submissions, chapters, etc.) written on the subject, 59 were directly addressing issues of distance learning in higher education. Within the remaining papers, 20 were dedicated to the educational challenges during the crisis in developed countries. Others focused on other aspects of education such as teachers training, student engagement, general challenges of e-learning, food insecurity as a result of school closure, the opportunities and shortcoming of distance learning for children with learning disabilities, teachers’ attitude towards e-learning, leadership in education during a crisis, using social media and radio for teaching, innovative assessment techniques, lessons learned by different stakeholders, the gap between private and public schools, learners’ social interaction, effective knowledge transfer, and different teaching-learning modalities with a focus on blended learning.

The remaining Publications, dedicated to ERT and online distance education (ODE) in primary and secondary educational levels in developing countries during the COVID-19 pandemic researched the challenges, shortcomings, and chances provided by these programmes in Palestine, Libya, and Afghanistan (Khlaif & Salha, 2020), Moldova (Tatiana, 2020), Latin America and the Caribbean (Jaramillo, 2020), China (Zhang, et al., 2021), Nigeria (Chiemek & Imafidor, 2020), Indonesia (Hidayat, Anisti, Purwadhi, & Wibawa, 2020), Lebanon (Rouadi & FaysalAnouti, 2020), Kenya (Mabeya, 2020), Sri Lanka (Ranasinghe, Kumarasinghe, Somasiri, Wehella, & Kathriarachchi, 2020), African countries (Aseey, 2020), and India (Raj & Khare, 2020) (Bhaumik, 2020). The outcomes of these studies is summarised in the below table.

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costs of access, maintenance, and design
digital learning tools and platforms

housing and access to shelter
lack of private space
stable location for nomadic communities

Organisational challenges
lack of national crisis response plan for education sector
funding problems
cooperation among different stakeholders
teacher training programmes

human development challenges (soft)
teaching capacities
quality of teaching content
evaluation and assessment
encouraging student participation
learning resources
teaching approaches
learning strategies
supports and services for teachers and students

students’ capacity
learning adaptability
participation and motivation
lack of, or insufficient, parental supervision

digital literacy
teachers
parents
students

increased exposure to harm
digital privacy and data protection
domestic violence
girls’ pregnancy
mental health
food insecurity as a result of school closure

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Table 1. Findings’ summary: publications on ERT in developing countries’ schools during the COVID-19 pandemic

The preliminary research in ECO countries shows similar challenges although it discovers some unexplored aspects such as challenges and chances for girls’ education in the region as a result of ODE programmes. The attitude towards girls’ education and the state of girls’ school attendance in ECO countries underlines the importance of taking a comparative approach to countries with socio-cultural similarities. Other collective projects have also taken a comparative approach amongst a variety of countries regardless of development or income-level. For example, in a comparative study between 31 countries (Bozkurt, et al., 2020) general areas of concerns are identified as psychological pressure, emerging educational roles of the parents, support communities and mechanisms, pedagogy of care, alternative assessment and evaluation method, data privacy concerns, digital divide, inequity and social justice, open educational practices and resources, gender issues, and essential (soft) skills and competencies to survive in a time of crisis. Although almost every country in the world has taken ERT measures to sustain educational and schooling programmes, the crisis response is fundamentally different between resourceful and lower- and lower-middle income countries. The regional choice in this research project, therefore, aims to overcome such fundamental disparities.
2. School Education During COVID-19 Pandemic

In this section, ECO member states’ response to the COVID-19 pandemic regarding school education will be discussed in more detail. Each country profile provides a short overview of the education statistics and main challenges in the country and the plans and programmes implemented as part of the national crisis management. As mentioned earlier, the research project is not yet concluded and the descriptive details will be evaluated in a resilient ICT4D framework to assess the resilience of school systems in ECO region with a focus on ICT tools and programmes.

2.1. Afghanistan

The number of children in school in Afghanistan has increased by almost nine times since 2001, and has grown to more than 9.2 million students in 2015, of which 39% are girls (Ministry of Education of the Islamic Republic of Afghanistan, 2016). Although the number of schools has increased from 3,400 to 16,400 (ibid.), 3.7 million children in Afghanistan, or nearly half of all school-age children, are not in formal education (Human Rights Watch, 2020). The nation-wide school closures in Afghanistan has exacerbated an already vulnerable education system. Even though Afghanistan has received more than $100 million in global aid to alleviate the impacts of COVID-19, private educational institutions receive no support from the government (Dawi, 2020). With schools closed for months, vulnerable children such as girls and child labourers are exposed to a higher risk of dropping out. UN Women, UNICEF and Human Rights Watch jointly issued an alert to highlight the gender-specific impact of COVID-19 in Afghanistan (Human Rights Watch, 2020), where Approximately 60% of out-of-school children are girls (UNICEF Afghanistan, n.d.).

![Figure 1. School Facilities in Afghanistan based on data from the Afghan Education Ministry, Human Rights Watch, PenPath, and the World Bank (Mehrdad, 2020).](image)

Meanwhile, the education ministry’s efforts to promote distance learning using radio and TV stations remain futile since almost 70 per cent of the population has no electricity access (Mehrdad, 2020). The lack of electricity is one of the many infrastructural shortcomings in the education sector, such as sanitation facilities, roads and transportation, school buildings, etc (Figure 1). Institutional capacities such as the insufficient number of teachers, especially female teachers, low quality of teaching, and shortage of textbooks also make an emergency response to a pandemic challenging.
Other cultural factors such as girls’ early marriage or patriarchal beliefs against sending girls to school become increasingly difficult to tackle during a health crisis.

2.2. Azerbaijan

The schools are reopening gradually in Azerbaijan after a shutdown since March 2020 and a nationwide distance learning programme. In this phase students will attend school three times a week and on the remaining days teaching will be online (JAMnews, 2021). During the lockdown national TV channels broadcasted TV classes as well as other creative arts competitions and programmes. Recorded TV programs were also available online on a learning platform of the Ministry of Education (United Nations Human Rights, 2020). The country also launched a National Platform called Virtual School in partnership with Microsoft in April 2020, but the enrollment was voluntary and relied upon each school’s decision (azərbaycan müəllimi, 2020). Local companies BestComp, AzEduNet, and Edumedia were involved in addressing possible technical issues (ibid.). In addition to training videos, the Ministry of Education provided ICT-training for 14,000 teachers and Azercell, a local mobile network operator, agreed with the Ministry of Transport, Communications and High Technologies to provide a free internet package to 30,000 teachers (ibid.). Azerbaijan’s cooperation with international institutions such as UNICEF helped the timely distribution of support material for children, particularly those with special needs, teachers, and parents (UNICEF Azerbaijan, n.d.). With a school enrollment ratio of almost 90% (UNESCO, 2021) and 80% of households enjoying Internet access (The State Statistical Committee of the Republic of Azerbaijan, 2020), the education system was resilient in response to the COVID-19 pandemic.

2.3. Iran

Iran launched its national virtual school platform at the end of September 2020, but according to official statistics, 38 per cent of students are not connected to it, and an additional 20 per cent have registered but are not active on the platform (Radio Zamaneh 2020). 21 per cent of students have no means of acquiring a digital device to access the platform (ibid.). Besides the shortcomings in digital devices, accessing internet is also challenging. In many villages, students have to climb nearby mountains to receive internet coverage on their mobile phones (Yousefi, 2020). Iran has supported privatisation of the education sector in the last decades, and currently, 12% of students study at private schools (Mehr News, 2020). These schools use more efficient technological platforms such as Webynar1, which offer local techno-solutions in the face of international sanctions that make access to global platforms such as Zoom or Skype impossible (S., 2020). The discrepancy between the resources, infrastructure and quality teaching available to public and private school students widens the educational gap between different economic groups.

2.4. Kazakhstan

Kazakhstan started distance-learning programmes concurrent with the first lockdown, and in the first semester of the 2020 school year (from September 1 through November 4), 2.4 million out of 3.4 million students attended virtual classrooms (RFE/RL’s Kazakh Service, 2020). With 70 per cent of schoolchildren receiving an online education, the educational platforms have shown progress: BilimLand Online Mektep (Knowledge Land Online School) provides access to complete school programs and libraries (ibid.), but the hybrid system of education with present teaching for children with no access to digital devices, in addition to postal services, radio and TV (UNESCO Almaty, 2020) has put an extra burden on teachers’ shoulders. The government has distributed 500,000 computers or laptops to students in low-income families and has pledged to provide 300,000 more (ibid.). Other civil society initiatives such as Connect-Ed donate used or new devices to schoolchildren in need (Gabdulhakov, 2020). The economic disparity between different regions of Kazakhstan contributed to poor education even before the COVID-19 crisis. The World Bank,

1 https://webynar.ir/
UNICEF, UNESCO\textsuperscript{2}, and WHO\textsuperscript{3}, jointly with the Ministry of Education and Science of the Republic of Kazakhstan, focus now on post-COVID learning recovery to hinder the educational disparity worsened after a long phase of unequal access to schooling (Jetpissova, 2020).

\subsection*{2.5. Kyrgyz Republic}

In December 2020, the UNICEF office in Kyrgyzstan published an appeal for humanitarian action for children (UNICEF, 2020). The appeal highlighted the profound impact of the pandemic on the well-being of children and warned about the “disruptions to education, water, sanitation and hygiene (WASH), nutrition and health – including vaccination – services, and the rise in violence, poverty and stress” (ibid.). UNICEF also reported that school closures have affected all 1.6 million school children, which the majority of them will continue remote learning in the 2020/21 school year due to lack of adequate WASH facilities and safety measures in schools (ibid.). Since April, the Ministry of Education and Science, in collaboration with UNICEF and other development partners, has developed a remote learning platform for all students and preschool children (Zhusupova, 2020). More than 200 teachers from Bishkek and Osh prepared video lessons and conducted their classes according to the school curriculum via various TV channels (ibid.). Teachers used other international platforms such as Google Classroom and zoom to provide one-to-one lessons and feedback (Abdieva, 2020), and 75,000 teachers were trained on delivering digital, distance and blended learning (UNICEF, 2020).

\subsection*{2.6. Pakistan}

All schools were closed in Pakistan as part of a sporadic lock-down from March 2020 until January 2021 (Ejaz, Khaliq, & Bajwa, 2021). The Ministry of Federal Education and Professional Training launched the TeleSchool initiative at the beginning of lock-down in collaboration with local education technology providers such as Knowledge Platform, Sabaq.pk, Sabaq Muse, and Taleemabad to broadcast free learning content to grades 1-12 students (ibid). In December 2020, the government introduced its first radio-school to expand student outreach (ibid.). Although experts warn about the learning losses in Pakistan due to school closures, digital infrastructure disparities, low-quality schooling systems in rural areas and general economic hardships (Geven & Hasan, 2020), others have pointed out the opportunities arisen in distance learning to increase girls’ education. In Pakistan, one out of three girls have never been to school as a result of distance from schools, security, and lower numbers of female teachers (Ejaz, Khaliq, & Bajwa, 2021). The demands for distance learning have also contributed to an 80%-growth in education technology start-ups (ibid.) The EdTech Pakistan 2.0 workshop organised by the World Bank used the momentum to connect start-ups with development partners, government, and other stakeholders to focus on distance education, blended learning, and girls’ education during and after the pandemic (ibid.).

\subsection*{2.7. Tajikistan}

Tajikistan denied the arrival of the COVID-19 Pandemic in the country for quite a long time (Putz, 2020a) but took cautionary measures to finish the 2020 school year early and start schools ahead of the traditional September opening in August (Putz, 2020b). At schools, students maintain physical distancing in the schoolyard, wear a mask, when possible organise classes outdoors, and regularly wash their hands (Putz, 2020b). However, the UNICEF office in Tajikistan has received a Global Partnership for Education (GPE) grant to support the Ministry of Education and Science with a National Education Preparedness Response Plan (GPE, 2021). The plan includes additional education interventions, such as developing TV lessons and a distance learning platform (ibid.). The

\textsuperscript{2} The United Nations Educational, Scientific and Cultural Organization

\textsuperscript{3} The World Health Organization
blended learning platform uses LearnIn, Learning Passport, and Maktab Mobile to make the video lessons available online (Ammon, 2020).

2.8. Turkey

The Ministry of Education in Turkey developed a digital education platform (EBA) at the early stages of the pandemic and also collaborated with the Turkish Radio and Television Corporation (TRT) to broadcast educational material (Özer, 2020). As an exception amongst other ECO member states, Turkey had already developed the EBA digital educational platform since 2011. The platform offers “various learning materials, including curriculum-based videos, documents, e-books, tests, [and] activities” for students from preschool to high school level (Özer, 2020, p. 1126). The platform also includes assessment tools and online broadcasting features. Students with no internet connection can watch the videos on national TV; “TV programs are transmitted via three different channels for primary, early secondary and secondary school students” (ibid.). The level of crisis preparedness is also evident in the 2018 Teaching and Learning International Survey (TALIS) among OECD (the Organisation for Economic Co-operation and Development) countries. As demonstrated in Figure 2, teachers show a good level of confidence in working with digital platforms. Other supporting measures such as free internet for student or training 125,000 teachers on distance teaching in collaboration with UNESCO (Özer, 2020, p. 1127) maintain a more inclusive crisis response.

Turkey is also home to more than 1.6 million child refugees, out of which 400,000 remained out of formal education even before the COVID-19 pandemic (UNICEF, 2019). UNICEF has established 170 physical EBA Support Centres, including six Mobile Centres in six provinces with a high refugee population and has distributed 90,548 learn-at-home kits (UNICEF Turkey, 2021), but the educational losses experienced as a result of the pandemic, in addition to the existing challenges of the refugee crisis will unfold in the mid and long term.

![Figure 2. School and student preparedness for ICT-based learning prior to the crisis - Survey conducted in 2018 (OECD, 2020)](image)

2.9. Turkmenistan

Turkmenistan might be the only country in the world that still denies the arrival of the COVID-19 pandemic within its borders. The government neither implemented a general lock-down nor closed
schools or educational facilities. The public measures remained limited to closing the borders, restricting cross-country travel, introducing social distancing, raising awareness on personal hygiene, and limiting access to certain public spaces (Chronicles of Turkmenistan, 2020). In 2017, Turkmenistan adopted the Concept for the Development of a Digital Education System, which aims to improve the quality of educational services through a digital platform and create conditions for continuous education for all segments of the population (Government of Turkmenistan, 2019). Despite such goals for sustainable development, a shaky digital infrastructure and lack of digital literacy have left this vision not implementable during the pandemic (Muhamedov, 2020).

2.10. Uzbekistan

Uzbekistan closed down all schools during its first response to the COVID-19 Pandemic (March-May 2020) but decided to gradually open up schools as of September 2020. In a close collaboration with the UNICEF country office with a US$70,000 grant from the GPE, a rapid household survey was conducted to evaluate education sector interventions and requirements (GPE, 2020). The survey describes the challenges for distance-learning programmes vividly (United Nations Uzbekistan, 2020), as many households have no access to either digital devices, stable internet connection, or the digital literacy how to use digital platforms (Figure 3). Based on other studies by the UNICEF office, television was identified as the key media for delivering distance learning material (ibid.). Consequently, the Ministry of Public Education has taken a hybrid approach by offering video lessons on TV, in Telegram messenger application, and on the Ministry’s digital platform, accompanied by feedback and assessment by teachers entrusted with supplementing lessons (ibid.).

![Figure 3. Access to online/digital resources and knowledge of using online resources (United Nations Uzbekistan, 2020)](image)

3. Next Steps

In the next steps of this research project, the resilience attributes of a resilient ICT4D would be applied to education responses described above. The resilience perspective is a helpful approach since it moves beyond a single focus on challenges and harms and identifies possible chances and opportunities in strengthening education systems in lower- and lower-middle-income countries using ICTs. Distance learning programmes offer resilient responses in countries with frequent school disruption, such as Nigeria through infrastructural development, the availability of resources in digital format, and innovative assessment methods (Oladip, Oyedele, & Fawale, 2020). Other research on open and distance learning in developing world (Perraton, 2006) shows the potential of e-learning in assisting post-crisis countries in rebuilding their education systems (see, for example, Rhema & Miliszewska, 2012, for a discussion on Libya), or in crisis-prone countries such as Lebanon (Baytiyeh, 2019) or in war zones such as Syria, where children experience insecurity, instability, lack of resources, and lack of adult supervision (Almasri, Tahat, Skaf, & Masri, 2019). Open and distance learning programmes could also be regarded as a response to the global crisis in teacher education and training (Banks, Moon, & Wolfenden, 2009).

Any emergency always affects the target population unequally. Researchers have already discussed the setbacks of crisis, especially on educating minority groups (see, for example, Ingbu, 2010, for a discussion on Sub-Saharan Africa). However, a thorough response analysis to COVID-19 as a
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global emergency situation can provide governments, international organisations, and regional institutions with tools and lessons for future planning and policy making. For instance, the current crisis has once more underlined the issue of girls’ education in ECO region. Recent studies have demonstrated how the lack of private space at home affects female college students in Palestine and facilitates returning to traditional gender roles and family obligations; therefore, putting an obstacle on their ability to study at home (Meler, 2021). As already discussed in the country profiles in Pakistan and Afghanistan, the effective educational platforms have increased girls’ attendance but have also increased concerns that digital means would pave the way for prohibiting girls’ school attendance in light of digital home schooling. Consequently, this project aims to highlight the complexities of crisis response in education sector especially in countries with existing vulnerabilities in educational systems.

**REFERENCES AND CITATIONS**


STUDENTS’ ENGAGEMENT IN AN ANONYMOUS PEER REVIEW: USING THE OPEN-SOURCE SAKAI PLATFORM

Fazlyn Petersen, University of the Western Cape, Fapetersen@uwc.ac.za
Bradley Groenewald, University of the Western Cape, 3658200@myuwc.ac.za

Abstract: There is a need to provide quality education without discrimination or prejudice to all students. However, there are challenges in implementing quality education in large classes, especially during remote learning. Literature indicates that providing lecturer feedback can become a tedious task, especially in large classes. Literature states that involving students in the peer review process can improve the quality of their submissions. This research used a case study and thematic analysis. Qualitative data were collected from 179 third-year Information Systems students who used the Opensource Sakai Platform. Students reviewed another student’s report, without knowing their identity. The research used self-determination theory as a theoretical basis. The achievement of perceived autonomy is supported as an anonymous peer review helped students to empower themselves. Perceived competence was also achieved as the anonymous peer review improved the quality of work submitted and the development of workplace skills. Perceived relatedness is supported as students indicated that the anonymous peer review allowed them to learn from their peers. It also improved their understanding and the ability to see errors in their work. Despite the negative aspects identified using the Sakai platform, it may provide a viable alternative for providing feedback remotely, especially during the Covid-19 pandemic.

Keywords: Quality education, eLMS, Sakai platform, anonymous peer review, diverse large classes, historically disadvantaged institution

1. INTRODUCTION
The achievement of quality education for all is complex. Authors indicate that the achievement of quality education requires that an equilibrium between the teaching style of the lecturer and the learning style of the student is achieved (Hill, Lomas, & Macgregor, 2003). One such challenge that various institutions of higher learning face are that the number of students who are attending university are and have been growing at an exponential rate (Özoğlu, Gür, & Gümüş, 2016) with a growing level of inequality among student groups.

Students are demographically diverse and digitally literate (Singh, 2016). These are students who are different in terms of race, culture, age, gender, religion, social class, and cognitive domain (Bowman, 2016). Teaching these demographically diverse students is challenging because each student may require different teaching and learning methods in terms of 1. How students assimilate concepts. 2. How students interact with their peers and lecturers. 3. How students and lecturers recognise the differences in terms of demographics (Sadowski, Stewart, & Pediaditis, 2018). To effectively teach diverse, digitally literate students, the literature indicates the importance of providing feedback to provide improved learning in higher education (Jonsson, 2013).

Additionally, lecturers are working remotely, via electronic learning management systems (eLMS), during the Covid-19 pandemic. Therefore, there is an increased need to provide quality feedback to students online.
According to (Baker, 2016), lecturer feedback can become a tedious task as most of the time is spent on fixing grammatical errors. Whereas a minuscule amount of time is spent on addressing students' ability to display their understanding of the concepts taught. Also, students do not perceive review in any form as positive, regardless of how constructive the criticism is (Jonsson, 2013). Therefore, if students do not engage with the feedback provided it will not lead to improved student learning and performance (Winterscheid, 2016). An alternative method of providing feedback is the use of peer review.

Peer review is a process to evaluate the work of others to ensure that is it of excellent quality (Harland, Wald, & Randhawa, 2017). Anonymous peer review is another type of peer review process that can be used. The key difference lies in the anonymity of the process (Panadero & Alqassab, 2019). Three benefits can be realised as a result of using an anonymous peer review:
1. It allows students to develop analytical skills,
2. It increases the engagement from the student which could be beneficial in improving the quality of education and
3. If utilised correctly, it enhances learning and the quality of education (Harland et al., 2017).

The literature provides evidence that anonymous peer review increases how students engage with each other and the research (Watkins & Ball, 2018). Anonymous peer review fosters a collaborative and communicative environment that improves learning according to experiential learning theory (Kolb, 2000; Sridharan, Muttakin, & Mihrat, 2018). The literature supports that anonymous peer review improves learning and the quality of education. Another study that supports this found that the challenges of anonymous peer review lie in “motivating students to complete the reviews” (Søndergaard & Mulder, 2012). Research has found that 87% of students believe that anonymous peer review is beneficial (Simpson & Clifton, 2016). However, this research was not conducted in a developing country.

South Africa is a developing country where the need to transform higher education has been highlighted (Department of Education, 1996). Due to the legacies of apartheid, there is a historical “inequitable distribution of access and opportunity for students and staff along lines of race, gender, class and geography” (Department of Education, 1997:8). Through the Extension of University Education Act of 1959 new universities were created for students of colour. Students of colour were only permitted entry to white universities where programmes were not offered at black universities (Department of Education, 1996). The inequalities between historically white and black universities are evidenced by the difference in participation rates among different populations, lower ratios of black and female staff and disparities in terms of capacities and facilities (Department of Education, 1997:8). Therefore, “despite the absence of data, it is not unreasonable to think that graduates from historically black universities may struggle to find work more than graduates from universities that served white students because of differences in the perceived quality of their degrees” (Altbeker & Storme, 2013:15).

Therefore, the research question was: How do students engage in an anonymous peer review in a large class at a historically disadvantaged institution? The objectives of this research were to determine students’ engagement in an anonymous peer review in a large class at a historically disadvantaged institution and to provide recommendations to improve future implementations.

2. RESEARCH DESIGN AND METHODOLOGY

The research utilised a case study design with a qualitative methodology to effectively answer the research question and its stated objectives (Yin, 2003). The aim of this was to understand students as actors and how they engaged in an anonymous peer review. This allowed for “thick descriptions” (Avenier & Thomas, 2015) of students engagement in anonymous peer review to be developed.

Data was gathered from students’ textual responses via an online survey from 179 third-year Information Systems students at a historically disadvantaged institution. Students used the Sakai
platform to complete the anonymous peer review. The allocation of reports to students was automatically done via the Sakai platform. Students were instructed to remove any identifying information (e.g. names or student numbers) from their submissions. Students did not know the identity of the student whose report they were marking. Students’ identities were only known to the lecturer.

The researchers had a low level of control over the students being studied to understand students’ engagement with little to no influence. The data analysis used thematic-content analysis which allows student data to be “identified, analysed, organised, described and reported” (Nowell, Norris, White, & Moules, 2017, p. 2).

Ethical considerations were based on the guidelines provided by (Dearden & Kleine, 2018). Students provided consent for participation in this research. The objectives of the study along with the anticipated benefits were explained to all students involved in this study. Student anonymity was maintained by removing unique identifiers, such as student numbers. The collected data was stored in an access restricted folder.

3. CASE STUDY: USING THE ANONYMOUS PEER REVIEW ON THE SAKAI PLATFORM

The University of the Western Cape (UWC) is a historically disadvantaged institution that was created for predominantly ‘coloured’ students. Coloured was a racial classification, based on apartheid. The population consisted of “class of African and Asian origin variously referred to as half-castes, bastards, Cape Boys, off-whites or coloureds” (Adhikari, 2009:xii). However, it also consisted of ‘sub-groups such as Malays, Griquas and ‘Hottentots’ (Adhikari, 2009:xii) who would typically not be allowed to attend the historically white institution, the University of Cape Town. The vice-chancellor in 1987, Jakes Gerwel, referred to UWC as the “intellectual home for the left” (Soudien, 2012).

UWC uses the open-source Sakai platform to host their eLMS. The Sakai platform is a free, educational software platform that supports teaching and collaboration (Sakai, 2020). The Sakai platform is regarded as an eLMS leader for three consecutive years (Sakai, 2020). The ability to complete anonymous peer reviews remotely can be accomplished by using platforms such as Turnitin and Sakai. The Sakai platform allows lecturers to use an anonymous peer review as an assessment option (Sakai, 2020). However, if students do not engage with the process having any platform available will not automatically result in the successful completion of a peer review or improving the quality of their work.

Authors provide the following guidelines for the creation of effective, high-quality feedback in Table 1:

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Application in the large, undergraduate course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Should be task-related.</td>
<td>An assignment was created, as indicated in the course outline, where the student had to create a report to obtain funding from a potential investor for their business. The anonymous peer review was set as the assessment option.</td>
</tr>
<tr>
<td>Focused on the quality of the student performance rather than the students’ characteristics.</td>
<td>The use of an anonymous peer review reduces the ability of markers to focus on students’ characteristics and rather focus on their performance.</td>
</tr>
<tr>
<td>Must help students to improve their performance.</td>
<td>There was an opportunity provided to complete an optional peer review with fellow class members before the submission of the final assignment on the Sakai platform. If students used this opportunity, they could improve their final submission. A rubric was provided to students to clearly define the marking criteria.</td>
</tr>
</tbody>
</table>
Should be delivered in a specific, timely and individualised manner. The Sakai platform allows the assignment to be released to students at a specific date and time, as indicated in the course outline. The deadline date was set on the platform and included in the course calendar.

Feedback will only assist in improving students’ performance if it is used. Students who did not engage in the optional peer review before their final submission performance may not have performed as well as students who completed the exercise.

Critical feedback improves the chances of improved student performance (Cutumisu & Schwartz, 2018). Students received marks and comments to assist them with future submissions.

4. RESEARCH MODEL

A theoretical model is a lens or blueprint which guides the researcher in answering the research question of how students engage in an anonymous peer review and the research objectives (Grant & Osanloo, 2014). It is based on theories from previous studies to guide the development of results in the data analysis (Lederman & Lederman, 2015).

Self-determination theory (SDT) has been used as a model to investigate students’ engagement (Reeve, 2012). SDT is constructed from five theories of motivation (Ryan & Deci, 2019):

1. Basic needs theory emphasises the importance of intrinsic motivation, engagement and psychological well-being for achieving psychological needs,
2. Organismic integration theory introduces extrinsic motivation. Extrinsic motivation is the “activities aimed at achieving outcomes separable from the behavior itself” (p.15). While intrinsic motivation refers to the performance of an activity for one’s satisfaction,
3. Goal contents theory differentiates between intrinsic goals and extrinsic goals. Intrinsic goals support psychological needs and well-being. Extrinsic goals neglect these needs and results in ill-being,
4. Cognitive evaluation theory predicts the effect of external events on intrinsic motivation and
5. Causality orientations theory identifies how individual differences influence motivation.

Based on SDT, the research model focused on three areas, namely:

1. Autonomy refers to people’s need to feel in control of their behaviour and goals,
2. Competence is the need to master tasks and to learn different skills and
3. Relatedness refers to the need to feel a sense of belonging and a connection to other people (Deci & Ryan, 2008).

The application of SDT to the research was completed as displayed in the research model (refer to Figure 1):
5. RESULTS

An analysis of demographic data for 179 third-year B.Com Information Systems students who participated in the survey was completed. Results indicated that the majority of students are between 16-24 years old (80.4%) and the minority between 35-49 years old (4.5%). The majority of students are male (54.7%) and full-time students (87.7%).

5.1. Perceived autonomy

Based on the research model, students’ level of perceived autonomy is based on three factors, as specified in the research model.

5.1.1. Acts with a sense of ownership of their behaviour

Evidence indicates that the anonymous peer review helps students to empower themselves. This is supported by students’ quotes: “I actually felt empowered reviewing another student’s work” (female, 16-24) and “Peer review might sound unnecessary but another student's review would make you feel proud about your own work or make you want to work even harder because that student’s work is inspiring” (female, 16-24).

5.1.2. Feel free to make own decisions

Perceived autonomy is positively supported by students’ ability to make their own decisions. Quotations included, “We all take different decisions and have opinions which differs but at the end we all can reach the destination. It proves that they is not just one formula in life they are other ways to get things done not just one way” (female, 16-24). However, the data is indicated that students also did not trust the anonymous peer review exercise. This is due to various factors, one of them being anonymous peer review gives students too much decision-making ability in marking assignments. This was highlighted by a student who said the following: “...it was frustrating to see
how other people did their assignments and have to think that those same people who are not good writers have to critique your assignment” (female, 16-24).

Evidence highlighted that there was an element of unfairness in the anonymous peer review exercise. This is summarised in the following quote: “The peer review exercise was okay, I did not enjoy marking the other persons. I feel like the peer review is not fair to some students, some will mark wrong and others right. It would have been better if the lecturer or the tutors marked our assignments” (female, 16-24).

5.1.3. Anonymous peer review allows for reflection

In the data, it was found that students perceived their learning to improve by being able to compare assignments. This finding is largely supported by the majority as summarised in the following quote: “I felt that it helped me judge myself and better my mistakes as I read through the other projects” (male, 16-24). Students also learnt the importance of following instructions, “It actually showed me how we actually lose marks by not following instructions” (male, 16-24).

5.2. Perceived competence

Students’ engagement in the anonymous peer review was analysed based on their level of perceived competence. Perceived competence includes four determinants, as indicated in the research model.

The findings of the research highlighted that there was a level of perceived competence achieved for the anonymous peer review. The following section will describe the themes identified in the research model and the application to the data.

5.2.1. Develops critical thinking and analysis skills

The data analysed indicates that students perceive anonymous peer review to aid them in developing critical thinking and analysis skills. This is summarised by the majority of the students who are males between the ages of 16-24 in the following quotes: “The peer review exercise taught me how to read with understanding and pushed me to improve my analytical posture”.

It was also found that students learnt how to be more objective in analysing and reviewing their peers’ work. This theme was highlighted by the following quote: “Forces one to be objective” (male, 16-24). However, the results also indicated that students did not understand the course content that was provided and thus could not effectively perform the anonymous peer review. Therefore, students did not provide adequate or any feedback during the anonymous peer review.

5.2.2. Develops workplace skills

Students indicated that the anonymous peer review aided them in developing workplace skills. The findings highlighted management and time-management skills. In support of this are two quotes from students: “I gained management skills” (female, 25-34) and “Learning how to best manage my time... qualities that will come handy in the workplace” (male, 25-34). However, it was also found that students are under the impression that not all of their peers can write reports. This negatively affected student engagement with the anonymous peer review. A student noted the following: “I learnt that not many of my peers actually know how to write a business report” (male, 16-24). Therefore, the ability of such students to conduct a peer review was questioned.

People skills was another social skill highlighted by a student who stated the following: “I did this in a respectful manner which built my people skills” (female, 16-24). In addition to this, it was found
that anonymous peer review helps students to understand marking from the perspective of the reviewer.

5.2.3. Improves the quality of work submitted

The findings highlighted student perceptions that there was an improvement in the quality of their work. This is summarised by the following quote: “I enjoyed it. It helped me to understand what I did wrong in my own report. It also helped me measure my own standards by peer reviewing someone else’s report” (female, 16-24).

The data also indicated that students found the anonymous peer review easy to understand. This can be summarised by a common quote from the majority of students: “It was quite straightforward and simple to do” (male, 16-24). Students’ engagement with the anonymous peer review decreased in complexity and become easier as they neared completion of the exercise. This is highlighted in the following statement from a student: “But when I realised how to do it using the rubric I was able to do it easily” (male, 16-24). However, findings also indicated that students found the anonymous peer review to be difficult and uncomfortable.

Although the majority of students perceived anonymous peer review to improve their learning, it is suggested that some students perceived the anonymous peer review exercise to be confusing and uncertain.

5.2.4. Develop skills to use eLearning systems

A finding that negatively impacted student engagement was that the majority of students found that they could not complete the anonymous peer review due to issues related to the Sakai platform used. Students’ views were summarised in the following quote: “It’s a bit difficult to do when the system itself made it difficult to complete” (male, 16-24). Although this issue appeared the data suggests that some students solved it by getting assistance from the lecturer. This is highlighted by a student who said the following: “This caused frustrations however the lecturer assisted me” (female, 16-24).

5.3. Perceived relatedness

The level of perceived relatedness was also investigated to assess students’ engagement in the anonymous peer review.

5.3.1. Students to learn from their peers

The finding is supported by the majority of students (78 quotations) who indicated that the anonymous peer review exercise allowed them to learn from their peers. This can be summarised by the following quote: “I got to see how other people tackled the problem. It also exposed me to thinking from different perspectives. Also adding to my learning experience” (male, 16-24). It was also found that students were able to understand how their peers thought, learnt and had differing ideas about the assignment.

5.3.2. Development of social skills

Evidence indicates that there are students who preferred to be marked by their peers. This finding was supported by the following quote, “It was really good to get marked by the student” (female, 16-24). However, contrary evidence indicates that students did not trust their peers enough to review each other’s work. The data analysed indicated that students themselves feel a level of uncertainty when it comes to anonymous peer review. This is highlighted in a quote from the following student: “Would prefer not having to do it again. I didn’t know if I did it correctly” (female, 35-49). The lack of trust finding could be improved if students adhered to or understood the instructions.
5.3.3. Peer motivation

Perceived relatedness was negatively impacted by students’ perceiving that their peers put in less effort than them. This factor is supported by the following quote, "I strongly disagree with this exercise, the anonymous marker may not be up to speed with the course work and may not know what you are writing about and it can put hardworking students in the deep end" (male, 16-24).

Despite the anonymous peer review being a compulsory part of the assignment not all students completed it by the deadline or complete it at all. This resulted in students who had completed their anonymous peer review but not receiving their results. It led to having to motivate students to complete the anonymous peer review. Evidence of this can be summarised in the following student comment: “Next time I will try and ensure that my peers meet the deadline so that it does not affect my work” (female, 16-24).

6. DISCUSSION

The findings indicated that perceived autonomy positively influenced students’ engagement with the anonymous peer review. Anonymous peer review also allows for students to reflect on their work is supported by (Wanner & Palmer, 2018).

Evidence indicates that students’ engagement was possibly influenced by perceived competence. Students believed that the anonymous peer review improved their learning, aid in the development of skills and improves the quality of work submitted. These findings are supported by (Noble, 2018) who found that the majority of students felt that their written work had improved. The literature states that involving students in the peer review process improves the quality of the result of their submission (Baker, 2016). This is because students are aware of others, their peers reading their work and thus put more effort into it (Watkins & Ball, 2018).

The authors also found that anonymous peer review aids in the development of skills such as critical thinking (Simpson & Clifton, 2016). Findings also supported the development of workplace skills and social skills, as indicated in the literature (Chaktsiris & Southworth, 2019). It should be noted that a certain level of uncertainty was created by when peers mark. This resulted in the anonymous peer review being difficult and uncomfortable. This also supported by (Meek et al., 2017) as they found that peers are not qualified enough to perform the review and that it is uncomfortable reviewing peers. Although, this finding is supported by the minority it should not be dismissed in attempting to improve the anonymous peer review process.

Positive perceived related themes resulted in students improving their learning by learning from peers. This finding corroborates with a finding by (Meek et al., 2017) as they found that anonymous peer review allows students to see a different viewpoint and seeing good examples of writing. However, a negative finding that impacts perceived relatedness are peers not trusting each other. Additionally, not all students were motivated enough to complete the review. This supports the above finding in that students did not trust their peers due and not all students completing the anonymous peer review. The majority of students enjoyed reviewing their peers and viewed it as beneficial.

The last notable finding is that there were issues related to the technology used in the anonymous peer review exercise. Students were required to complete their anonymous peer reviews using the open-source Sakai platform. The authors found that the reliability and validity of the peer review were put into question when the technology used does not work (Søndergaard & Mulder, 2012; Wanner & Palmer, 2018). However, the lecturer worked with Sakai support staff to address the matter and assist students. Using an open-source eLMS may be a viable option for other historically
disadvantaged institutions, due to the lower costs such as not paying for licences. At UWC, the Sakai platform was zero-rated to allow students access to remote learning during the pandemic.

7. CONCLUSIONS

The benefits of the peer review were discussed as a means of achieving quality education. Ultimately, it was discovered that there is not sufficient literature on this topic on the implementation of anonymous peer review in large classes in a historically disadvantaged institution. Therefore, this research adds to the body of knowledge by examining students’ engagement in an anonymous peer review. The research findings can be used to identify areas for future improvement.

This research aimed at answering the research question by identifying students’ engagement with an anonymous peer review exercise using the open-source Sakai platform. The research used a case study research design and qualitative methodology.

The findings in the research highlighted that the anonymous peer review helped students develop critical skills related to thinking, working and socialising. It was also found that it improves students’ learning through reflection and students learning from each other. Although there were positive findings, negative findings also emerged. These findings are that students do not trust the anonymous peer review and that they are uncertain about its use. Also, it was found that the Sakai platform used in the anonymous peer review could lead to further challenges.

The findings are limited to third-year students at a historically disadvantaged institution and therefore cannot be generalised. Recommendations for future research are that a mixed-methods approach should be used. This is due to the effectiveness of a mixed-methods approach in effectively understanding the data. Moreover, future studies should gather data from postgraduate students as well. This will allow researchers to evaluate the efficacy of using anonymous peer review in both undergraduate and post-graduate courses.

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ACCESS TO DIGITAL PLATFORMS: CAN ‘MOBILE’ NETWORKS COVERAGE REPORTS BE RELIED UPON? OBSERVATIONS FROM RURAL ZAMBIA AND ZIMBABWE

Gertjan van Stam, Masvingo, Zimbabwe, gertjan@vanstam.net

Abstract: As access to digital platforms in Africa is mostly through ‘mobile’ networks, this paper addresses the mismatch of universalised reports on ‘mobile’ access and the experiences from digital health practice and cases in Zambia and Zimbabwe. Further, the paper shines a critical light on the meaning of terms like access and the 4th industrial revolution from an African context. It argues for the need to invest in contextual research and development, also to gain a comprehensive understanding of how to access digital platforms in and from Africa.

Keywords: access, digital platforms, Africa.

1. INTRODUCTION

In Africa, accessing digital platforms is closely related to the operations of ‘mobile’ operators as their networks are the only two-way communication network widely available. Digital platforms offer online mechanisms enabling value-creating interactions between external producers and consumers (UNCTAD, 2019, p. 25). ‘Mobile’ network operators manage fixed infrastructures that consist of a radio access network with base stations, a transmission network providing the communication backbone, and a core network with switching facilities and database servers handling user information. The role out and use of ‘mobile’ networks is heralded as one of the successes of the introduction of technology in Africa.

The adjective mobile, however, is only meaningful in reference to fixed phones (sometimes called landlines). In most places in Africa, a fixed, copper-based telephone network has never existed. Therefore, the term mobile does not refer to a technological configuration: the mobility or immobility of a particular device (Odumosu, 2018) This ambivalence goes unrecognised in most literature. In this paper, therefore, the term mobile is put between quotes or avoided.

The widespread use of communication devices has an enormous influence in Africa. Handheld devices are the contemporary drums of Africa (Nyamnjoh, 2009). Writings on digital developments often start with statistics on the availability of ‘mobile’ network connectivity and a number of users, gleaned from reports published by the International Telecommunications Union (ITU), the Global System for Mobile Communications Association (GSMA), and other international organisations. In most reports, narratives pivot around the economic benefits of being connected and how connectivity numbers and the potential for expansion represent opportunities for the particular intervention being featured. Here, narratives position telecommunication networks as engines of growth and change, generating benefits and opportunities for the poor. However, the categories, definitions, structures, and their assessment appear unaligned with the local experience of connectivity and access, community understandings and the purpose of the appropriation of, and interaction with, digital technologies and services (Loh & Chib, 2021). The reports do not explain the reality of what exists from the perspective of Africans in Africa.
This paper was developed from long-term research into the question “how to regard witnessed mismatches between access realities described in (international) reports and the longitudinal experiences of realities and practices in Zimbabwe and Zambia, among other African countries?” The result is a critique of the implied weight placed on access to digital platforms via ‘mobile’ telephone networks. It questions the perceptions – *certainties* – derived from reported quantifications.

2. **METHOD**

This research is set along a dynamic and integrative epistemological route, integrating long-term, diverse and differentiated experiences, embodied understandings, value judgements, and actions while residing in rural and urban areas in sub-Saharan Africa (Bigirimana, 2017; van Stam, 2019). The author harmonises longitudinal observations, experiences and learnings of over 19 years living and working in rural areas in Zambia and Zimbabwe, and 2 years in urban areas in Zimbabwe, augmented with most frequent and extensive travels in rural areas in Southern Africa. This is done through reflexive science using the method of living research (van Stam, 2019). The aim is to recognise patterns and wrestle local understanding out from under a Eurocentric gaze as an act of decolonisation (Hlabangane, 2018). As such, the research seeks decentered, inclusive, multifaceted understandings and the emancipation of polyvocality (the consideration of many voices), diversity and multiple perspectives, with preference for the contextual (in this case, African) positionality (Adamu, 2020).

3. **CONTEXT**

The GSMA represents the interests of nearly 800 mobile network operators. The association reports that there were 3.6 billion unique mobile subscribers, half of the world’s population, using mobile phones at the end of 2014 (GSMA Intelligence, 2015). In 2015, the GSMA report stated that: “the unconnected population is predominantly rural” (GSMA Intelligence, 2015, p. 3). At the end of 2018, there were 456 million unique mobile users south of the Sahara in Africa (GSMA Intelligence, 2019). This accounts for 44% of the African population south of the Sahara. With regard to the use of digital services, the GSMA reports that 239 million of these use the Internet. The word *rural* is not found in the latter report.

In Zimbabwe, most phone users do not venture beyond the use of basic services, like telephony and instant messaging (Zimbabwe National Statistics Agency (ZIMSTAT) and UNICEF, 2019). In Africa, the use of a phone cannot be readily understood by applying the normative meaning attached to the term *phone* as current in the West. In Africa, ‘mobile’ phones are to be understood as a concept (Odumosu, 2018). For example, these handheld computing devices act as messaging centres, wallets, and even mirrors. For many, they are an entrenched part of the social constructs of African life. The normative view of the phone’s mobility, or as a device for making calls or link to digital platforms, is subject to the fluid and dynamic social function assigned to the technology. For people to connect with digital platforms, such practice must be part of the social constructs of the meaning and function of communication devices in Africa.

The accessibility and use of ‘mobile’ Internet connectivity vary greatly, depending on the services on offer and the price packaging of so-called *bundles*. In the Africa south of the Sahara, Facebook dominates social media with its WhatsApp service and portal. For instance, early 2020, in Zimbabwe, Facebook traffic was over 85% of all ‘mobile’ data usage (Postal and Telecommunications Regulatory Authority of Zimbabwe, 2020, p. 10). Having skipped other technologies, and with increasingly powerful computational information and communication devices in the hands of people, ‘mobile’ phones have led to *leapfrogging* and structure the way many Africans south of the Sahara communicate, handle finances, and are educated (Nyamnjoh, 2009).

In 2015, the Internet Society reported that 94% of the global population was covered by a mobile telecommunication networks, 48% by mobile broadband, and 28% have subscribed to mobile
Internet services. **Coverage**, however, can be defined in many ways. Often, reports are confusing the coverage of population with geographical coverage (land covered). As African cultures closely connect people with notions of geography – *land* – geographical coverage is most important. In Africa, the majority of people live in rural areas. Outside of the main cities, large inequalities can be experienced between the mobile coverage reported and the ability to use mobile services and data-connectivity. Reception of a radio signal (coverage) is often patchy, with large areas without any coverage at all. Witnessing the discrepancy between reports and experienced realities outside of towns makes one wonder about how such reports substantiate their claims of coverage. And, even while a radio signal can be available, data-connectivity can be next to nothing.

Configuring ‘mobile’ networks in Africa is particular, as users of communication networks behave differently from users elsewhere. Configuring and dimensioning of telecommunication networks in Africa, therefore, diverges most significantly from the standard rules as they are set outside of Africa (Odumosu, 2018). For example, as the establishment of communication channels appears to often fail, African users will continue trying to establish the communication channel, even when confronted with a busy signal. This African traffic profile has major technical consequences, for instance, for the signalling traffic which needs over-dimensioning network backbones and computing systems. With any change of service provisioning, African ways of appropriation and use behaviour have to be understood for dimensioning the technology, so as to ascertain the networks’ usefulness to connect with digital platforms.

In the universal reports by the GSMA, Internet Society, and ITU, statements about rural areas are sparse and invariably generic. They often echo an Africa failing narrative. Definitions of, or distinctions between, urban and rural areas are commonly absent. Most significantly, the urban/rural disjoins remain unquantified; most access statistics do not differentiate between urban and rural areas and scant (if any) detail is provided on how the numbers break down between them. The lack of detail can also be seen in other fields of interest; for instance, there is no quantitative information on the access of those with disabilities or those among the vulnerable in Africa. Although not made explicit, it seems that available information emerges from desk research, possibly using imputation (Unesco institute for statistics, 2012). Reports seem to reflect the biases induced by the daily experiences of their authors, who appear to be connected and seated in urban areas.

There appears to be great variation – a disconnect – between the macro-figures and practical, local experiences with the availability and usability of access. This disconnect is lost in the arguments derived from those numbers, but obvious to African practitioners, who often struggle to transmit and received digital information (Chawurura, Manhibi, van Dijk, & van Stam, 2020). Questioning these generic reports, some guestimate geographical coverage areas to be as low as 30% in certain countries (Nyambura-Mwaura & Akam, 2013). Even when explicit about geographical coverage, the reliability of the information on coverage area from mobile operators is questionable – measurements or imputation? – especially in the large expanses in Africa.

The flattening of the growth of connectivity observed during recent years seem to be turning the tide of generalisation or urban bias. Some initiatives have been taken, such as the ITU resolution in Buenos Aires, shifting the focus towards inclusion, with a renewed interest in rural connectivity being featured in a dedicated chapter in its 2020 report (International Telecommunication Union, 2020). Discordant approaches need attention, different from contemporary models that have served for half of the world’s population who access digital platforms through the Internet. Obviously, they do not work nor serve the other half.

There are little, if any, dedicated and longitudinal studies on the availability of communication devices and networks utilised to connect with digital platforms from rural areas in Africa. This could be related to the general lack of funding for embedded, African research (Mawere & van Stam, 2019), a general paucity of data (or reluctance to share precious information in situation of power-differences), and Africa’s huge size – the second largest continent on Earth. The challenges to physically access and review realities in African rural areas are daunting. Nevertheless, some
indications are available, often as a by-product of other research. To substantiate examples of how such information can creatively be recognised, three quantitative cases are presented, one from Zambia and two from Zimbabwe. These cases are gleaned from research on health interventions and digital literacy. Among the research data collected is information on the availability and use of communication devices like phones by clients of rural health institutes.


While reviewing data from a study in early infant diagnosis of HIV exposed children, researchers in Macha, a rural village about 70 km north of Choma in the Southern Province of Zambia, noticed how the availability of phones for essential use was quite uncertain (van Dijk et al., 2014). In their study cohort, only 30% of 490 mothers had used a phone (reported use in 2013: 33%; 2014: 26%; and 2015: 30%). The researchers argued that, although phone calls and text messaging had the potential to improve early infant diagnosis of HIV exposed children, access issues needed to be addressed first. They recorded low phone ownership, low use, and limited coverage in rural areas around Macha.

3.2. Nurse training schools in Masvingo, Zimbabwe (2017)

Jerera is a sizable semi-rural settlement in Masvingo province in southern Zimbabwe, about 100 km south-west of Masvingo town. Musiso Mission hospital is located in Jerera. Silveira is another rural mission settlement with a hospital, also in Masvingo province, 100 km west of Masvingo town. Both hospitals operate a nurse training school (NTS). Musiso’s NTS provides a three-year programme for Registered General Nurses. Silveira NTS offers a six-month upgrading programme for Primary Care Nurses.

Upon request by the hospital NTSs, SolidarMed, a Private Voluntary Organisation, established computer labs to support the students and the schools’ operations. In the labs, low power, shared computer resources provide access to digitised information. Regular, basic computer training and support is provided by the digital health team of SolidarMed. In 2017, they surveyed the digital literacy among nursing students at these two hospitals (Braat, Sithole, Chikwati, Bishi, & van Dijk, 2018). The survey took place at the start of the school period. The purpose was to establish a baseline on students’ knowledge about computers and the use of information and communications technologies (ICT). In total, for the two NTSs, 74 student nurses (of which 62, or 84%, were female) completed a questionnaire. Less than half (31 students, 42%) had ever used a computer before their exposure to the computer lab at the NTS and only 3 (4%) had received training in using computers. About one third of the students (24 students, 32%) owned a computer. Out of 74, only 2 persons (3%) used a computer for their studies: one did an online course and the other visited medical related websites. About a quarter of the students (19 students, 26%) were users of Facebook. The majority of students (56 students, 76%) owned a smartphone. More than half of the respondents (43 students, 58%) did not connect to the Internet on their mobile devices. Less than one third (20 students, 27%) used email (Braat et al., 2018).


In Zimbabwe, the Friendship Bench developed a mental health intervention, aligned with the Zimbabwean context and culture (Chibanda et al., 2016). In 2018, SolidarMed initiated the Friendship Bench method in a closely monitored group of 20 rural health facilities to assess the feasibility of implementation, acceptability and utilisation of the method in rural settings. Operational research accompanied the execution of this work. Binary meta-data regarding the availability of a communication pathway was assessed for 7,230 persons receiving Friendship Bench services in the rural district of Zaka in Masvingo province. Information was gathered from the 20 health facilities during a 13-month period from February 2019 to March 2020. During enrolment, to ensure quality, tracking and tracing, health care clients were asked for a telephone number through which the health institute could reach the client. The availability, or absence, of a telephone number provides an indication of whether or not the person has ready access to means of communications.
Of the 7,230 clients, only 54% provided a telephone number (unpublished data, SolidarMed). In the context where the intervention took place, phone numbers are part of social practices to establish and maintain relationships. Exchanging telephone numbers is regarded as good behaviour. As telephone sharing is common practice (Krah & de Kruijf, 2016), the actual ownership of mobile telephones is likely to be lower than 54% (Okon, 2009). This tallies with the report from the Zimbabwe Multiple Indicator Cluster Survey (MICS), performed between January and April 2019 in 11,091 households across Zimbabwe (Zimbabwe National Statistics Agency (ZIMSTAT) and UNICEF, 2019). The MICS survey found that phone ownership was around 64% in rural areas and around 50% for those categorised poor (Figure 1).

Figure 1. Phone ownership in Zimbabwe (Zimbabwe National Statistics Agency, 2019)

4. FURTHER OBSERVATIONS

Weak performance of communication networks frustrates the role of digital platforms, services and interventions at health facilities and for clients (Chawurura et al., 2020). In 2018 and 2019, Zimbabwe’s Ministry of Health and Child Care endeavoured to decentralise data-entry in the electronic District Health Information System 2 (DHIS2) from district to primary level in Masvingo province, Zimbabwe. The aim was to improve the quality and availability of data and quicken report throughputs. Although around 80% of the 25 facilities involved received a communication network radio signal, implementation of the ideas was severely hampered by poor communication network performance. In two-thirds of the cases, the data throughput was unsuitable for a health information transfer to take place (unpublished data, SolidarMed).

Of course, there are large grey areas regarding the availability, accessibility, and usability of networks. Being in or out of the coverage area of phone networks is an ambiguous judgement. Mobile phone towers can be out of service in times of load shedding by the mains electricity supply company, shortages of fuel to run the back-up generator, low solar energy yields, or depleted battery systems. Network design, set up, and management are challenging endeavours in Africa, and implemented technologies might not be conducive for African environments (Johnson & van Stam, 2018) as developments took place without African inputs (van Stam, 2016). And, while data-communications within the communications network can be fine, interconnectivity with other networks can be congested, blocked or managed sub-optimally, while latency can hamper usability of access with digital platforms (Johnson et al., 2012).
In areas of patchy radio coverage, community members often know where a signal can be found. Receiving or making a phone call or sending a message might necessitate climbing a hill or travel to a certain spot. Due to fluctuating propagation of radio waves, network signals are known to fade in and out, especially when the booster (telecommunications network tower and equipment) is at a considerable distance or located in a jagged landscape. For instance, at the author’s home, 18 km outside of Masvingo town, network access is not possible with a handheld phone: connectivity is achieved by using a high-gain, directional antenna coupled with a router that converts the network signal to an analogue output for a fixed phone and a Wi-Fi signal to access digital platform by means of the Internet Protocol.

5. DISCUSSION

In the assessment of access, there is often no clear dichotomy between haves and have-nots, unless a radio signal or fixed network is not available at all. There is rather a gradation based on different degrees of access to information and communication technologies (Cisler, 2000). A binary divide between the haves and have-nots is patronising because it fails to value the social resources that diverse groups have (Warschauer, 2003). Therefore, not only is plain access crucial, but so is social knowledge and knowledge about how technologies interact in the integration of digital platforms into the practices of communities, institutions, and societies. The aim of information flows should be social inclusion. In many parts of Africa, the conventional access model, i.e., one-to-one (or many-to-one) is non-functional, or even potentially destructive (Gurstein, 2012).

The concepts of the digital divides and digital exclusions are multifaceted and complicated. Definitions remain ambiguous, especially when they are imported from elsewhere. The use of phones in Africa differs from the use of phones in most Western countries, where fixed, mobile, and digital technologies and services are conceptualised as distinct entities, and where they are designed and produced to exist (Alzouma, Chibita, Tettey, & Thompson, 2013). Furthermore, there is no single definition of rural area. In the same token, there is no common understanding of the term poverty, or consensus on what the boundaries of availability are. Concepts of ownership vary widely among cultures, and individual ownership (or individualism per se) is not necessarily a common faculty in Africa (Sheneberger & van Stam, 2011). General assessments of access, as shown above, almost without exception, are set frames derived from the cultures from which the terminologies and subsequent technologies emerge (Mavhunga, 2018; Nkwo, Orji, & Ugah, 2021). Universal definitions are mostly linked to measurable outcomes, devoid of social components like experience, judgement and action. Local perceptions, definitions and interlinked categories denoting access may diverge significantly from extant understandings. The use of universal categorisations and their attached boundaries is limited and confusing if their meaning is not understandable in context, and have a history of being used to colonise (Mamdani, 2012). Therefore, the definition and interpretation of the availability of access is a complex issue, although crucial when looking at the feasibility of accessing digital platforms.

The fact is that ‘mobile’ phone networks have been largely designed without contributions from Africa. In the conceptualisation and standardisation of the 5th Generation (5G) mobile networks, no African interest nor embedded knowledge was represented during its constitution (van Stam, 2016). With the installation of imported technical systems, Africa does not primarily purchase technology, but first and foremost establishes links with teams of designers and ways of doing. For instance, after integrating Waze with Google, Noam Bardin (2021) noted “No one buys technology, you buy a team and a way of doing things”. These teams and ways of doing increasingly focus on facilitating machine-to-machine communication, instead of communication among people. This shift of attention leads to a reduction in access opportunities, as: “much attention is focused on the roll-out of this the next generation of networks, much of the energy from the mobile sector around connecting the unconnected is dissipating” (Bloom, 2019 online). Alternatives to ‘mobile’ networks depend on cable, satellite, or stratospheric communication platforms. Sea cables exist in coastal
areas, but inland cables are relatively sparse and scarcely reach beyond the line of rail. The cost and latencies of satellite systems are often prohibitive for use (Johnson & van Stam, 2018).

In Africa, the 4th industrial revolution – in which automation, like robotics, the industrial Internet and big data analytics are positioned as new engines of the economy – is nascent, at best. In most African places, especially rural areas, the second revolution – electrical power – and the third – use of electronics – has not yet taken hold (Naudé, 2017). From the outset, access, among other fundamentals for the 4th industrial revolution, was glaringly lacking (Ministry of Foreign Affairs, 2018; Rodrik, 2018). The pursuit of the 4th industrial revolution could be working against the need to solve the frustrating lack of basic access to digital platforms. A case in point is the lopsided benefits of the digital platform economy. At present, China and the USA own and control around 90% of the worldwide market of digital platforms, while Africa together with Latin America account for only 1% (UNCTAD, 2019). Of course, culturally appropriate alternatives and participatory, community focused and involving arrangements do exist. Examples are the field of community networks (Bidwell, 2020) and dynamic spectrum allocation for the use of TV White Spaces (Gweme & van Stam, 2016).

6. CONCLUSIONS
This paper shines a critical light on available, generalised reports on (data) access, as derived from general, mostly international, reference material. In light of the practices and cases presented from Zambia and Zimbabwe, it appears these reports provide false certainty and seem to (create/impute) realities instead of providing a description of realities in rural areas.

Currently, the way in which access and service availability can be understood and used remains obscured by limited research from embedded, African experience and understanding on technology and in rural Africa in general. There is a distinct void in understanding, due to the ongoing normalisation through universalised, external reports. Therefore, the quality and quantity of access to digital platforms remains a shot in the dark in Africa.

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**Abstract:** The primary objective of our exploratory research is to contribute to the ongoing conversation on Digital Afterlife from the lenses of Global South during the COVID-19 period. Digital Afterlife is fast becoming a challenge for our increasingly connected society. Moreover, the situation got worse with the COVID-19 pandemic. The on-going research is to address the disparity in the Global South, specifically in countries like Indonesia, India and The Philippines compared to the Global North for Digital Afterlife services such as policies and digital mourning services. By addressing the research question, ‘What services and policy frameworks are available for Digital Afterlife in the Global South during COVID-19?’, we aim to find the multitude of ways people in the Global South are managing their digital footprints. Our preliminary findings show that some considerable research and death related digital services and innovation have taken place during the pandemic. However, overwhelming majority of these works are western-centric and mainly dealing with post-mortem personal asset management. Cultural nuances, socio-economic perspectives, religion, political climate, regional infrastructures are mostly sidelined. We found significant disparity in Digital Afterlife product and service designs, which got worse during the global pandemic. Our goal is to collect further in-depth data within the three big ICT powerhouses of global south (Indonesia, India and The Philippines), identify the challenges as well as the innovations around Digital Afterlife. We envision proposing a set of recommendations, based on our findings, for developing a more inclusive and equitable digital space in this pandemic-stricken world.

**Keywords:** COVID-19; Global South; Global North Concepts; Digital Afterlife; Legal; Religious; Cultural; Privacy; Technology.

1. **INTRODUCTION**

1. This research aims to develop an in-depth understanding whether various online services foster digital dependencies in the Global South (developing nations) and Global North (developed nations) specially for Digital Afterlife services (Dados & Connell, 2012; Lemuel, 2010). This is an ongoing research to understand the ways different technology services have affected the Global South society in dealing with death and related consequences specifically in the most densely populated and COVID-19 affected countries like, Indonesia, India and The Philippines (World Meter, 2020). This knowledge can help us to design, develop, and manage inclusive and efficient technological solutions for Digital mourning services with social and religious empathy in the COVID-19 world. Our previous research shows that, there is a considerable gap in the Digital Afterlife scholarship for addressing the developing region's (Global South) (Hussain, et.al, 2017). Moreover, due to COVID-19 it is now significant that we recognize the gaps and challenges faced in the Global South for both Digital Afterlife and Digital Mourning services.

2. Connections with numerous digital services (Facebook, Twitter and Instagram) have ensured better access to information, citizen services, communication, productivity, and much more.
However, such a digitization process enforces every user to leave a part of their presence, big or small, in digital formats in cyberspace. Digital Afterlife is the digital footprint we leave behind through our Google mails, Facebook accounts, Amazon’s online services, or Apple’s iTunes (Hussain, et.al, 2017). After our biological death, these digital remnants would continue to exist in cyberspace, as our Digital Afterlife. Information and Communication Technologies (ICTs), as we know, are yet to be designed to properly manage the eventual death of their users and the related inherent challenges.

3. Based on a rapid and in-depth qualitative ethnographic research, we seek to answer the following questions:

I. What services are available for Digital Afterlife in the Global South during COVID-19?
   a) Will digital mourning services become mainstream COVID-19? How will this affect religious, cultural and traditional ceremonies?
   b) Are there localised and customised services for the focused countries in this research?

II. Are there policy frameworks available to address Digital Afterlife in Global South?
   a) Are all the global services ensuring same or equivalent policies for both Global South and Global North?
   b) Are there any new policies for Digital Afterlife in India, Indonesia and The Philippines during COVID-19?


According to HCI, Kaye et al. talked about “legacy” elements of any user, which represent an individual’s digital work (Kaye, et. Al, 2006). Massimi and Charise mentioned the need of sensitive orientation of any technological solution in dealing with the deceased’s data (Brubaker, 2015; Massimi & Charise, 2009). ICT providers are yet to be designed to effectively acknowledge and reflect the eventual death of their users (Vitak; et.al., 2012). Nevertheless, with few exceptions like the works of Gray and Paul, who recognized the need of inclusion and diversity in design, majority of the works on digital post-mortem literature had an underlying assumption of somewhat universality of Digital Afterlife related challenges (Ellis & Coulton, 2013). The cultural nuances, socio-economic perspectives, political climate, regional infrastructure- the factors which have proven to be immensely critical for ICT diffusion in Global South are not considered and included in the present Digital Afterlife scholarship.

Based on the lack of awareness and understanding about Digital Afterlife, people are confused with which laws or social practices to follow as far as the digital bequeathing is concerned. Up until now, there has been no consensus on following a common set of policies in this regard. The Uniform Law Commission (ULC) in United States approved the Uniform Fiduciary Access to Digital Assets Act RUFADAA in 2015 (Uniform Law Commission, 2015). The RUFADAA does not allow any decedent or incapacitated person’s digital assets to be disclosed to anyone, even to their fiduciary. In such situations, the digital service providers will have control of any deceased users’ digital assets. Until now, at least 46 states have enacted laws addressing access to email, social media accounts, or certain electronically stored information, upon a person’s incapacity or death (Uniform Law Commission, 2015). In contrast, European Union (EU) leaves discretion in implementation to EU member states to extend this minimum protection, which is guaranteed. Some European Union countries have used this possibility, and their data protection laws offer post-mortem data protection, limited in its scope and post-mortem duration (Harbinja, 2013).
ICT services, online and offline in the Global South are not designed to include options for dead users or the management of digital resources after the corresponding users’ death. The major net based global entities like Facebook, Google, Twitter are now putting considerable provisions, and policies in place to deal with Digital Afterlife. “Firms such as Eterni.me and Replica now offer consumers online chat bots, based on one’s digital footprint, which continue to live on after users die, enabling the bereaved to ‘stay in touch’ with the deceased” (Öhman & Floridi, 2018).

During COVID-19 quite a few services were introduced in the Global North. There are four categories of firms in the Digital Afterlife Information - Information management services, posthumous messaging services, online memorial services, re-creation services. One can now create wills online and download them to a Digital Afterlife service provider. Along with that some Digital Afterlife service providers offer free data management and others require a once off fee or monthly/yearly subscription to remain in use (Racine et al, 2020). In April 2020, funeral live streaming start-up, OneRoom, was working to meet demand to install cameras into funeral homes to offer funeral streaming services (Kuri, 2021).). Sadly, these new options are too western society specific and do not include Global South oriented challenges such as absence of copyright laws, scarcity of localized ICT services, poor governance, apathy of policymakers and service providers, etc. Moreover, such services are based or priced at a rate that is not feasible or intended for the standard of living in many developing countries, specifically low per capita income countries like India, Indonesia and The Philippines (Dados & Connell, 2012). Given the disparity in living standards these new Digital Afterlife services are becoming farfetched in many parts of the world due to lack of awareness. Even though COVID-19 has raised more demand for such Digital Afterlife services however, the lack of inclusion, cultural awareness resulted in limited or no services for the Global South.

3. RESEARCH METHOD

4. This qualitative research has two parts. The first half is primarily based on in-depth literature review and ICT policy and service provision analyses. Major digital service providers with global footprints, prominent Digital Afterlife specific legal provisions, and real-world case studies are the main sources for our research, alongside key academic research on this interdisciplinary topic.

At the second phase of this research, we plan to engage with topic experts across different regions through in-person interviews and focus group discussions. Initially, we aim to work with approximately 20 to 50 respondents in each of our country sites in India, Indonesia, and the Philippines. The number of research participants will increase after that. For this research, online interviews will be conducted with religious, legal, social, and technical experts. Approximately 4 to 5 experts will be interviewed individually via online platforms. In addition, online interviews and focus group discussions with people who recently have availed different Digital Afterlife options for themselves or their deceased family members or friends; and with people who have not yet used any Digital Afterlife options for any of their digital accounts online.


4.1. Increasing Digital Legacies Without Proper Guidelines

At present, due to COVID-19 pandemic, we were required to limit our mobility significantly. All these enforced changes in personal and professional lives have resulted in a huge surge of digital footprints. The present-day ICT services, both online and offline are not in general designed to include conducive options for digital legacy management. We are now creating new contents, opening new digital service accounts, and conducting online financial transactions at a much higher rate. Hence, another disturbing trend we have observed to be on the rise is the potential identity theft and targeted blackmailing through exploiting the deceased users’ accounts.
4.2. Digital Afterlife and Religion - Mourning of The Deceased Users Online

The validity of various online funerals and mourning sessions through different religious lenses has also initiated a lot of confusions and conversation within the space of religion, society, and technology. Funerals and last rituals performed over Zoom, FaceTime, or Skype became a new normal during this period of COVID-19 (Observer Report, 2021). It has been observed that various online groups and online chats have been formed voluntarily by the families and friends of a deceased person to mourn and perform religious activities during the pandemic (Bray, 2021). Despite the lack of internet or electricity connectivity in parts of India, Indonesia and The Philippines families of the deceased tried to perform online religious activities to pray for the departed soul (Bray, 2021).

During COVID-19, we have observed a shift towards online platforms to mourn, even as social distancing is coming at an ease. However, expectations of privacy and ownership of such online events (and the related content) in the long term is unclear. According to Bray, “...the pandemic is transforming the global “death care” market, which consists of funeral, burial, and internment services and which, in 2020, was estimated to have a market size of $106.3 billion” (Bray, 2021). Startups are beginning to capitalize on the “end of life sector, Guruji on Demand (Indian Hindu ritual service startup) charges $339 to take care of everything (revenue jumped 219% from the first quarter of 2020 to the end of September) (Bray, 2021). Therefore, unknowingly the demand for all online services for religious rituals for a deceased increased. For instance, Fu Shou Yuan International Group (China’s largest funeral provider) offers services that allow mourners to “virtually clean” the graves of their loved ones and upload virtual offerings (Bray, 2021). The demand for end of life (shūkatsu) services has shown in a survey in 2020 that 28% of Japanese had signed up with a funeral company (Bray, 2021).

4.3. New Services with Limited Digital Afterlife Policies

According to our initial research, few of the new and leading digital communication and professional services have Digital Afterlife policies for its users to manage their post-mortem data, both nationally and internationally. For instance, in February 2020, the only existing Google policy directly related to the user’s Digital Afterlife is the Inactive Account Manager (IAM), which allows users to determine what happens to their accounts after a certain period of inactivity (Google, “Inactive Account Manager”, 2021). In addition, other start-ups such as GoodTrust, “Provide information about the account, and upload documents like proof that the person has passed away and create necessary online Power of Attorneys (GoodTrust, 2021). SafeBeyond, uses Amazon’s Cloud technology to store sensitive information in “vault-like” servers that cannot be accessed by third parties (SafeBeyond, 2021), Afternote, provides users with the opportunity to digitally store their life story, leave messages to their loved ones and record their last will (Afternote, 2021). Eter9, social network that uses Artificial Intelligence to create a virtual being (deceased) that publishes, comments, and interacts with you intelligently (Eter9, 2021). Nevertheless, in most cases, according to our observation, people have limited knowledge about the everlasting consequences of such massive digital presence. Majority of the users in the Global South are neither aware of the concept of Digital Afterlife nor the traditional challenges it poses (as mentioned above), making them further vulnerable online.

Moreover, we are observing a big spike of the number of deceased users’ social media and other digital service accounts in our focused counties due to COVID-19. We aim to closely study some of these accounts closely to see how those are managed (or left behind or exploited) in the coming days. Such knowledge would help us to better understand our societal vulnerability in the absence of proper awareness options.
5. FUTURE WORK

5.1. Raising Awareness About Digital Afterlife
According to our research, lack of understanding about the basic concepts of Digital Afterlife is a
major obstacle in Global South. People are still unaware about the negative impacts (e.g., copyright
infringement, privacy violation, identity theft, loss of private data, etc.) of a poorly managed digital
account of a deceased person. Digital Afterlife specific factors have to be included in the ICT
policies with relative ease alongside the traditional perspectives of online copyright and intellectual
property rights in in India, Indonesia and The Philippines.

5.2. Digital Afterlife and Religion
In the long history of human society, afterlife has played a prominent role in shaping up significant
socio-religious events and activities. During this period of global pandemic, the situation has
become even more challenging. Our initial findings showed that people are forced to transition to
digital platforms to perform religious rituals and mourning for the deceased. It also opened the need
for new interpretations of afterlife in relation to the ongoing digital presence of any human being.
Through our research, we plan to engage with the religious experts and general population to know
more about their perceptions and interpretations related to this new phenomenon. Our findings can
shed some lights on the entangled worlds of social media and religion.

5.3. Responsible and Inclusive Service Providers
Our aim is to ensure that the disparity between knowledge and services are improved in both Global
South and Global North. We need to understand what the society is aware of and whether we need
to address the Digital Afterlife concept from a cultural or religious point of view or implement
policies. Moreover, creating inclusive ICT policy framework, which without blindly following the
western solutions, can recognize the Digital Afterlife specific challenges and localized solutions.
The proposal is to work on raising awareness about Digital Afterlife by creating dialogues among
different stakeholders, in Public Interest Technology forum. To mitigate the disconnection and
disparity between Global North and Global South in aspect of a global pandemic, COVID-19 and
Digital Afterlife. We eventually envision proposing a set of recommendations, based on our findings,
for developing a more inclusive and equitable digital space in this pandemic-stricken world.

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DESIGNING MOBILE HEALTH FOR USER ENGAGEMENT: THE IMPORTANCE OF SOCIO-TECHNICAL APPROACH

Tochukwu Ikwunne, ADAPT Centre, Trinity College Dublin, Ireland, ikwunnet@tcd.ie
Lucy Hederman, ADAPT Centre, Trinity College Dublin, Ireland, hederman@tcd.ie
P. J. Wall, ADAPT Centre, Trinity College Dublin, Ireland, pj.wall@tcd.ie

Abstract: Despite the significance of user engagement for efficacy of mobile health (mHealth) in the Global South, many such interventions do not include user-engaging attributes. This is because socio-technical aspects are frequently not considered during the design, development, and implementation, stages of such initiatives. In addition, there is little discussion in the literature about the role socio-technical factors play in user-centered design processes for mHealth. This research posits consideration of socio-technical factors is required as techno-centric approaches to mHealth design and user engagement, as well as those relying on existing universal frameworks for user-centered design, have proven to be ineffective with the result that most mHealth projects in the Global South fail to sustain. This research examines projects in Sierra Leone where semi-structured interviews were conducted with mHealth designers and developers in order to explore their attitudes towards user engagement in this case. Barriers and facilitators to user engagement were identified and classified as either technical or socio-technical. Findings from the study indicate that adoption of a techno-centric approach without consideration of socio-technical factors can negatively affect user’s engagement. Based on these findings, we propose to develop a new design framework for more effective inclusion of user-engaging attributes in mHealth.

Keywords: mHealth, user engagement, socio-technical, techno-centric, user-centered design

1. INTRODUCTION

It is broadly accepted that the ubiquity of mobile phones in the Global South presents an opportunity to address many of the challenges posed by severely under-resourced public health and education systems. However, the design, development, implementation and use of systems leveraging mobile phones for healthcare (mHealth) has proven to be problematic for a variety of reasons, and a majority of such systems fail to sustain and scale (Heeks, 2016). There are many reasons put forward for this (Wall, 2013), but the lack of attention to user-engaging attributes has not received attention in the literature to date. This paper seeks to acknowledge that socio-technical factors responsible for user engagement in mHealth need to be considered as part of the design process. Socio-technical factors are used to represent broadly socio-cultural, and technical factors. According to (Whetton and Georgiou, 2010), a socio-technical perspective seeks to explore the organisational, professional, cultural and technical factors inherent in the design of information systems. A socio-technical approach includes consideration of both social and technical factors based upon combination of the human and the technology (Hadi et al., 2019). Moreover, according to Whetton (2005), a socio-technical approach seeks to identify the synergy between technology and the social, professional, and cultural environment in which it is used. This is because techno-centric approaches, and other approaches which rely on existing universal frameworks for user-centered design, have been proven to be ineffective (Tabi et al., 2019). For example, the literature discusses designers’ assumptions during the design process (Cornet et al., 2020) resulting in a lack of user engagement with mHealth.
systems (Gopalakrishnan et al., 2020; Nicholas et al., 2017), as well as lack of socio-technical understanding of mHealth design (Aryana et., 2019). Based on this lack of attention to user-engaging attributes in mHealth, and specifically the absence of a focus on socio-technical factors in user engagement, we identified an important research gap. In an attempt to address this research gap, our research proposes that socio-technical factors responsible for user engagement need to be taken into account in the mHealth design and development process. We thus propose the following research question: how does consideration of socio-technical factors in the mHealth design and development process improve user engagement? In order to answer the research question, we examine an mHealth implementation in the Bonthe District of Sierra Leone. Data was collected by semi-structured interviews with mHealth designers and developers to explore their experiences of why users either engage or not with the mHealth application in this case. The objective is to identify facilitators and barriers to engagement with mHealth interventions through the lens of the COM-B model, and to classify these facilitators and barriers as either technical or socio-technical factors of user engagement. The outcome of the interviews to date indicates that the inclusion of socio-technical factors during mHealth design and development is a requirement for more effective user engagement with the technology.

The remainder of this paper proceeds as follows: Section 2 presents the literature review, with the mHealth case in Sierra Leone presented in Section 3. Section 4 details the methodology adopted for this research, and Findings are presented Section 5. Section 6 presents DECENT, the proposed mHealth design framework resulting from this work. The paper concludes with brief conclusions from the work to date in Section 7.

2. LITERATURE REVIEW

This section commences with an examination of the literature on user engagement before moving to examine the body of work relating to mHealth failure and underperformance in the Global South. In particular, attention is paid to the relevance of socio-technical factors in the design process of mHealth.

2.1 User Engagement

There is an extensive body of literature on the theme of user engagement with technology. The term “user engagement” is an all-inclusive phrase encompassing the relationship between users and the technology they are using. There are a variety of descriptions and definitions of the term provided, including by Attfield et al., (2011, p. 10) who defines user engagement as “the emotional, cognitive and behavioral connection that exists, at any point in time and possibly over time, between a user and a resource”. User engagement is important to mHealth, with many researchers (e.g. Schnall et al., 2016; Curtis et., 2015) proposing that the design process of mHealth should meet various users’ needs. However, many current mHealth interventions are designed on existing healthcare system constructs (Verhoeven et al., 2010) which encourages designers to base their designs on assumptions that are not validated with primary user input (McCurdie et al., 2012). Thus, the resulting interventions are not as effective as those that involve end-users’ needs (Verhoeven et al., 2010) and inputs from relevant stakeholders such as commercial app industries and experts in the design process (Curtis et al., 2015). Furthermore, McCurdie et al. (2012) state that user-centered design involves an approach which is informed by the needs and understanding of a specific end-user group and plays a key role in achieving user engagement with technology.

In addition to this, there is an extensive body of work discussing socio-technical and socio-cultural factors associated with user engagement (McCurdie et al. 2012), as well as the environment in which the intervention will be used. As stated in the Introduction, socio-technical factors are used to represent broadly socio-cultural, and technical factors. According to (Whetton and Georgiou, 2010), a socio-technical perspective seeks to explore the organisational, professional, cultural and technical factors inherent in the design of health care information systems. Wickramasinghe, (2018) posits
that lack of engagement with mHealth systems is due to socio-cultural and organizational issues, for example, when mHealth applications developed in the Global North are implemented in the Global South where there may be many and varied social, cultural and political differences and beliefs. In cases such as this it is essential that implementation be localized to enhance success of the mHealth systems. This point is also emphasized by Shozzi et al. (2012, p.1) who suggest that the assumption that technology designed in the Global North can be simply dropped into the Global South and expected to work is “fallacy”. Furthermore, according to Manda, T. D., & Msosa (2011, p. 210), “mHealth comprises multiple socio-technical arrangements, which, among others, include workers’ information needs, workflow and usability requirements, available technology options, and how best technology can be adapted to suit these needs and requirements”. Thus, there is a need for a better understanding of the complexity of user needs and how to incorporate this information effectively into the design process of mHealth.

### 2.2 mHealth Failure and Underperformance in the Global South

There have been many reasons presented for the high level of mHealth failure and underperformance in the Global South. Writing many years ago, Kaasbøll & Nhampossa (2002) identified that socio-cultural considerations have a huge influence on the outcome of any health information system (HIS) implementation. They discussed the socio-cultural issues associated with transfer of HIS between the public health sectors of Mozambique and South Africa. The paper showed that socio-cultural differences between the two countries necessitated considerable adjustment and adaptation to cope with local variations. Similarly, a wide range of papers (e.g., Wu et al., 2007; Huang et al., 2019; Tate et al., 2013; Bentley et al., 2019; Ikwunne et al., 2020; Jacob et al., 2020; Woodland et al., 2021; Hofstede, 2011) have argued that successful implementations require better understanding of socio-technical practices of user groups and environmental differences because of their significance and impact. Additionally, it is recognized that a major reason for failure is unsuitable design as related to the needs and context of use (Braa, 2007). Koskinen (2017), posited that global technology carries meanings and structures that may or not fit with local realities and highlights the need for a framework for understanding context which contributes to the understanding of local technology production in under-resourced and developing contexts. Moreover, Wall et al. (2013) observed that the adoption of a techno-centric approach without consideration of socio-technical issues can negatively affect an mHealth implementation. A further reason for mHealth failure is the use of a top-down approach by implementers (Braun et al. 2013). Such an approach adopts a techno-centric style without allowing users to provide feedback to the technology that they expect to use. Despite this abundance of literature on mHealth and HIS failure and underperformance however, there is a little discussion concerning the role played by socio-technical factors in user-centered design processes for mHealth (Aryana et al., 2019; Farao et al., 2020).

### 3. MOBILE HEALTH IN SIERRA LEONE

The research presented in this paper is based on an mHealth case study in the Bonthe District of Sierra Leone, where significant emphasis has been placed on using technology as a key weapon in the fight against disease outbreaks and the promotion of child health. In particular, mobile technologies are viewed by the Ministry of Health and Sanitation (MoHS) in Sierra Leone as an integral component of overall public health strategy with many mHealth initiatives being launched over the past few years by both the MoHS and a variety of non-governmental organizations (NGOs). One example is the use of MOTECH mobile health application, which is a result of collaboration between World Vision Ireland, World Vision Sierra Leone, Dimagi and Grameen Foundation. These mHealth systems are primarily designed to be used by community health workers (CHWs) who are typically the backbone of healthcare systems in the Global South (Babughirana et al., 2018). MOTECH is a mobile application developed to be used by CHWs to improve maternal, newborn and child health across the Bonthe District of Sierra Leone. This system implements the Timed and
Targeted Counselling (TTL) initiative to improve outcomes for maternal and child health and nutrition.

Another example from Sierra Leone is the development of the Mobile Training and Support service (MOTS) to deliver refresher training to CHWs on the topic of vaccines and outbreak response. MOTS is an open-source platform which provides refresher training via an interactive voice response (IVR) system in the participant’s preferred language (Babughirana et al., 2018). It provides mobile training to CHWs via their mobile phones as the basic requirement (MoHS, 2017). MOTS was initially developed under the Ebola vaccine deployment acceptance and compliance (EBODAC) programme and piloted with CHWs to promote the acceptance and uptake of Ebola vaccines (McKenna et al., 2019; Babughirana et al., 2018). However, the emergence of COVID-19 has introduced another relevant application of MOTS due to the critical need to inform CHWs of health and medical protocols related to the virus without bringing them together for in-person training.

4. METHODOLOGY

This paper adopts a qualitative methodological and interpretivist philosophical approach to address the research question. Initially, we rely on 5 semi-structured interviews which have been designed to ascertain how designers and developers of the mHealth initiative in Sierra Leone perceive the role of socio-technical factors as a means to improve user engagement. The COM-B model (Figure 1) is then used to map the facilitators and barriers of mHealth application engagement to understand users’ behaviour of engaging with the mHealth app, with this being discussed further in section 4.2 below.

4.1 Data Collection and Methodology

A total of 5 semi-structured interviews were conducted during February and March 2021 with people who have been involved with the mHealth project in Sierra Leone. These included mHealth project managers, mHealth development facilitators, and others with a detailed knowledge of the project. The interviews were digitally audio-recorded, transcribed, and thematically analyzed. Thematic Analysis is a method for examining and classifying patterns of meaning in a dataset (Braun & Clarke, 2006). This involved the use of codes and themes to interpret and describe phenomenon under study. The codes are created, and themes are generated from collating codes to get acquainted with data (Ghasemi and Rasekh, 2020). Codes refer to an idea or feeling expressed in that part of a phrase in the data with the aim of organising data for subsequent interpretation, while themes refer to a specific ideas and patterns of meaning that come up repeatedly from the codes, that captures something significant about the data or research questions (Maguire and Delahunt, 2017). According to Braun and Clarke (2006: p. 78), thematic analysis “provides a flexible and useful tool, which can potentially provide a rich and detailed, yet complex account of data”. The analysis of the interview data is guided by the six-step model of thematic analysis outlined by Braun and Clarke (2006).

According to Maguire and Delahunt (2017, p. 3352), “thematic analysis is the process of identifying patterns or themes within qualitative data”. Since the six steps model of the thematic analysis described refers to themes, the notion of how the twelve themes were generated is explained in detail. The first step was to have a thorough overview of all the interview data about identifying what drives users to engage/disengage in the use/disuse of mHealth applications in order to design a better design process to improve user engagement in mHealth technologies. Hence, the concern is to address and analyse the data with the research question in mind. Initial codes were generated by highlighting phrases or sentences in the interview and shorthand labels (codes) were devised to describe their content. Coding reduces the data into small chunks of meaning. The codes were developed and modified through the coding process without using pre-set codes. Coding was done using NVIVO 12 (details in Appendix A), and the intention is not to code the content of the entire data set. The interview transcripts were coded separately by two persons. Each of the codes was compared,
discussed, modified before moving to the rest of the transcripts. Every piece of the text was not coded; however, each coded transcript was relevant to or specifically addressed the research question.

The next step was to examine the codes created and search for a theme – an idea or concept that captured and summarised the meaningful pattern and recurring pattern in the data. Braun and Clarke (2006) clarified that there are no certain rules about what makes a theme. A theme is described by its significance. At this stage, codes were examined to ensure that they fitted together into a broader theme in order to address the research question. The next step was to name, review and refine the themes. Data associated with each theme were read to consider whether the data really did support the theme and how the themes work both within a single interview and across all the interviews. Naming themes involved providing a concise and easily understandable name for each theme. Themes were thus extracted from the transcripts of the interviews until we concluded that more themes could not be extracted from the data.

These interviews aimed at identifying what drives users to engage/disengage in the use/disuse of mHealth applications in order to design a better design process to improve user engagement in mHealth technologies. This obviously determined the interview questions and the analysis of the data. The interview participants were clear and consistent about what facilitates users’ engagement with mHealth technologies in the transcripts. These facilitators generated the following themes: involving user early in the design stages of the mHealth, providing social connectedness; offline functionality; practice test; user manual or guidance and statistical information; and, tangible and intangible rewards. Each of these themes was classified as either socio-technical or technical in order to determine whether the socio-technical factors were deemed important for user engagement with mHealth in the transcript (as shown in Figure 2).

In identifying facilitators to user engagement, participants also highlighted barriers to user engagement. These were grouped into the following themes: cognitive overload; non-user-friendly design; cultural dimensions; lack of encouragement; perceived non-utility; and lack of app skills. In the final step, each of these themes is classified as well, as either socio-technical or technical in order to determine whether the socio-technical factors were deemed important for user engagement with mHealth in this case (details in Appendix B).

4.2 COM-B Model

The themes identified were analyzed with the Capability, Opportunity, Motivation – Behaviour (COM-B) model (Michie et al., 2014) to understand users’ behaviour of engaging with the mHealth app. By considering user engagement with an app as a behaviour, the COM-B model provides a broad framework for understanding mHealth application engagement. According to the COM-B model, behaviour (e.g. user engagement with app) arises from the interaction between the individual’s capability, both physical (e.g. app skills) and psychological (e.g. knowledge of using an application), their opportunity to behave in a certain way, both physical (e.g. via features of the app) and social (e.g. resulting from recommendations to use an app), and their motivation to behave, both automatic (e.g. emotional rewards from using an app) and reflective (e.g. belief in the benefits of the app). Further details of the mapping process and the elements of the COM-B model are discussed in more detail in the following section.

5. FINDINGS AND DISCUSSIONS

The identified facilitators and barriers to mHealth application engagement in this case as derived from the interview data and mapped onto the components of the COM-B model are presented in Figure 1.
The individual elements of the COM-B model and the outcome of the mapping process are now discussed in greater detail.

1. Physical capability refers to the appropriate skills and stamina that are required of users in order to take part in a particular behaviour. Many of the CHWs in this case struggle to engage with mHealth apps due to a lack of technical and language skills and low digital literacy. Several interviewees explained that CHWs expressed that the level of training provided to acquire technology skills shaped their level of commitment to engage with mHealth. This was highlighted by one interviewee as follows:

“Ministry of Health and Sanitation in Sierra Leone provided training for CHWs to acquire skills to engage with mHealth apps in language of prefers, which helped to enhance learning uptake and engagement” (D2).

This indicates that CHWs could be helped to more fully engage with the mHealth app by offering app-use tutoring.

2. Psychological capability refers to a user’s knowledge that is required to engage in a particular behaviour. All interviewees identified interface minimalism—i.e making app interface as simple as it needs to be, as a factor that facilitate user engagement. A fewer elements on an interface results in lower cognitive load for users. This factor is consistent with previous literature that reported engagement with health apps is impacted by factors affecting users’ capabilities that include different types of knowledge such as user guidance, statistical information, health information (Szinay et al., 2020; Baumeister et al., 2014) and reduced cognitive load (Szinay et al., 2020;
Lyzwinski et al., 2018; Szinay et al., 2021). The education level of users was highlighted by one respondent:

“When the MOTS mHealth solution was to be designed, the idea was to use smart phone but because of the level of education of users, basic features phones were recommended so that the CHWs can easily relate with” (D3).

Furthermore, some of the interviewees reported that clear instructions on how to increase capability to perform a behaviour such as accessing the MOTS system by CHWs affects their engagement with an app. This is evidenced by the following quote:

“When a CHW delays in responding to instruction given by the system when accessed due to lack of clear instructions, call ends if phone key is not immediately pressed/navigated after instruction” (D3).

This means that these CHWs could be provided with clear instructions on what they need to do to achieve a given task, to get fully engaged with the mHealth app.

3. Physical opportunity refers to the set of circumstances that make it easier for the users to engage with a behaviour. All the interviewees highlighted that an opportunity for two-way communication between the mHealth app and user, as well as user-friendly design and interaction, facilitates user engagement in this case. This aligns with the previous literature that explains how apps can be improved by targeting the design and engagement features, such as user-friendly design, or health professional support (Zhao et al., 2016; Coughlin et al., 2016).

Some of interviewees suggested that careful selection of the terminology used to explain the app and what it does, such as simple and clear local language, and pictorials, creates an impact on user engagement.

“The terminology used within the app, such pictorials, language and aesthetic can affect user acceptability and engagement” (D2).

In addition, the need for offline functionality was identified as a physical opportunity factor impacting user engagement. This was highlighted by the example provided by one of the interviewees about accessing the MOTS system from a weak or poor network connection, and how this negatively affects CHWs from engaging with it. In addition, an interviewee identified free network access and working with data in offline mode even when CHWs do not have access to internet as an important factor for engagement:

“CHWs can use MOTS system without paying for it and work offline mode using Bluetooth technology to upload information to DHIS system” (D1).

This indicates that these CHWs could be assisted to engage with the mHealth app more fully by providing free internet and Bluetooth technology where there is no or poor network connection.

4. Social opportunity refers to a user’s social circle enabling and facilitating a behaviour. Users’ sharing of knowledge and experiences of their mHealth app engagement within their social circle makes it easier for them to engage with mHealth app. The possibility for community health workers to share knowledge and experiences within mHealth apps was considered important social support that facilitates engagement with mHealth apps. According to Puszkiewicz et al., (2016), this type of social circle was found to improve intention to engage with a mobile app intervention designed for regular participation for physical activity during and after cancer treatment.

In order to ensure that there is social opportunity, we need to study users’ culture and capture it into mHealth apps. Here, culture is defined according to Ford and Kotzé (2005, p.716) as “the patterns of thinking, feeling and acting that influence the way in which people communicate amongst themselves and with computers”. Culture is divided into two layers – objective and subjective (Stewart & Bennett, 2011). Objective culture means that intended meaning of user interface representations, such as symbols, icons and language, are translated to suit the target cultures, so that they are understood correctly (Ford and Kotzé, 2005). While subjective culture ensures that
interface representations reflect the values, ethics and morals of the target users (Russo and Boor, 1993). This is evidenced by one particular comment from the interview as follows:

“Social and Cultural dimension needs to be incorporated in considerations of user engagement designs for user acceptability before deployment” (D4).

This indicates that the user’s social circle, or community of practice, who also use the mHealth app could assist with engagement. The social circle should be considered by integrating the social norms and cultures of users at the design and development stages of the mHealth app.

5. Automatic motivation refers to the user’s reinforcement and emotions that sustain engagement with the mHealth app. All the interviewees stated that offering rewards and various non-financial incentives was found to be a useful way to increase engagement. This is also consistent with the literature (Anderson et al., 2016; Perski et al., 2017; Perski et al., 2018), and this type of motivation is consistent with previous literature that observed that users found intangible rewards (e.g. badges) motivating (Peng et al, 2016), while others would want to receive tangible rewards instead (e.g. gift cards, cash, reduction in health insurance or vouchers provided by hospitals) (Peng et al., 2016; Baskerville et al., 2016). Our interviewees confirmed this by stating the following about bonuses given to CHWs:

“At the end of the year or month CHWs that have performed very well are given bonus which could be in a form of token payment, boots or any other programmatic tools as a way of acknowledging them as outstanding users” (D4).

This means that these CHWs could be provided with reinforcement and encouragement that will invoke their positive emotions to get them fully engage with the mHealth app.

6. Reflective motivation refers to user’s beliefs that their needs and values are reflected in the mHealth apps. Some of the interviewees observed that lack of perceived utility of the app during the design can hinder user engagement. Perceived utility refers to where there is no disparity between what the users’ needs and what an app offers. Siznay et al. (2019, p.39), observed that “unmet expectations of an app would lead to disengagement and frustration with the app”. This was particularly apparent in one interviewee’s comment on CHW engagement with mHealth indicators:

“Users of mHealth apps such as CHWs may have issues engaging with mHealth apps if they are not involved in making sure that the indicators of their needs are reflected in the mobile apps, involving users to reflects their needs at the design stages of the mHealth apps, boosts their confidence of using mHealth apps” (D2).

All the facilitators and barriers of engagement with mHealth interventions that were identified from the thematic analysis discussed above were classified as either technical or socio-technical factors as shown in Figure 2. This was achieved using thematic analysis (as specified in section 4.1) to identify the technical and socio-technical facilitators and barriers to user engagement with mHealth in this case.
The presence of these technical and socio-technical facilitators and barriers of user engagement with mHealth apps are important because they hold key position for mobile health system to sustain and scale as indicated by the COM-B analyses of data collected from interviewees. This aligns with the previous literature that discusses mHealth sustainability and scaling (Gagnon et al., 2016; Putzer & Park, 2012; Koivunen & Saranto, 2018). Therefore, the presence of only the techno-centric facilitators and barriers of user engagement with mHealth apps cannot offer an improved user engagement.

The facilitators and barriers identified, and the result of the COM-B analysis completed, has informed the development a new mHealth design framework called Design Process Enhancement System (DECENT). DECENT will allow designers/developers uncover user engagement impacting factors in order to improve user engagement. DECENT is discussed in detail in the following section.

6. PROPOSED DESIGN APPROACH FOR USER ENGAGEMENT - DECENT

DECENT will help inform mHealth designers and developers to understudy mHealth context and uncover user needs to improves user engagement with mHealth interventions. DECENT will serve as a guide towards making decisions in the design, development, implementation of mHealth for user engagement in the Global South.

DECENT uses design science research and use of theories to uncover socio-cultural contexts of the user group as shown in Figure 3. The design science research is guided by the three research cycles outlined by Hevner (2007). The first research cycle is the relevance cycle, where the environment of the end-user is understood. The second cycle is design cycle, where artefacts that are relating to solution of research problem are created and assessed. The third cycle is rigour cycle, where findings from evaluating proposed solutions form part of the existing knowledge base.

It is established in this study that technical and socio-technical facilitators and barriers of user engagement with mHealth apps are important because they hold key position for mobile health system. Our future work will present a new framework – DECENT – that will help mHealth designers and developers discover the key factors impacting user engagement with mHealth apps and will serve as a guide towards making decisions in the design, development, implementation of mHealth for user engagement in the Global South. The proposed structure of DECENT is shown in Figure 3.
Figure 3: The Design Process Engagement Enhancement System (DECENT) model.

DECENT will incorporate various theories which will help designers and developers to uncover and take account of socio-technical factors that impact user engagement with mHealth. One of the theories we propose to use is activity theory. Activity theory is a tool which can be used to uncover the socio-technical context of mHealth implementations. We propose to leverage activity theory to support the creative design process and to provide a theoretical framework of social and cultural contexts in the design process of DECENT for user engagement. Activity theory is embodied with primary units that aims towards incorporating social-technical content for user centered design.

Activity theory presents a robust framework for studying contextual factors, and it shows us the complexities and fluidity of activities in context. However, it does not tell us how activities are structured by contextual factors. The vision of context and culture here is still limited. For example, using activity theory does not tell us how user engagement with mHealth technologies are structured in social contexts. Thus, the Communicative ecology framework (CEF) will be applied (as described in Foth & Hearn, 2007) which integrates three layers of interpretation (technical, social and discursive) to deliver a rich description of how mHealth is structured in a social context.

7. CONCLUSIONS

This work contributes to the advancement of knowledge in the mHealth field by showing that socio-technical aspects of mHealth design are important for user engagement. However, it is not enough to simply analyse mHealth design from a socio-technical perspective. Thus, this research proposes a new DECENT framework for designing mHealth for user engagement which will be developed in order to aid inclusion of socio-technical factors in mHealth. This will allow users’ needs and goals to be taken into account and advance identification of problems concerning lack of user engagement.

Although this research has provided promising results, part of our future work will discuss our proposed DECENT framework with a wide variety of stakeholders following the steps highlighted in this work. In addition, we will make a particular effort to engage as fully as possible with the CHWs in Sierra Leone as part of this process. Finally, we call on the wider IFIP WG 9.4 community to engage more fully with the concept of user engagement in information systems and mHealth in the Global South.
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Appendix A: Coding

Appendix B: Extracting themes from codes
Understanding the Interplay between Boundary Resources and Governance Practices in Influencing Ecosystem Value Co-Creation for Digital Platforms: A Case from the Global South

Elijah Chirwa, University of Sheffield, echirwa1@sheffield.ac.uk
Pamela Abbott, University of Sheffield, p.y.abbott@sheffield.ac.uk
Jonathan Foster, University of Sheffield, j.j.foster@sheffield.ac.uk

Abstract: Despite their potentially transformative impact, few studies have investigated how commercially-driven digital platforms such as mobile money facilitate ecosystem value co-creation in the global South. Consequently, using a boundary resources model and platform governance approaches, this paper aims to examine how a payment platform facilitates ecosystem value co-creation with third party actors. An in-depth qualitative inquiry was adopted for the study using an embedded single-case design. The results show that although ecosystem value co-creation was enabled by the introduction of boundary resources tools, some platform governance practices hindered some complementors from harnessing the affordances of the platforms. These constraints include lack of visibility of the boundary resources and transparency challenges in the acceptance criteria. We thus argue that platform generativity on its own is not sufficient to support ecosystem value co-creation, but requires appropriate platform governance to deal with behavioural complexity of ecosystem actors by using optimal control mechanisms.

Keywords: digital platforms, value co-creation, boundary resources, platform governance, digital affordances, generativity.

1. INTRODUCTION

In the new global economy, digital platforms are becoming pervasive and powerful, primarily as they enable transactions between different groups of actors and facilitate innovation of products and services (Cusumano, Gawer, & Yoffie, 2019). Recent evidence suggests that the advent of digital platforms has democratized innovation, shifting it from being a standalone firm-centric activity to open and distributed ecosystem-based value co-creating practices, extending beyond a single firm’s locus (Chesbrough, 2003; von Hippel, 2005; Yoo, Henfridsson, & Lyytinen, 2010). The impact of this phenomenon is also being experienced in the global South as digital-based platforms enable ecosystems that facilitate value co-creation amongst a diverse set of actors (David-West & Evans, 2015).

Koskinen et al. (2019) argue that although many digital platforms first emerged in the global North, they have also gained wide usage in the global South due to the proliferation of mobile devices and ubiquitous connectivity. Despite significant challenges encountered during the creation and scaling of digital platforms in the global South, which include deficient infrastructure, market constraints, and lack of consumer trust and knowledge, these platforms possess the potential to address some of the social and economic challenges faced by the people at the bottom of the income pyramid (David-West & Evans, 2015; Koskinen, Bonina, & Eaton, 2019; Praceus, 2014). Additionally, Heeks et al. (2020) argue that digital platforms can potentially address the perennial issue of institutional voids that have caused market constraints and hindered the successful implementation of previous
technology-led initiatives in the global South. Mobile money platforms are a typical example of a digital platform offering transformative financial services both as a transaction and innovation platform in the global South.

However, despite their potentially transformative impact, there is a paucity of studies that investigate how commercially-driven digital platforms such as mobile money facilitate ecosystem value co-creation in the global South. Existing research conducted on how platform owners stimulate third party innovation on platform ecosystems in the global South has focused on non-commercial digital health platforms, which present different operating dynamics compared to profit-driven digital payment platforms (Miska, Nielsen, & Kaasboll, 2019). This lack of research further provides an opportunity to explore how the dynamics of platform-based service innovations such as mobile money are integrated and used to facilitate complementor value co-creation. These third party innovations have potential to address contextual challenges specific to these low-resource settings. Although third-party developers may have the capacity to co-create value on such digital platforms that can address context-specific challenges in the global South, they face numerous governance related challenges that hinder their participation in platform ecosystems.

Therefore, using the case of mobile money in Malawi, this paper aims to investigate how commercially driven digital platforms facilitate ecosystem value co-creation with complementors. More specifically, the study addresses these questions: (a) what boundary resources are provided by the platform owner to support ecosystem value co-creation? (b) what governance practices have been implemented as control mechanisms to secure the digital platform? (c) how does the interplay between boundary resources and governance practices influence ecosystem value co-creation for digital platforms in a global South setting? This research adopts the boundary resources model as the conceptual framework to analyse ecosystem value co-creation since this model has been shown to play a vital role in understanding platform owners’ governance approaches, which ultimately influence complementor outcomes (Eaton, Elaluf-Calderwood, Sørensen, & Yoo, 2015; Ghazawneh & Henfridsson, 2013; Huber, Kude, & Dibbern, 2017).

2. THEORETICAL BACKGROUND

2.1. Digital platforms as value co-creating ecosystems

Cusumano et al. (2019) divide digital platforms into three types, firstly innovation platforms which are characterised as those that provide the building blocks for innovation and enable recombination of heterogeneous functionality on the platform from ecosystem actors. Secondly, there are transaction platforms largely comprising those that play an intermediary role or provide marketplaces for interaction between various sides of a market. The third type of platform comprise those that exhibit and support both innovation and transaction characteristics. A common feature amongst all these different types of digital platforms is that they are all underpinned by digital infrastructures that facilitate innovation between the platform owner and third-party developers (complementors). Tilson et al. (2010, p. 748) describe digital infrastructures as “basic information technologies and organisational structures, along with the related services and facilities necessary for an enterprise or industry to function”. Thus, digital platforms represent a socio-technical collection comprising digital infrastructures and associated organisational agents, processes, and standards that enable different actors to orchestrate their service and content needs (Constantinides, Henfridsson, & Parker, 2018; De Reuver, Sørensen, & Basole, 2018; Tilson, Lytinen, & Sørensen, 2010). Thus, digital infrastructures inherently possess properties that facilitate generative value co-creation which can be harnessed by the wider community in the ecosystem. Generativity refers to the “capacity to produce unprompted change driven by large, varied and uncoordinated audiences” (Zittrain 2006, p.1980).
Digital platforms provide a functional utility for the ecosystem actors to potentially undertake value co-creation afforded by the properties of the underlying digital infrastructure (Autio & Thomas, 2019). However, the value from this functional utility is usually undefined and unknown, and can thus only be realised if the ecosystem generativity is harnessed. Consequently, Bonina and Eaton (2020) argue that the platform owner plays a vital role in nurturing the platform ecosystem’s growth by enabling innovation activities that facilitate value co-creation and by preventing actions that drain value away from the platform. Bianco et al. (2014) point out that platform ecosystems’ success depends highly on the diversity and value of end-user products and services. This is evident in the case of the flagship M-pesa, a thriving mobile money digital platform from the global South, where value co-creation enabled third-party developers to extend the functionality of the platform. Research shows that the platform owner for M-pesa played a significant role in enabling value co-creation with complementors and end-users to address context-specific needs, which ultimately contributed to the platform’s success (Kendall, Maurer, Machoka, & Veniard, 2011; Markus & Nan, 2020; Mwiti, 2015).

In spite of the clear evidence of the value co-created by the diverse actors interacting on the digital platform and the potential success it may bring, the literature also shows unique organisational challenges and tensions that exist between the platform actors in the ecosystem. For example, Tilson et al. (2010) refer to the governance challenge of balancing different interests of ecosystem participants between platforms' stability and flexibility as it determines the realization of ecosystem value co-creation. This tension is one of the critical challenges in developing digital platforms’ innovations and entails a wider role for platform owners that involves platform governance. Previous studies have defined platform governance as the fundamental decisions undertaken by the platform owner in relation to complementors, including the ownership of the platform and the interactions with the ecosystem of complements (Boudreau, 2012; Gawer, 2014; Wareham, Fox, & Giner, 2014).

Although research has ascertained platform ecosystems’ rising importance in facilitating value co-creation, platform owners may still encounter challenges in addressing context-specific needs of distant and unknown end-user communities due to lack of familiarity with them (Bosch, 2009; Henfridsson & Lindgren, 2010). The challenges are further exacerbated by the contrasting requirements of different groups of end-users that might be beyond the focus or core expertise of the platform owner (Boudreau, 2010; Ghazawneh & Henfridsson, 2013). The literature on consumer innovation in BoP contexts further highlights the challenges that service providers face, such as lack of knowledge concerning the lives, needs information, and the preferences of the poor, which calls for local embeddedness into innovation ecosystems that support co-creation of value (Cañeque & Hart, 2017; Praceus, 2014; Viswanathan & Sridharan, 2012). Accordingly, extending platform functionality to complementors close to the end-user contexts is becoming increasingly appealing to platform owners as it enables third-party developers to address context-specific needs (Ghazawneh & Henfridsson, 2013; Msiska, 2018).

2.2. Boundary resources model: governance mechanisms for ecosystem value co-creation

Foerderer et al. (2019) argue that examining the complex and dynamic socio-technical interactions at the boundary between platform owners and complementors offers an opportunity to gain more insights into platform governance and ecosystem related tension. In resolving the ecosystem tension, the platform owner undertakes a delicate balancing act between opening up the platform functionalities to complementors for value co-creation and maintaining optimal control over the platform ecosystem through boundary resources and boundary-spanning activities (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013; Huber et al., 2017). Boundary resources are defined as “the software tools and regulations that serve as the interface for the arm’s length relationship between the platform owner and the application developer” (Ghazawneh and Henfridsson, 2013, p.174). Boundary resources provide governance mechanisms that help to manage the socio-technical
interactions between the actors, and serve as the interface between platform owners and complementors in the value co-creation process (Bianco, Myllarniemi, Komssi, & Raatikainen, 2014; Eaton et al., 2015). Consequently, since boundary resources facilitate access to core platform services and fuel generative value co-creation in digital ecosystems, they also play an important role in shaping complementor outcomes. Therefore, this paper adopts the boundary resources model to gain insights into how platform owners facilitate ecosystem value co-creation as they manage ecosystem governance through enforcing control and enabling platform generativity.

The boundary resource model provides a tool to analyse two vital roles in platform governance, which are resourcing and securing the platform, as depicted in Figure 1. Examples of tools for resourcing include application programme interfaces (APIs) or software development kits (SDK), both of which enable developers to access the platform’s core resources (Ghazawneh & Henfridsson, 2013). The second governance role is to enable the platform owner to secure platform control and maintain its integrity by providing appropriate rules and regulations that ensure the overall quality is not compromised and remains in line with the platform’s goals (Boudreau, 2010). A typical example of a securing role would include implementing a set of guidelines, rules or activities for platform complementors. The rules and tools provided by boundary resources assist in understanding platform owner’s control and complementor’s contribution towards innovation.

![Figure 1: Boundary resources model Source: Ghazawneh and Henfridsson (2013)](image)

3. METHODOLOGY

3.1. Research design

In order to investigate how a mobile money digital platform facilitates ecosystem value co-creation within its surrounding context, an in-depth qualitative inquiry was adopted using an embedded single-case design. This approach was chosen due to its suitability to understand the dynamics of a novel phenomenon and its context in a single setting (Yin, 2018). The embedded single-case approach was utilised with the aim of incorporating multiple units of analysis at different levels of the case, with the platform ecosystem offering the overarching unit of analysis whilst the boundary
resources and complementors provided the primary subunit for the study. These varied embedded subunits at different levels of the study avail an opportunity for detailed analysis that enhances insights derived from the research of the phenomenon. The case study strategy resonates well with the aims of the study as it allows us to understand the phenomenon in its real-life setting and gain deep insights into the development and emergence of value co-creating practices for the mobile money digital platform (Benbasat, Goldstein, & Mead, 1987; Saunders, Lewis, & Thornhill, 2018).

3.2. Case description – Mobile money digital platform

This case study is based on the mobile money digital platform in Malawi and its digital innovation ecosystem, which is referred to here as Alpha. Alpha platform commenced provision of mobile money services in early 2012, focusing on facilitating exchange between cash and electronic value through mobile phones for various entities on its transaction platform. Between 2012-2016 Alpha transitioned to a start-up stage, where the platform offered some basic first-generation services and products (UNCDF, 2018). From 2016, the platform commenced its main expansion and consolidation phase, which has been characterised by the deployment of more services and facilitation of partnerships due to its increased technical capabilities to deliver additional value-adding services for the platform. This study focuses largely on this latter phase as the platform owner is able to allow and foster value co-creation with third-party firms as a way of extending the platform functionalities. Furthermore, the increasing need for a wide array of actors to integrate into the mobile money ecosystem as well as the generative affordances that the platform offers in addressing varied user needs in Malawi make this an interesting and appropriate case for this research study.

3.3. Sample and sampling techniques

The participants for the study were selected from the ecosystem actors constituting the mobile money innovation ecosystem, which comprised the platform owner, the financial regulator, banks, civil society organisations and third-party developers, who included complementors. On average, two interviewees were selected from each participant category through purposeful sampling. The participants also included a group of ecosystem actors who have either developed complementary services or attempted to develop third-party services for the platform. A total of twelve semi-structured interviews were conducted for this research, five of which were face to face and the remaining over Skype due to Covid-related constraints.

Informed and voluntary consent was obtained from the research participants as part of the ethical considerations for the study. This involved full disclosure to all participants of the purpose of the study and adequate details regarding how to participate, decline or exit from the study at any point during the course of the research.

3.4. Data collection and analysis

The data collection was conducted primarily through semi-structured interviews as they afford the researcher an opportunity to gain first-hand views as well as room for improvisation and probing of the studied phenomenon (Hein et al., 2019; Walsham, 1995). The areas of focus for the research included aspects of how the platform owner facilitated resource integration with complementors to achieve value co-creation, understanding in detail the governance mechanisms employed by the platform owner in supporting generative innovation, and examining contextual issues surrounding ecosystem value co-creation.

An abductive approach to theory building was used and included iterations between data and theory to help uncover deep insights into our research study (Dubois & Gadde, 2002). The theoretical constructs were derived from the literature on platform governance and ecosystem value co-creation with concepts from the boundary resources model guiding the initial coding process (Ghazawneh & Henfridsson, 2013, 2015). The key focus of the analysis was to explore the phenomenon of ecosystem value co-creation and the role of governance mechanisms in supporting generative
innovation with the goal of identifying key themes that could explain the noted patterns from the data and match these to the theoretical concepts.

4. FINDINGS

In this section, we present the results on how the platform owner has facilitated ecosystem value co-creation and the role of governance mechanisms in supporting generative innovation.

4.1. Resourcing platforms to enable ecosystem value co-creation

During its early stages, Alpha provided mobile money services that were largely developed within the firm. However, this changed in 2016, when the platform owner undertook a technological upgrade that enabled a transformation of its digital platform to facilitate collaboration and integration with external third-party actors. The upgrade enabled the platform to provide an API that granted access to external third-party actors to develop services on top of the mobile money service, as explained by the platform owner:

“Initially, the system was able to accommodate the original requirements of sending and receiving electronic money which were the original needs of a mobile money service. However, gradually we realised that the system was not flexible enough to extend its functionalities to third-parties and yet the mobile money service needs kept growing with more integration and development requests coming from other firms... and thus it became obvious that we needed to upgrade our system”[Res1].

These newfound digital platform capabilities were confirmed by several participants:

“...the upgrade allowed our firm to offer API functionalities to some external third-party companies, who were then able to integrate to our platform and develop new innovations in line with our rules” [Res3]

“Our firm provides micro loan targeting the unbanked based on their phone usage, and the presence of the API enabled us to integrate to the platform and provide the service to any eligible phone user” [Res9]

The ability to integrate seamlessly with third-party entities through the API enabled complementors such as a micro loan firm to provide new services to a wider group of end-users by harnessing the potentially transformative capabilities of the platform. Indeed, the results show that various services were developed by third-party actors on the platform ecosystem:

“So the micro loan product was developed by combining our specialised knowledge and development resources with some core data from the platform owner and other capabilities of the digital platform to come up with a credit rating score for mobile phone users. Then the service runs an algorithm that will determine the loan thresholds for various users. We also partnered a bank which then provides the resources for these loans.” [Res9]

“We developed a mobile payment product in collaboration with the mobile money platform owner with whom we partnered to come up with a solution using their platform capabilities and our own expertise to come up with an innovation that enabled farmers use cashless payments to procure agricultural seeds at the same time the platform provided market access to the seed company.” [Res6]

It was also noted that the availability of the API enabled technical integration between the ecosystem actors. Several interviewees highlighted the importance of the API as a tool to achieve integration:
“The API allowed us to integrate with various firms such as banks, as they used the platform as one of their service delivery channels; innovators that came up with services which operate exclusively on mobile money platforms; and software developers that offered mobile money integration services to other firms” [Res2].

“In the absence of the API from Alpha, our firm would not have been able to use mobile money as a service delivery channel for our products” [Res12]

Upon being approved to integrate to the platform, Alpha provides standardized interfaces to the external actor to facilitate development of additional services on the mobile platform. Describing this stage further, one of the participants commented:

“We started the integration work by being provided the documentation of the API and being informed of the other processes and technical tasks that we needed to undertake to achieve the integration. It was clear in terms of what we were allowed or not allowed to do from accessing the API itself and the documentation that was provided.” [Res9]

However, there are also divergent views among the complementors who are already integrated to the platform as to how the platform owner supports ecosystem value co-creation as evidenced by these two participants:

“At some point, we experienced challenges with the standard API as presented on the platform to integrate with our banking application as it could not meet some of our needs and therefore we had to put in a request to the platform owner who accepted our request and went ahead to make the necessary changes which worked to our satisfaction” [Res12]

“We have had challenges to have one of our requests with the integration since we went live over a year ago and we needed changes on the API but to-date nothing has materialised” [Res5]

The results show that the platform owner lacks consistency in addressing issues from the complementors. Additionally, as part of extending the platform’s diversity and providing a bridge to startup firms which face challenges to meet platform owner’s conditions, it was noted that an internationally funded firm had installed a hub solution that served as a single entry point to the platform for some third-party actors:

“We were approached by an international organisation requesting to be allowed to install a hub solution that would serve as an entry point to the mobile platform for smaller firms. The organisation is targeting small entrepreneurs who provide critical utilities such as water and power to off-grid populations that pay small amounts and may thus require to use mobile money service for such payments” [Res3]

The provision of a hub solution is aimed at enabling smaller firms to participate on the Alpha platform ecosystem and bring their innovations to a wider audience. The target group are those entrepreneurs who that may not have resources required by the platform owner.

4.2. Supporting innovation by securing the platform

In line with its governance approach to securing the platform, Alpha has implemented a number of processes as part of its control mechanisms. The processes impact the decision-making rights of the platform actors and provide control mechanisms for the platform owner such as gatekeeping and enforcement of regulations. It was noted that the platform owner makes all key decisions pertaining
to the platform and uses tools such as contract agreements and platform rules to provide regulation-based governance in addition to its technology-based controls. Several interviewees confirmed this arrangement:

“The responsibility to accept or reject a third to integrate to the platform rests with us as the platform owner and is based on several factors” [Res1]

“Upon being accepted to integrate to the mobile money platform, we were requested to sign a contract agreement with the platform owner” [Res6]

The decision-making process and the regulatory tools enable the platform owner to use non-technical governance tools as a means of managing innovation on the platform. Additionally, to ensure controls in accessing the platform, the owner evaluates the business viability before any third-party actors are granted access to the platform. One research informant explained the process as follows:

“A rigorous assessment of the business case in line with platform owner’s strategy whereby they decline the services if they are not sure of its viability or not in tune with their overall strategy” [Res6]

It was stated that these measures by the platform owner were aimed at controlling access by ensuring that the quality of the services developed for the platform are in tune with the owner’s overall strategy. In line with this control mechanism, there seems to be a deliberate approach for limited communication on the availability of the API:

“We have not yet openly published the API on our website” [Res3]

“I am surprised to hear that Alpha platform has an API that can enable small firms like ours to bring innovations to the platform. I approached them some few years back and they indicated that they don’t have an API for third-parties and haven’t tried again since that time”[Res11]

This lack of adequate communication for the API to external parties led to a number of firms being unaware of their existence. Additionally, a number of respondents from third-party firms that were aware of the API availability had been rejected to develop services on the platform and they highlighted their experiences:

“We tried to integrate our village savings and loan association application targeting the unbanked to the mobile money platform but have faced numerous challenges mainly due to the business viability disagreements, prohibitive costs and lack of trust in our firm” [Res10]

“We were declined access to Alpha mobile platform in a manner that lacked a clear and consistent approach, however are now just trying to find alternative ways of enabling payment functionalities for our service which we know the mobile money platform could have provided the best solution”[Res7]

“We approached the platform owner on several occasions to integrate our transportation application which we wanted to integrate with the mobile money platform, however on numerous occasions we were informed that their API is not available despite being available on some banking websites. We are now pursuing other means to achieve the same goal” [Res11]
These statements reveal that varied sentiments exist amongst third-party firms as regards the API such that even some of the firms that were aware of its availability and had attempted to gain access were nevertheless declined access due to various reasons. Furthermore, it shows that Alpha puts some restrictions as regards who can participate on their platform and the criteria was based on the platform owner’s goals and objectives.

5. DISCUSSION

The results have demonstrated that Alpha’s design of platform boundary resources enabled the introduction of the API as a software tool and heralded a new era for the platform as it opened up opportunities for the owner to collaborate with third-party actors in co-creating value beyond the boundaries of the firm. The API enabled the platform to respond to external contribution opportunities and thus offer digital affordances that extend the scope and diversity of the platform functionalities. This is consistent with the intellectual account provided by the boundary resources model (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013). The platform owner offers digital affordances through the boundary resources that in turn facilitate third parties in developing services on the digital platform. This finding confirms that boundary resource tools such as APIs are indispensable in extending platform’s functionality as they stimulate external contribution opportunities by allowing complementors the capability to provide additional applications for the platform ecosystem.

This case study has also shown how the platform owner, through the provision of APIs, enables a third-party actor, such as the macro loan provider, to use boundary resources tools to integrate and develop complementary services by harnessing the digital affordances of the platform, and thus enabling ecosystem generativity. The result confirms that platform value co-creating mechanisms are dependent on the provision of digital affordances, which enable platform generativity (Nambisan, Song, Lyttinen, & Majchrzak, 2017; Yoo, Boland, Lyttinen, & Majchrzak, 2012). The result explains how the Alpha digital platform ecosystem as an affordance platform provided a functionality role through boundary resources and orchestrated generativity, which allowed value-creating services to emerge. These value co-creation instances allowed the enhancement of the scope and diversity of the Alpha mobile money platform.

However, despite some complementors being able to harness the generativity of the platform’s affordances to co-create value, the results also show some challenges faced by some complementors due to a “deliberate” lack of visibility of the boundary resources and transparency challenges in acceptance criteria. In some instances, third-party actors were either denied access to the platform through a non-transparent process or were not even aware of the availability of boundary resources. These actions curtail the development of further value co-creating services as third party actors with potential generative capacities are denied the opportunity to co-create value. These observations match those expressed by several other authors that to successfully build platform-centric ecosystems, the platform owner must shift the design capabilities to external actors so as to enhance their generative capacity (Avital & Te’Eni, 2009; Msiska, 2018; Von Hippel & Katz, 2002). This reinforces the point that generativity is a potential passive capability that needs to be activated; otherwise, it is not useful. Furthermore, this lack of transparency seems to support observations from some third parties that there is an inconsistent application of the control mechanisms against smaller firms. In contrast, Tiwana (2013) identified transparency and fairness as some of the critical elements in designing effective platform controlling mechanisms. The seeming lack of fairness and transparency in our study might deter other third-party innovators from joining the platform and discourage others from remaining on the platform, thus impacting generativity. Therefore, although Alpha platform provides generative capability, the lack of visibility and transparency of boundary resources stops complementors from offering new resources, knowledge and capabilities that would harness platform affordances.
The findings reveal that the platform owner designed the boundary resource rules such as contract agreements, platform acceptance criteria and API guidelines as non-technical governance control mechanisms for exerting its authority and decision making responsibility over the platform. For example, the use of a business case assessment as a predefined condition to be allowed on to the platform ecosystem denotes a gatekeeping role being used as a control mechanism for accommodating third-party actors to use the boundary resources. These observations confirm the vital role played by the platform owner in securing the platform by employing control mechanisms over heterogeneous actors to enforce rules in line with its interests (Constantinides et al., 2018; Ghazawneh & Henfridsson, 2013; Van de Ven, 2005). The use of these various control mechanisms assisted Alpha to ensure third-parties develop services that are aligned with its interests.

The introduction of a new boundary resource tool as a “hub solution” by an international organisation represents the emergence of distributed governance that allows smaller entrepreneurs circumvent some controls exerted by the platform owner. This hints at some underlying challenges facing this group of startup firms which need to be overcome to open up the platform to a wider set of actors and innovations. This is supported by the observation that the emergence of new boundary resources can be triggered by either the owner’s perceived external contribution opportunities or by external third-party use of the boundary resources (Ghazawneh & Henfridsson, 2013). The development of the hub solution seems to emanate from the need to support marginalized third party actors to innovate for the platform as they address context specific needs.

Overall, the underlying assumption in digital platform ecosystems is that generativity drives ecosystem value co-creation. However, this ecosystem value co-creation is determined by how platform owners overcome the tension between supporting generative capacity of autonomous individual actors that provide unpredictable innovative inputs, thus requiring some control, and the logic of technological flexibility that requires stability (Eaton et al., 2015; Huber et al., 2017; Wareham et al., 2014). Our findings support these assertions on how digital affordances enabled generative value co-creation and also how governance approaches using control mechanisms attempted to address behavioural complexity but in the process constrained generativity. It is evident that most of these constraints are coming from the control mechanisms and that ‘circumventing’ and allowing the platform to create opportunities for further value co-creation has been necessary by introducing different types of governance approaches such as the hub solution.

The results also suggest that, as a commercially driven platform, Alpha focuses on economic value, cost-benefit trade-offs and producer-centric value co-creation. As a result, due to its governance approach of centralised authority and responsibility, it runs the risk of under-appreciation of the role of generative value co-creation. In contrast to a non-commercial platform running in the global South context, we observe that the focus is primarily on developing generative capacities of third-party developers (Msiska, 2018; Msiska et al., 2019). This observation might suggest the need for changes in governance of such commercial platforms if they are to support context specific challenges that affect those at the BoP.

6. CONCLUSION
The aim of this study was to examine to what extent commercially driven digital platforms facilitate ecosystem value co-creation in the global South using the case study of a mobile money platform. Although the findings suggest ecosystem value co-creation is enabled by introduction of boundary resources tools, there are impediments that are hindering third-party actors harnessing the generativity of the platforms. Taking all this together, we can conclude that platform generativity on its own is not sufficient to support ecosystem value co-creation but requires appropriate platform governance to deal with behavioural complexity of ecosystem actors using optimal control mechanisms.
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Chirwa et al. Understanding the Interplay between Boundary Resources and Governance Practices


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Improving Data Use and Participatory Action and Design to Support Data Use: The Case of DHIS2 in Rwanda

Scott Russpatrick, University of Oslo, scottmr@ifi.uio.no
Magnus Li, University of Oslo, magl@ifi.uio.no
Jørn Braa, University of Oslo, jornbraa@gmail.com
Alexander Bruland, University of Oslo, alexbrul@ifi.uio.no
Mikael Olsen Rodvelt, University of Oslo, mikaelor@ifi.uio.no
Andrew Muhire, HISP Rwanda, muhireandrew@gmail.com
Adolphe Kamungunga, HISP Rwanda, akamungunga@hisprwanda.org
Kai Vandivier, University of Oslo, kai@dhis2.org
Silvia Masiero, University of Oslo, silvima@ifi.uio.no
Peichun Wu, University of Oslo, peichunw@ifi.uio.no
Peter Biro, University of Oslo, peterbir@ifi.uio.no
Stian Rustad, University of Oslo, stiaru@ifi.uio.no

Abstract. This article reports from an ongoing ‘evaluation for improvement’ action research and participatory design project in Rwanda, where the aim is to improve data use practices and the capabilities of the District Health Information Software 2 (DHIS2), an open source health information management platform, to support data use. The study of data use at health facility and district level showed that while data was used routinely at, for example, monthly coordination meetings, the DHIS2 dashboards and other analytical tools were in limited use because users preferred to use Microsoft Excel for data analysis and use. Given such findings, a major focus of the project has been directed towards identifying shortcomings in data use practices and in the software platform and to suggest, design and eventually implement changes. While the practical work on implementing improvements have been slow due to the COVID-19 pandemic, the suggested design improvements involve many levels of system design and participation, from the global core DHIS2 software team, the country DHIS2 team and local app development, the Rwanda Ministry of Health, and health workers at local level.

Keywords: Participatory action research, Participatory design, HIS, multi-level design, data use

1. INTRODUCTION

This article is about an ongoing participatory design (PD) project in Rwanda, which has the twofold aim to both assess and improve the use of data and the use and usefulness of the District Health Information Software 2 (DHIS2) software platform (https://dhis2.org/), which is the standard software tool in the health services in the country. A team of core DHIS2 developers and students from the Design lab at the University of Oslo are working with the team from the Rwanda Ministry of Health in responding to users requirements by developing apps and DHIS2 features in direct interaction with DHIS2 users in the Rwanda health services. Given this background, this article will describe and discuss some key challenges related to multi-levelled and local / global participatory design using the DHIS2 open source software platform. While DHIS2 has a flexible metadata structure and a certain plasticity allowing for local PD and customization, many local requirements...
cannot be accommodated by the generic core DHIS2 platform. The way to address user requirements which cannot be met by the core platform, as described in [1], has been to add needed new features to the roadmap for core DHIS2 development. As it is demonstrated by the case of Rwanda, core development is too slow for practical PD and end users requests, and all user requirements do not necessarily fit in as new features and apps in the platform.

Another aim with this article is to develop approaches whereby PD can be better applied at large global scale addressing what Bødker and Kyng [2] label ‘big issues’. They argue that PD is now too much confined to small and insignificant pilot projects with a focus on direct collaboration between users and designers in co-design processes to engage with usability and human-computer interaction (HCI), leading to a focus on ‘small issues’, in contrast to ‘big and important ones’. In their aim to revitalize and revise PD to better address and influence big issues, they use HISP [3] as their inspiration to revitalize PD for a new type of PD (ibid.). While HISP’s aim to improve data use for better health in the global south is an obviously ‘big issue’, important inspirations, according to Bødker and Kyng, are HISP’s self sustaining global network, ongoing participatory processes in support of local/local and local/central cooperation on data use and thereby facilitating scaling up (ibid.).

Improvement in the DHIS2 technical design is going on both at local and global levels. While the DHIS2 country team is configuring the DHIS2 to suit the identified requirements within the generic capabilities of the platform, other requirements need involvement by the DHIS2 global team. Using DHIS2 as a platform and developing apps to address specific features and user requirements represent a third ‘in between’ opportunity. Apps can be, and are, developed both locally in Rwanda as well as in other countries and shared. We present examples of all these types and levels of responding to user requirements and discuss the findings related to challenges and opportunities in engaging - and being dependent upon - both local and global system developers in participatory design going on in a real world context where not all factors are controlled, such as for example the ongoing pandemic.

This research will contribute to the theory and practices of participatory design and action research in a global-local multi-level perspective [4,5,6], and to the role of app development to provide more agile responses to identified user needs [7].

2. BACKGROUND DHIS2

Since 2012, the Ministry of Health has been implementing the DHIS2 powered Health Management Information System (HMIS) to manage countrywide health related data. The HMIS system includes health facility level data from all health service areas and programs. Although much effort has been invested in improving the quality of data, timeliness of routine reporting as well as data use for informed decisions, supervisions and assessments conducted have shown that data use at health facility and district levels is far from optimal and that the various analytic tools in the DHIS2 were in limited use. These gaps and challenges faced had to be addressed and documented to guide the next steps.

As DHIS2 is designed and developed to be used across multiple countries and user organizations, design unfolds on multiple levels. A core team is responsible for the design and development of the generic software features and caters for the wide audience of use-cases, forming a level of generic design. Further, for each implementation, the DHIS2 is configured and customized according to the more specific circumstances, and this forms a process of implementation-level design [8]. DHIS2 has a flexible metadata structure and can be configured for a variety of needs and system requirements [4]. When addressing user needs, new functionalities and requirements not covered by the generic features can basically be met in three ways; 1) customisation of the generic functionalities in DHIS2, done locally, 2) request changes in the core platform through interacting with global teams, and 3) develop specific apps, which can be developed locally, regionally and globally.
The objectives of the research reported in this paper are to evaluate and document gaps and challenges faced by local level users at districts and health facilities, to use DHIS2 analytics apps for data analysis and other features in their use of data for management, planning and service delivery. Furthermore, having identified the requirements, interventions will be designed and implemented on the basis of the three approaches of local customisation, DHIS2 core development and/or app development.

Given the above objectives, a team from the University of Oslo in collaboration with HISP Rwanda under the guidance of the MoH/HMIS conducted an assessment on the status of data use in Rwanda. We used a data use checklist developed by the University of Oslo to guide countries in assessing the level of use of data and dashboards.

3. DHIS2 AND DIGITAL PLATFORMS

Tiwana defines a software platform as a “software-based product or service that serves as a foundation on which outside parties can build complementary products or services” [9]. Tiwana also argues that platforms must be multisided, meaning they bring together two or more actors or groups of platform users, such as end users and app developers, similar to our case of DHIS2 and app development. Henfridsson and Bygstad argue that in order to analyse digital platform developments, the focus need to be on the boundary resources of the platform and not on the platform itself [10].

In the literature are two types of boundary resources, technology and knowledge [11, 12]. Technology boundary resources, provided by the platform owner, enable 3rd party developers to create new applications and features through technical resources such as APIs, SDKs, code libraries, UX templates and standards, etc [13, 14, 15]. Knowledge boundary resources provide practical knowledge necessary for 3rd party developers to access and utilize the technical boundary resources. There are guidelines, programming tutorials, information portals, courses, development roadmaps, workshops, and co-innovation projects [15, 16, 17]

In our case, these resources are made up of the technical: the DHIS2 app development environment, tools for mock-up development, and resource libraries, and the knowledge: zoom and shared google doc environment facilitating the interaction and collaboration between app developers in Oslo and users and developers in Rwanda. To further emphasise such socio-technical understanding of platforms we use Gawer’s approach to bridge two theoretical perspectives: economics, which see platforms as double sided markets that have both demand and supply-side users and with network effects between and within them, and engineering, which sees platforms as technological architecture. This leads Gawer to a new conceptualization of platforms as evolving organisations or meta organisations [18], which is in line with how we conceptualise our case of global participatory design and app development within and around the DHIS2 platform.

DHIS2 is an example of an innovation platform that provides the foundation for which applications or components can be built upon. A classic example is the Android operating system, where a stable core is maintained that allows for periphery application to be supported. Mandel [19] describes this as application economies, or “a collection of interlocking innovative ecosystems where each ecosystem consists of a core ecosystem, which creates and maintains a platform and an app marketplace.” In the application economy multiple individuals, groups and organizations – eg. developers, companies, or governments- are able to create, launch, and maintain their own applications. Innovation platforms enable a large number of innovators to develop complementary applications or services within the platform ecosystem by providing technical foundational elements [20]. Applications can be highly specific to a single end-user, such as an application that aids community health workers in Zambia in diagnosing Malaria, or highly generic to a broad range of end-users, such as Whatsapp [21].
DHIS2 has a core database and API developed and maintained by the Health Information System Programme (HISP) headquartered at the University of Oslo. The core development team also develops and maintains a suit of “core” generic applications that are intended to be the minimal tools necessary for an HMIS. These are: data capture applications, analytics applications, such as dashboards, pivot tables, charts, and maps. There are also data quality application as well as meta-data configuration and user management applications. These applications reuse common components and exist on top of a stable application programming interface (API) forming a layered, modular architecture. Beyond the core is a proliferation of locally developed applications that are developed with little or no involvement from the core development team. These periphery applications can be generic and, thus, more reusable across countries and contexts or highly specialized for a specific end-user or function [7].

4. METHODS

The research is carried out in two phases. While the first ‘pre pandemic’ phase was based on fieldwork in Rwanda the second phase was carried out during the pandemic and consisted of online meetings and collaborative work between users in the health services and technical HISP team in Rwanda and core DHIS2 developers and students in the Design lab at the University of Oslo.

First phase - 2019
The research approach has included both qualitative fieldwork and user interaction at district and health facility levels using a semi-structured interview guide and a quantitative approach using questionnaires. A WhatsApp group has been created bringing together the Data Managers of Health centers and District Hospitals to freely and openly keep sharing their experiences and providing feedback to inform improvements in DHIS2. Requirements identified through the field visits, questionnaires and the WhatsApp group were both addressing needs for global level changes in DHIS2, i.e. input to new releases, and requests to the local DHIS2 team.

The team visited three district offices and 6 health facilities in Kigali, the capital, and in Gisenyi, in the north-west of the country, during three weeks September 2019. Here focus group discussions were conducted and digital information practices were investigated hands-on. A series of planning meetings organized at National level with the global DHIS2 team (HISP Rwanda, Uio, MOH) to ensure more issues are identified and feedback are shared. The team also attended monthly meetings (DHMTs, coordination meetings, quality assurance meetings) and in-depth interviews with data managers and facility managers to identify best practices, challenges, and user requests. We conducted group discussions with key players at health facilities and district offices following a check-list which included investigation and discussion of the computerised tool they used, such as reports, dashboards, graphs and tables. The questionnaire was shared with additional 36 District Hospital Data Managers who were asked to provide feedback and request new features to support their data use needs.

Phase 2 - November 2020-March 2021
The overall cyclic research approach was initially planned is as follows:
1) Identify situations and venues for routine data use and use of DHIS2 at facility and district levels and assess data use with a particular focus on assessing the way the DHIS2 software platform and other digital tools are used, or not used, to support and enhance data use,
2) Identify shortcomings in how DHIS2 is used and or designed to support data use and users and suggest improvements in software design and use practices,
3) Implement and evaluate suggested changes, and repeat the cycle of through 1, 2 and 3. This last cycle of implementing changes, however, has been somewhat halted due to the COVID-19 pandemic.
The research was halted during about 10 months in 2020 due to the COVID-19 pandemic. It was eventually restarted as an online collaboration using zoom and teams tools for communication and also a Mock-up tool facilitating participation and collaboration on specification of the app to be developed. Students and staff from the Design lab at UiO, as well as staff from the global DHIS2 team made up the UiO part of the collaboration while the Rwanda team consisted of MoH and HISPRwanda staff and information system officers from selected District hospitals. These district officers are responsible for information management and use in the district which is typically made up of about 20 health centres and one district hospital. Support and improvement of data management and use at district level and in hospitals and health centres are key targets for the project. During February - March, 6 online meetings between Oslo and Rwanda were conducted, with about 15-20 participants, and where use cases and requirements were presented and solutions discussed. A Mock-up tool was used as a means to communicate potential solutions between the developers in Oslo and users in Rwanda. A team from HISPRwanda did also participate in the meetings. They are experienced app developers and the intention is to include them in the practical app development.

To collaboratively develop potential prototypes/mockups, the UiO students suggested a mockup tool called Figma. Figma is supported both in browsers and as a desktop application, and allows for real-time synchronization across different instances. Such a feature serves as a key element in supporting the development process in a cross-country, cross-institutional setting, when also being restricted by online-tools as the sole means for communication. The approach taken in this project when developing concepts of a minimal viable product (MVP), is as an attempt to incorporate a more agile tendency in the development process of current and future software for DHIS2. During this phase, the HISPR teams and representatives from UiO have iteratively met to discuss the potential of the current prototype, and provided feedback to guide the improvement in the next iteration. As a result, the development process has engaged the collaboration in a more agile fashion, benefiting both the developers and stakeholders.

5. CASE: ONLINE GLOBAL PARTICIPATORY DESIGN

We made contact through Google Meet between the teams from Rwanda, Tanzania and UiO. Rwanda and Tanzania described their problem and the need for a Data Form App. The need was clear, but the user stories caused confusion and questions. We discussed two cases as possible solutions;

1. Create a feature within the existing Data Set Report App, which allows to combine different data sets from Provincial Hospital report forms, into customised formats.

2. Create a DHIS2 App. (Selected approach)
   1. Create Report format (Admin/ Super User ) in accordance to MOH-HMIS agreed formats.
   2. Share Report format to respective groups of users for the responsible teams to generate the report with respective datasets that correspond to the particular level.
   3. Generate the consolidated report once the data manager confirms all the data sets have been reported in.
   4. Reports can then be downloaded as xls or pdf.

It was discussed that the use case was similar to an existing Dashboard feature. The dashboards have printing options and are made for decision making. The teams agreed to proceed on the second approach. Both Rwanda and Tanzania showed great interest in the project and understood the need for generic development and collaboration. Further weekly meetings were used to summarise and comment, while tasks were spread between teams. The first meeting discussing the use case had 27 invited members, representing Health Ministry of Tanzania, HISPRwanda, HISPTanzania, UiO team and students.
The weekly meetings had around 18 attendees. They have been used to present work and obtain feedback from the whole team. These meetings are very important, as they provide feedback from the DHIS2 team. The will and understanding of a generic development exists for all the participants, but it’s lacking knowledge and experience of the DHIS2 platform resources. Feedback has been very important, to help the team create a plan that involves the correct use of DHIS2 resources and design. For example, using the DHIS2 components already in the prototype ensures generic development further in the project. As it can seem obvious once it’s brought up, it was not a general understanding before feedback was given.

There have been four meetings between HISP Rwanda team and UIO students, with 7 to 20 participants. First meeting had some confusion due to time zones, but the following meetings got more attendees from Rwanda and Tanzania. HISP Rwanda made a Data Flow Diagram, and these meetings are currently used to create an interactive prototype and to create a detailed roadmap.

It has been a total of four meetings. One discussing the use case, one discussing the proposed flow diagram from HISP Rwanda, one between UIO students, Rwanda and Tanzania, and another weekly meeting presenting roadmap and prototype drafts. The process is moving fast with a lot of involvement from all sides.

6. FINDINGS

An important finding is that all districts in Rwanda are conducting monthly meetings where health facility and district managers and data managers come together at the district level in a meeting called ‘coordination meeting’ and evaluate last month’s data, look at trends and discuss needed action. This routine event is identified as a key area for DHIS2 to provide information support. However, while the finding was that the level of use of data from the DHIS2, for example at the coordination meetings, was maybe surprisingly high, use of DHIS2 for analysing and presenting data, for example through dashboards, was surprisingly poor. The data managers preferred to download the data from DHIS2 to Excel and analyse and present the data using Excel as the preferred tool. Given this finding, ways to improve the DHIS2 as a tool for data managers and other users and to improve data practices using the DHIS2 became the focus for the participatory design and action research part of the project.

One example of why users preferred Excel to DHIS2 is from a posting on the WhatsApp group where a data manager explained that he needed to be able to add comments as text and colours as, for example, red for poor performance, in a table of an overview of health facilities’ performance, as in the figure.

![Fig. 1. Excerpt – health facility data presentation, Rwanda](image-url)
Adding text and colours in a table in a web based system such as DHIS2 is not straightforward. This is an example of an user request that requires involvement of the core DHIS2 development team. Other identified requirements are also addressing core DHIS2 features and global involvement, for example to be able to build reports combining visuals and text and which is populated with data from DHIS2.

The results from the questionnaires confirmed the findings from the field visits, with four notable pointers:

- Most of the Health Facilities and district offices download data from DHIS2 pivot table to Excel for doing their reports by-passing DHIS2 limitations like to be able to manipulate charts and tables, to add text and colours etc.
- Nearly all know how to make pivot tables, charts, maps, and dashboards in DHIS2, but due to the limitations in DHIS2, pivot tables are generated as a means to download data to Excel.
- An additional reason for downloading to Excel was that target population denominator data were not available in DHIS2 for sub-units like health posts under the health centres. The local users will know the figures and then it is easier to enter them directly in Excel.
- Most to all respondents wanted the ability to: mix colours and text in tables as in the figure above; share dashboards to predefined groups of users; print dashboards and use as reports; build reports where visuals are dynamically generated and text can be added e.g. for monthly reports; generate pdf of monthly reports to print out and sign for archiving.

7. ADDRESSING ISSUES THROUGH DESIGN: GENERIC AND IMPLEMENTATION-LEVEL DESIGN AND DEVELOPMENT

The evaluation revealed several important requirements for new features and performance that would need to be addressed before the DHIS2 platform may effectively support the identified data use situation. Some of the requested improvements can be carried out locally on the level of implementation through customisation of the DHIS2, such as the ability to print out reporting forms dynamically filled with data for signature and archiving. The local HISP Rwanda team is capable of optimally configuring and customising the DHIS2 platform, but many requirements go beyond the current customization capabilities of the DHIS2. These can either be addressed through design on the generic level by the global developer team, or on the level of implementation by building custom apps.

Addressing issues on the generic level of design and development

DHIS2 and dashboard enhancements requested need to be considered for in the core platform development. This includes among the other features that can allow/support print and downloading of dashboard or dashboard items. A community participatory design approach is employed for this in which the requirements are gathered from the field via a lead implementer in HISP Rwanda. Those requirements are then passed to the platform owner through which collates all field requests. Representatives from all HISPs then vote on the collated requirements to produce a development roadmap that is then produced by the core developers. The DHIS2 platform owners must take into account what is technically achievable for the core developers to accomplish. In this case study from the direct field requirements coming from Rwanda the core developers appreciated that dashboard downloading and printing was a realistically achievable for the next DHIS2 core release; however, editing cell color and adding comments in a pivot table required an extensive expansion of the current pivot tables functionality and would not be possible in the release. It also is not possible for the core development team with limited resources and many demands to reproduce Excel into DHIS2, so the priority of this request is relatively low given its technical achievability.

Given the inherent inertia and understandable slow pace of change of the DHIS2 platform, local participatory design efforts need to look elsewhere to be able to respond fast enough to users requests.
Implementation-level participatory design

Implementation-level participatory design processes require a constant agile response by way of new features and solutions to be fed back and tested by the users. When, as in our case, the generic features in DHIS2 cannot fully be used to respond to user requirements and the generic-level design process of the global developer team is too slow to achieve, app development is a way to bridge the gap. Rwanda has already developed several apps and have both expertise and experience in this regard, for example:

- When implementing the DHIS2 Tracker for the immunisation program vaccine stock management was not part of the package, and was immediately identified as a gap. HISP Rwanda then developed an app for managing vaccine stocks and requests for vaccines and distribution from available sources; central and regional warehouses and hospitals. This app is now being developed as a generic central DHIS2 app.
- An app including a certificate for having tested negative for COVID-19 and linked to laboratories was developed in collaboration with HISP Uganda and is now used by truck drivers and other travelers crossing the borders between the two countries. Tanzania, neighbouring both countries, is now adopting and adapting this app.

Analysing the requirements and responses from the DHIS2 core team, we see that they fall into two levels:

1) Generic level design and apps by DHIS2 core team apps. Very few user requirements identified during the process can be met by generic features and apps within a participatory timeframe, as fast responses are required. Ability to print dashboards is one example of a generic app which will be made available soon.

2) Implementation level design, as described in Rwanda. Three options are available; 2.1) customise solutions based on generic features, and 2.2) request generic features from the core team, which we have seen may be too slow. 2.3) Building custom apps. As with requesting features from the core team, the other options also imply challenges. Customizing generic apps requires an understanding of their existing codebase and will later result in issues with updating to new versions released by the core team. Building custom apps provide a flexible alternative, yet development and future maintenance must be done locally, which could be costly.

Of the requirements identified, the ability to print reporting forms filled dynamically with data is a ‘low hanging’ fruit. This is a most wanted feature and can be done by customisation or a small app. Other requirements, such as a more advanced report builder than the previous example need to be addressed through building custom apps. Rwanda and regional partners have proven their ability to build apps, but as described, it will involve development and maintenance work locally.

Boundary Resources: Building local and global knowledge together

Boundary resources, both knowledge and technological, have been defined in the existing literature to be produced by the platform owner, University of Oslo, for the 3rd party application developer, HISP Rwanda. However, in this case study we see that knowledge boundary resources through close, interactive interactions are developed simultaneously and complementary on by both the platform owner and the 3rd party developer.

Specifically, by HISP Rwanda communicating needs and user-stories, the UiO product management team was able to define new features that could be added to the core DHIS2 feature sets. However, it also illuminated the necessity for features that the core UiO development team would not develop, for example reproducing many excel features in DHIS2. This understanding of what UiO would and would not develop gave HISP Rwanda the knowledge needed to build a new application locally that would satisfy those unmet requirements. For UiO, knowing the user stories added the product management team to formulate a more explicit roadmap that is communicated to all DHIS2 implementers globally. The more clearly defined roadmap then gives other 3rd party
developers the information they need to know if they will have to make a new application or feature based on their unique needs that UiO is not planning to develop.

This case-study shows that generation of knowledge boundary resources is not solely top-down, but can be bidirectional, informed from direct engagement between platform owner and 3rd party developer.

8. CONCLUSION - AND FURTHER RESEARCH

The traditional means of conducting participatory design using the DHIS2 platform has been to address needs through generic features, and when that is not possible, to request changes by the core team. A conclusion of this research, however, is that participatory design and addressing emerging needs in a mature DHIS2 user country such as Rwanda, where the generic features are already exhausted, needs to rely on custom app development. In a global perspective, then, local custom apps will inform development of core generic apps and features. There are however challenges related to local apps development, such as for example, maintenance. Our further research will explore challenges and opportunities for a custom app development strategy.

The contributions of the research reported in this paper are in 1) developing practical action research approaches synthesising research and practice in developing information systems in developing country settings [8, 5], and 2) providing approaches and analysis of multi-levelled participatory design and interaction across local site, country and global levels [4, 7, 10, 6]. At the practical level contributions are on how tension can be eased between slow global responses on generic platform features and local needs through local app development.

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ROLE OF DIGITAL PLATFORMS IN ENTREPRENEURIAL PROCESSES: A RESOURCE ENABLING PERSPECTIVE OF STARTUPS IN PAKISTAN

Hareem Nassar, NUST Business School, Pakistan, hareem.msie19nbs@student.nust.edu.pk
Fareesa Malik, NUST Business School, Pakistan, fareesa.malik@nbs.nust.edu.pk

Abstract: This article aims to explore the role of digital platforms as external enablers in entrepreneurial processes. The recent infusion of digital platforms into different aspects of innovation and entrepreneurship has supported digital entrepreneurship; however, the altered entrepreneurial processes are yet to be explored. This study focuses on digital platform-based startups of Pakistan and draws on entrepreneurial bricolage theory to understand the enabling external resources. We followed multiple qualitative case studies approach and collected data through semi-structured interviews from two startups operating solely on digital platforms, 1) XYLEXA and 2) Toycycle. The findings show that entrepreneurial process is a continuous process. Digital platforms have made entrepreneurial processes less bounded i.e. the products and services keep on evolving even after they have been endorsed to the end user. Moreover, platform-based startups having limited resources can move through the entire entrepreneurial process by combining available resources efficiently and effectively.

Keywords: Digital platforms, Entrepreneurial processes, Digital Entrepreneurship, Entrepreneurial Bricolage theory, External Enablers.

1. INTRODUCTION

The recent infusion of digital platforms into different facets of innovation and entrepreneurship has transformed the nature of uncertainty inherent in the entrepreneurial processes along with the ways of dealing with such uncertainty [13, 19, 23, 33, 36]. This has opened up some essential research directions, at the intersection of digital platforms and entrepreneurship i.e. digital entrepreneurship, which considers digital platforms and their distinctive features in influencing entrepreneurial pursuits [24]. Digital platforms have not only shaped the entrepreneurial processes (opportunity generation, opportunity development and opportunity exploitation) but have also brought changes in innovation, competences, control, financing, institutions and ecosystems [34]. Digital entrepreneurship includes transforming existing businesses or new ventures with the help of digital technologies. It is viewed as a vital pillar for development in the digital economy [34]. Digitalization has rendered entrepreneurial processes less bounded i.e. there has been a shift from discrete and steady boundaries to highly porous and fluid boundaries which enables the products and services to continuously evolve even after they have been introduced in the market [24]. Digitalization of entrepreneurial processes has also helped in breaking down the boundaries between various phases along with bringing greater levels of unpredictability and nonlinearity into how they fold [24].

Businesses operating on digital platforms are quite different from the traditional businesses in terms of building trust, governance, resources and entrepreneurial processes. The study explores this through the theoretical lens of entrepreneurial bricolage which explains how entrepreneurship can be done through minimal resources [2, 14, 16, 27, 42]. Entrepreneurial bricolage can be a feasible path for platform-based startups or SMEs, having limited resources, to help in facilitation of entrepreneurial processes.

Even though, a considerable number of entrepreneurs and businesses are using digital platforms to tap opportunities, research is still quite limited in this context [34]. In Pakistan, digital platforms have originated in recent years. Since many digital platform-based startups have started operating...
in Pakistan and various SMEs are also shifting their businesses on platforms, it becomes an important research area to explore. The study focuses on the following research question:

“How do digital platforms act as external enablers in entrepreneurial processes?”

To find answers to the above research question, we conducted an interpretive and qualitative study. We selected two platform-based startups operational in Pakistan: 1) Toycycle and, 2) XYLEXA for comparative case studies. The article explores the role of digital platforms as facilitators of various resources for startups. It also highlights the resource challenges that platform-based startups face in the execution and implementation of their ideas.

2. LITERATURE REVIEW

2.1 Digital Platforms

Digital platforms are characterized as a sociotechnical grouping which includes the technical elements of software and hardware as well as the organizational processes and principles [6, 28]. They are a shared and common set of services and architecture that provide help in hosting complementary offerings [24]. Digital platforms and related ecosystems are often marked by the role of a single firm, the platform leader, in creating the modular platform and in generating both value creation and value appropriation [24, 25]. Digital platforms serve to be infrastructure, marketplace and ecosystems at the same time. For instance, Facebook and Google are digital platforms which provide social media and search but at the same time, they also serve to be the platforms on which other platforms can be built [18]. They have flourished as engines of innovation so that other firms can build complementary products and services in ecosystems [36]. Although the concern regarding the governance of digital platforms is a prevailing issue [28], digital platforms still have the potential of disrupting traditional business models, organizations and all other forms of value creation and capture. They filter and customize information, which are shared by many companies within same or different industry, and also take the form of business community platforms, which are personalized for usage by all the members of a particular business community [18, 21].

Modular systems are leading to the development of platform architectures [36, 39]. In digital platform sites, there is greater interdependence between entrepreneurial firms that launch specific modules and platform firms for whom the modules are launched. Platform firms spend significant amount of resources to attract third-party developers to their platforms to get support from them and build a higher installed base which incentivizes entrepreneurs to introduce more complementary modules [1, 11, 39].

Digital platforms having large user base is more valued by entrepreneurs as they have the largest potential market for their complementary products [39, 41]. They create indirect network effects [7, 22, 39, 40] which serves as the basis of competition in digital platform settings. The choice of an entrepreneur to support the platform is greatly influenced by the network effects for the platform. The presence of network effects and installed base advantages are vital elements of success in platform industries, leading to many new platforms and competitors [39, 41].

2.2 Entrepreneurial Processes

The entrepreneurship process is an activity which processes the opportunities. It goes through the process of opportunity generation (creation and discovery), opportunity development and opportunity exploitation with the objective to transform an opportunity into a viable venture and thus, achieve success [13, 33].

Previous studies on innovation and entrepreneurship as well as the present theories on product life cycle, architectural innovation and product development process have assumed constant and discrete boundaries for ideas relating to new products and services that underlie an entrepreneurial opportunity [8, 24, 35]. However, infusion of digital technologies has made these boundaries more permeable as the scope, attributes and importance of product or service keep evolving even after the
idea has been endorsed. For instance, Tesla has introduced various new functions and features in its cars even after they have been endorsed to the market, simply by modifying digital artifacts or components. With digital technologies and platforms, entrepreneurial processes have also become less bounded as they allow ideas and business models to be formed, endorsed, amended and restructured rapidly, e.g. 3D printing [24]. The scalability of digital platforms (e.g. cloud computing and mobile networking) also causes variations in entrepreneurial activities [24]. For instance, Airbnb started with its primary attention on providing hotel space for various meetings and events. Later, it catered to the demand for affordable accommodation which the hotels were unable to meet thus, rapidly scaling up its services enabled by cloud computing services. Thus, digital technologies infuse a greater level of fluidity and variability into entrepreneurial processes. These changes in entrepreneurial processes enabled by digital platforms lead to change in behaviors and actions of entrepreneurs in the digital arena [24].

With traditional models and frameworks on entrepreneurship assuming fixed and stable boundaries for an entrepreneurial opportunity, a more evolving stream in entrepreneurship research presents alternate views regarding opportunity creation and enactment that reflects fluid boundaries for entrepreneurial processes. For instance, the perspective of ‘opportunity creation’ is of the view that opportunities are emergent and the entire creation process is evolutionary [14, 24]. Likewise, the ‘effectuation’ perspective suggests that the entrepreneur continuously re-evaluates all the available means and shape the offering [24, 30]. The ‘narrative’ perspective makes sense of the meaning associated with entrepreneurial opportunities [15, 24]. All these perspectives indicate that there are fluid boundaries with respect to entrepreneurial processes.

Thus, it is concluded that alternative concepts and theories are necessary for integrating new ways of evaluation of entrepreneurial success and inform on all those factors that are linked with progression of entrepreneurial processes. Digital platforms play a major role in shaping such liminal entrepreneurial processes [24].

2.3 Entrepreneurial Bricolage Theory

The “theory of entrepreneurial bricolage” allows entrepreneurs to endure or even establish strong and growing firms in spite of scarce resources [37, 38]. It allows entrepreneurs to build available resources in an innovative manner into new products or services rather than merely accepting their current potential [2, 43]. The theory of entrepreneurial bricolage has three important features. (1) assessing whether an effective outcome can be generated from what is currently available. (2) combining and orchestrating resources in an innovative manner for new applications rather than only using them for their originally intended purposes. (3) using available resources rather than looking for new resources [43]. Startups are generally very resilient, flexible and creative [4, 12, 17] but their limited network and scarce resources pose to be a great challenge for them [10]. With the help of this theory, startups are able to discover many new prospects by overcoming difficulties in resource acquisition [16, 27, 43]. Entrepreneurial bricolage theory also complements with the Resource based view (RBV) and the institutional view. This is because RBV is not much readily applicable in the context of startups as it is quite difficult for startup to acquire unique resources in undeveloped market. Thus, this theory asserts that startups can take benefit from existing under-utilized resources by combining them in unique ways [3, 43]. Moreover, firm’s operations being in conformity with traditional values and beliefs create suboptimal resource choices which prevent firms from pursuing economically viable options [5, 26, 32, 43]. Thus, the theory states that startups should cross the traditional boundaries to create new products and services [9, 43].

Based on the nature of resources, entrepreneurial bricolage has been classified into three types: First, the input bricolage which combines physical (materials) and human (labor and skillset) resources in an innovative manner and apply them to new problems and opportunities. It leverages low cost labor for various entrepreneurial activities by making full use of available resources. Input bricolage increases operational efficiency when startups have very limited financial resources or have to react instantaneously to the demands of their customers [43]. Input bricolage also helps platform-based
startups in recombining available resources and improving sales performance by broadening the distribution channels, providing infinite shelf space and targeting new audience [14, 43]. Second, the market bricolage transforms existing network of entrepreneurs (customers, friends, suppliers and competitors) to create new customers from that market in which rivals operate. In platform businesses, many customers begin as or become friends. Suppliers become customers and vice versa. Such shifts and expansion of roles deepens the understanding of customer needs and receive feedback from them. Market bricolage enables digital platform-based startups to broaden their product and service combinations at low cost through economies of scale as well as develop trust among business partners [2, 14, 43]. Third, the institutional bricolage incorporates innovative procedures and practices resulting in an institutional transformation. It involves socially reconstructing the available resources and combining them in ways which sets up new institutions. Institutional bricolage is essential for platform-based startups in breaking the inertia of routines [2, 9, 43].

3. METHODOLOGY
We adopted a qualitative multiple case study approach to deeply explore the role of digital platforms in entrepreneurial processes of platform-based startups in developing countries like Pakistan as it is a context-based research. Considering the early stage of establishment of the startups, multiple case study approach was more suitable to develop an in-depth understanding of the phenomena than a single case could provide and to explore the answers of ‘how’ questions for theory building. The evidence created from a multiple case study is strong and reliable and similarities and contrasts can be made. Moreover, this approach creates a more convincing theory when the suggestions are intensely grounded in several empirical evidence, thus allowing for a wider exploration of our research question and theoretical evolution [31]. We selected two platform-based startups operating in Pakistan, ‘Toycycle’ and ‘XYLEXA’, for data collection. Toycycle is an online platform for the buying and selling of preowned items including baby gear (strollers, high chairs, bouncers and carriers), clothes and toys (games, puzzles, electronic toys and wooden toys). Whereas, XYLEXA is an online platform for provision of diagnostic services to caregivers using AI and image processing techniques. The platform serves as a decision support system for radiologists by providing medical image diagnosis and disease and is also involved in R&D for timely diagnosis of cancer.

The primary data was collected through informal chats and semi-structured interviews with founders, co-founders and employees of both startups. Altogether five semi-structured interviews were conducted from founders (2 interviews – both males), co-founders (2 interviews – 1 male and 1 female) and employees (1 interview - male) of both startups. All interviews were conducted in English language which were later transcribed. The transcriptions were read multiple times for thematic analysis. The concepts of ICT and entrepreneurial bricolage theory helped us in making sense of the data. The themes were finalized after extensive discussion within the project team.

4. FINDINGS
This section summarizes the research findings in three themes to explain the role of digital platforms as resources enabler in entrepreneurial processes.

4.1. Input Bricolage: Combining Internal and External Resources
Building a platform-based startup is challenging in Pakistan. The digital economy of Pakistan is still in the developing phase which leads to technological and acceptance issues. Apart from this, startups also face the issue of resource scarcity due to limited resources. But by fully utilizing some available resources, they move through the entire entrepreneurial process.

When the startups were at the opportunity generation stage i.e. opportunity discovery and creation, they made full use of skills, experience and knowledge base for selecting market and customer problems. As explained by one respondent:
Market research was very critical in the starting as we had to get it right to let our customers buy from us. However, I have been in healthcare industry for about 16 years, so I am already familiar with the market and I am bringing in those customer voices and concerns.’ (R 3, XYLEXA Co-founder)

Due to their newness and smallness, it was very expensive for them to seek and acquire resources from their stakeholders. But with the startups operating on third-party digital platforms, friends and family resources came in handy to lower the operational costs by bringing in supportive infrastructure and less expensive labor.

‘We brought in consultants who were relevant in areas of Artificial Intelligence (AI) and Machine Learning to come in and help the team at different stages where they get stuck. They were expensive resources but we were able to negotiate a very good package with them so that they can provide guidance to the team.’ (R 2, XYLEXA Co-founder)

Moving towards opportunity development and exploitation, startups also faced financial and technological resource challenges. They had developed a viable prototype but lacked resources to turn it into a tangible product.

‘We raised two pre-seed rounds for this challenge. As a result, now we are close to our break-even.’ (R 4, Toycycle Founder).

Another respondent also articulated this:

‘Dealing with Machine Learning is very resource intensive. Also, we are using Multiple Languages which is an IBM cloud based application. It is quite expensive but since we have got credits from IBM, it is advantageous for us. We are also stuck with paying license fees.’ (R 2, XYLEXA Co-founder)

Recombining available resources in an effective manner also helped in improving sales performance. Having operations entirely on digital platforms broadened the distribution channels and provided infinite shelf space for new products and services and targeting new audience.

‘As we had compact houses, we were facing the issue of disposing of extra baby gear in an eco-friendly manner. So we started off with the platform for which we allowed people to subscribe and swap things free of cost.’ (R 4, Toycycle Founder)

4.2. Market Bricolage: Creating New Customers and Building Trust

As the startups moved from opportunity generation to opportunity development and exploitation process, they felt the need to create new markets and new customers for which they transformed the existing network of entrepreneurs i.e. customers, friends, suppliers and competitors. Customers became friends, suppliers became customers and vice versa.

‘We did partnerships with relevant suppliers and startups to enhance our customer base.’ (R 5, Toycycle Employee)

Aiming for a large user base was an issue as advancement in digital technologies in Pakistan is still at a nascent stage, either because of lack of adequate technological knowledge or because of high costs.

‘Not a single hospital in Pakistan is using CAD system. It is not that they do not know about it. It is just that they cannot afford it. It can cost you as much as $300,000 plus the maintenance charges. So we had to make it very comparative in terms of price point and entry where they do not have to invest any dollars in capital investment, there is no expense and they only have to pay for what they use. Wherever we gave our commercial proposals, nobody said that it is too expensive. They said that it is very reasonable. So we are creating a new market by making sure that we have enough customers who would be our referential customers and that will help us grow and expand our system in the hospitals in Pakistan and globally.’ (R 2, XYLEXA Co-founder)
Through digital platforms, it was easier to shape the offerings i.e. the products and services even after they had been introduced to the end users simply by modifying digital artifacts or components. As customer requirements change with time, entrepreneurship process becomes ongoing and continuous. This also helped in retaining customers and attracting new ones.

‘We generally go through a product management process. We have built a base product; we have requirements coming in from customers whether they are related to user experience or new functionality. We go through a standard release process. We prioritize them and implement them.’ (R 2, XYLEXA Co-founder).

Another respondent also articulated this:

‘We keep our eyes on whether our old product design is up to date and working properly, if we can improve our conversion and customer acquisition. We already have two defined KPIs i.e. the amount of stuff that we pick up, which is also our inventory that we need to sell. The other is sales that we generate. In order to increase sales, we incentivized our check-out page like offering discount to boost our sales because some customers used to add stuff to the cart and left instead of purchasing the items. So this was a way to bring back such customers as well.’ (R4, Toycycle Founder)

Emerging startups also faced low level trust and governance issues as well as less committed relationships between the business partners at the opportunity development and exploitation stage.

‘At this stage, it was very important to build trust. Since I had already been in the industry for 16 years and selling to same hospitals so our customers were all referral customers. This helped us in building trust among them comparatively easily.’ (R 3, XYLEXA Co-founder)

To build an even better level of trust with the customers and business partners, products and services went through an entire process of trial and error and feedback was received from customers. This is how the startups went from concept to proof of concept. Minimum Viable Product (MVP) was released in the market. The needs and concerns of the customers were received and now the beta product is incorporating those customer feedbacks.

4.3. Institutional Bricolage: Adoption of Innovative Approaches to Bring an Institutional Transformation

Startups adopted some innovative principles, rules and practices that were away from the traditional ones, to socially reconstruct the resources at hand. This helped them to break the inertia of routines. Various innovative approaches were implemented to employ available resources. Individualized and customized services were made available to the end users and open source was used to build components and add new functionalities. Labor was one of the most important resources so every effort was made to retain them to transform the institution (startup). As one respondent articulated:

‘In order to retain our employees, we offered them trading, a good working environment, the interesting product that we were making and the cutting-edge technology that we are using. We took care of our employees and gave them a chance to learn and grow and not make empty promises to them. We are sitting in the same office, working on the product and funding. So they have seen the progress themselves and they are committed to what we are doing.’ (R 2, XYLEXA Co-founder)

These platform-based startups have become pioneers in their area by introducing novel products in the market. As a result, the perception of people has changed to some extent. They are adopting new technology based products. The startups have also experienced first-mover advantage.

5. DISCUSSION AND CONCLUSION

The study seeks to make contribution to research and practice in digital entrepreneurship. It offers novel insights into digital entrepreneurship literature by exploring role of digital platforms as facilitators of various resources for startups.
The answer to the research question – “How digital platforms act as external enablers in entrepreneurial processes?” has been examined with the help of entrepreneurial bricolage theory. Digital platforms serve to be infrastructure, marketplace and ecosystems at the same time [18]. They help in continual updating of entrepreneurial processes. Our findings concur with the literature that digital platforms create fluid boundaries of the entire entrepreneurial process as the products and services keep getting modified even after they have been introduced in the market and to the end user. This is done through modification in digital artifacts or components [24].

The limited resources are an important challenge that almost all small startups face. They have the required skillset, social network and creativity but are unable to have access to costly new resources [10]. Having enough finances to turn a viable prototype into a tangible product is a challenge for which help from pre-seed rounds is needed. However, various incubation and accelerator programs help overcome the financial challenges faced by digital platform-based startups. Combining available resources (internal and external) and seeking help from the limited social network can help in operationalization, improving sales performance and efficiency and creating customers. Technological challenges are also common in Pakistan where technology is still in its nascent stage. It is a little challenging to enhance platform user base in Pakistan as customers are at times less familiar with the technology either because it is expensive or due to less adequate technological knowledge. Making the technology comparative in terms of price point and entry and allowing the customers to pay only for what they use can help platform-based startups in overcoming technological resource challenges throughout the entrepreneurial process.

Startups in developing countries like Pakistan are more inclined towards operating on digital platforms as it enables entrepreneurship even in resource constraint environment. Scarce resources are a huge challenge and people in developing countries tend to have technology acceptance issues. However, combining available resources in an effective manner and taking help from existing network of family and friends can help in operationalizing the startups. Moreover, digital platforms charging customers only for what they use becomes a major solution to cater to the technology acceptance issues and enhancing user base.

In this article, we try to bring the attention of IS scholars towards exploring the interaction of digital platforms and entrepreneurial processes. It is a right time to focus on digital entrepreneurship as the entire world is moving towards digitization. In developing countries, startups and small enterprises can catalyse the economic and social development. This initial level research identifies the need of future research to unpack the various stages of entrepreneurial process from input, market and institutional resources facilitated by digital platforms in developed and developing countries. These theoretical and practical insights will not only contribute into emerging literature of digital entrepreneurship but also assist in flourishing the entrepreneurial ecosystems in developing countries where resources are scarce.

REFERENCES
E-COMMERCE FOR RURAL MICRO-ENTREPRENEURS: MAPPING RESTRICTIONS, ECOLOGIES OF USE AND TRENDS FOR DEVELOPMENT

Aditi Bhatia-Kalluri, Faculty of Information, University of Toronto, aditi.bhatia@mail.utoronto.ca

Abstract: This paper addresses the struggle of rural micro-entrepreneurs in the Global South in utilizing e-commerce to reach wider markets. This research paper looks at the adoption of e-commerce as a sustainable marketplace by the micro-entrepreneur sellers from the lower socio-economic rural communities in India, a booming digital economy in the Global South. ‘Sustainability’ here refers to a model for sustainable economic development sustaining the e-commerce as business model for the rural micro-entrepreneurs to flourish. This paper explores rural development by dismantling the factors that shape the ways technology and trade impact micro-entrepreneurs. The aim is to offer recommendations and solutions to contribute building the e-commerce as a sustainable marketplace for rural micro-entrepreneurs. Recent information and economic policy changes in India, along with the expansion of mobile infrastructure and a growing user base in rural regions makes this research timely and important. By scrutinizing the infrastructure and auditing the information needs and challenges of users, this research will illuminate the gaps that are leading to a lack of sustainable economic development, and information asymmetries discouraging the rural micro-entrepreneurs from selling online. The purpose of the paper is to find hurdles in the sustainable development of e-commerce as a business solution.

Keywords: ICTD (Information Communication Technology for Development), sustaining e-commerce, poverty reduction, financial inclusion, rural microentrepreneurs, information access.

1. INTRODUCTION

1.1 Significance of the Study and Background

Despite the current availability of technology, networks, and infrastructure, microentrepreneurs in rural India have yet to capitalize on e-commerce. According to Kalambe (2019), “rural India accounts for two-thirds of the country's population” (p. 29) and their active participation in e-commerce can contribute to the exponential growth of e-commerce. This growth has to come with sustainability or sustainable development, which means longevity of information technology. Sustainable economic development includes ensuring that the information infrastructure, technological affordability and information policies are in place to sustain the development for the long haul. Factors such as overall information environment, social justice, ethics, and participation of the locals at the grassroots level are among other factors contributing to sustainability. Being at the juncture of recent policy changes, the recent expansion of infrastructure, and the rapid growth of mobile use in India contributes to the immense timeliness for raising awareness of the barriers faced by rural micro-entrepreneurs for their financial access and inclusion in e-commerce. Before delving into economic development for micro-entrepreneurs, it is important to understand the transformation of the information environment in India.
1.1.1 Affordable network services and devices

Mobile phone use has proliferated among lower socioeconomic populations due to the affordability of network services (Wasan & Jain, 2017). Paradoxically, rural communities that never had landlines now have access to mobile phones, skipping the conventional technological development trajectory. These communities lack basic amenities such as clean water and sanitation yet have access to mobile phones. For many rural users, mobile phones are the only way of accessing the internet. In 2017, India’s leading cell phone provider, Reliance Jio launched 4G LTE networks offering practically unlimited data plans for about CAD 6 a month, making it one of the lowest data tariffs in the world (NDTV, 2017). The entry of Jio into the market forced competing firms to reduce their rates, causing India to jump from 150th to 1st in total mobile data usage (Economic Times, 2017). This is the fastest penetration by any mobile network operator anywhere in the world. Moreover, for over a decade non-branded handset have been popular with the lower socio-economic masses. These non-branded phones are reliable yet lower in cost while also supporting all the features as other smartphones (Jeffrey & Doron, 2013). They are significantly cheaper than the name brands yet claim to have many of the same multimedia functions. Hence, according to Wasan and Jain (2017) for the rural masses, mobiles have become commonplace through affordable devices and network services.

1.1.2 Digital India Programme

The transformation of the information environment in India is also influenced by recent public policies. In 2015, the government launched the Digital India programme that contributes to infrastructural development in rural regions (Digital India, 2017). The programme aimed to bridge the digital divide between rural and urban areas by providing access to high-speed broadband, WiFi hotspots, and digital literacy to deliver public services digitally. With the slogan for Digital India being “Faceless, Paperless, Cashless” (Digital India, 2017) the aim is to facilitate e-governance and promote financial inclusion by creating awareness for e-banking and digital payments.

1.1.3 Demonetization

With the Digital India programme contributing towards digital empowerment for the citizens, the subsequent goal of the government was to foster a less-cash society. In November 2016, the government demonetized all ₹500 and ₹1000 banknotes for various reasons, such as to curb the black money in the economy, to promote digital payments and more. Indian banknote demonetization came across as an unexpected economic policy shock that forced a shift to digital payments (Singh & Singh, 2017). Cashless India’s agenda came as a by-product of this policy change, leading to an exponential rise in e-banking, plastic money, mobile wallets, and e-commerce (Shirley, 2017). A large number of micro-entrepreneurs, even street vendors, now accept digital payments, prompting the public to learn to transact the cashless way at a faster pace with the help of the available modes of digital payment. According to Sheetal et al. [2018], Kumar and Puttana [2018], overall a sharp jump in mobile banking was noticed post-demonetization. When the currency bills came back into circulation, a significant portion of the population moved back to using cash; this transition period lasted for 4-5 months allowing the population to rely on digital payments as one of the primary means of financial transactions. As per Kumar [2020], the digital payments in the micro-merchant and micro-enterprise segment create digital footprints such as transaction and credit histories, which helps them be included in the formal mainstream banking sector, get access to credit and eligibility for loans.

1.2 The Statement of Problem

With the required affordability of the mobile handsets and network infrastructure, access to the online marketplace for rural microentrepreneurs for a wider market outreach should be evident. The factors prohibiting outreach to the online marketplace could be a lack of tech-savviness and understanding of e-commerce platforms. However, there are factors that question a sustainable
penetration of e-commerce such as a lack of access to information knowledge for microentrepreneurs. By auditing the impact of various government schemes on the ground, also the information needs and challenges of rural users, this research will illuminate the gaps that are leading to information asymmetries, and hindering sustainability by discouraging the rural microentrepreneurs from selling through e-commerce. The purpose of the paper is to find hurdles in awareness creation for rural entrepreneurs for adopting e-commerce as a sustainable business solution.

1.3 Research Questions
How can microentrepreneurs in rural communities utilize ICTs, especially mobile phones, to sell their goods through online marketplaces and ensure sustainable economic development? What factors might be prohibiting users from financial inclusion such as deficient information infrastructure, financial policies, lack of digital literacy and other socio-economic factors?

2. METHODOLOGY
This research utilizes a systematic literature review to collect qualitative data from peer-reviewed journal publications. The date range is from 2017 up until this point, which would give an account of digital payment penetration post-demonetization (demonetization implemented in November 2016). The search criteria would include the following keywords: India; rural, e-commerce; micro-entrepreneurs; artisans; handicraft merchants. This would help understand the social behaviour of the rural users by assessing digital literacy rates, affordances of the mobiles, available infrastructure and information resources. I will review the publications that scrutinize the ways the information environments have been transformed in the rural communities and e-commerce practices in the rural regions of India. The paper focuses on creating a structured literature review starting with challenges to e-commerce penetration in rural regions, and the current status of e-commerce operations with in-depth analysis of the e-commerce sites, newspaper reports, and articles.

2.1 Theoretical framework
The research will adopt Information, Communication, Technology for Development (ICTD) as a major theoretical framework. As articulated by Burrell [2009], an ICTD framework would assist me to look at “human and societal relations with the technological world and specifically consider the potential for positive socioeconomic change” [pp. 84][1]. The Cube Framework is an ICTD framework that would serve as a conceptual model depicting three-dimensional interdependencies between technology, policy, and social change [2]. As per Martin Hilbert [2012], the cube framework is based on the Schumpeterian notion of creative destruction, which “modernizes the modus operandi of society as a whole, including its economic, social, cultural and political organization” [pp. 244][2]. The cube framework would help comprehend the process of development for rural micro-entrepreneurs through mobile phones with various co-determinants at play helping determine the information dissemination gap. The cube framework would help scrutinize factors contributing to the social inclusion and/or exclusion of people in rural India.

3. LITERATURE REVIEW
3.1 Challenges to e-commerce penetration in rural India
As per a study by The Boston Consulting Group, 25% of the rural consumers find e-commerce sites and apps are hard to use. Anooja (2015) and Goswami (2016) have analyzed the impact of the Digital India programme on the ground and have identified high illiteracy and lack of tech-savviness as gaps that restrict the effective utilization of e-commerce technologies. The discrepancies in the
urban and rural literacy rates, digital infrastructure, and accessibility to information lead to a lack of access to knowledge for rural communities. UNESCO defines literacy as “the uses people make of it as a means of communication and expression, through a variety of media.” In the article, “Design Studies for a financial management system for micro-credit groups in rural India” Parikh, Ghosh and Chavan (2003) claim that as per UNESCO there is 43% illiteracy in India, and “in some of the grossly underdeveloped states of northern India, illiteracy rates can hover as high as 70 to 80 percent of the population” (p. 16). This is critical in understanding the lack of literacy in some regions that might refrain the people from utilizing the available technology to its maximum potential. According to Bakshi (2019), lack of literacy is also a hurdle for professionally handling customer support. Moreover, the fear of insecure online transactions inhibits rural microentrepreneurs from using e-commerce applications; these challenges arise due to poor education, and a dearth of financial and social support (Goswami & Dutta, 2016). Despite the availability of mobile phones, digital knowledge management lags due to inefficient information use in rural communities. The lack of access to information knowledge still exists.

Furthermore, there is poor geographical access to facilitate sustainable e-commerce, which demands smooth access between the urban and the rural and remote rural regions are victims of poor transport infrastructure. A geographical challenge in the rural area is shipping goods to and from remote areas with poor access and transportation. According to Khatri, transportation and accessibility, “infrastructural problems negatively affect the productivity and profitability of the MSME sector” (p. 11) because it impacts supply chain efficiencies. As per Karnik (2016), India Post, Department of Post by the government, which is a fading away service, in the past couple of years gained a boost by collaborating with around 400 e-commerce websites, including Amazon and Flipkart.

### 3.2 E-commerce platforms to encourage participation for micro-entrepreneurs

#### 3.2.1 Bottom-up approach to the empowerment of the rural micro-entrepreneurs

In the article, “Local, Sustainable, Small-Scale Cellular Networks,” Heimerl, Hassan, Ali, Brewer and Parikh (2013) propose a model to build bottom-up where the local entrepreneurs would own and operate their services for the local population. This was proposed in the context of small-scale cellular networks in Papua, Indonesia; however, this can be re-modeled for the e-commerce in the India. Also called ‘inverse infrastructure,’ the idea was initially coined by Egyedi and Mehos (2012) that propagates benefits of decentralization such as lower operational costs. This also creates opportunities for the locals and brings in certain freedoms (Sen, 2001). Heimerl et al. (2013) investigate the financial sustainability by scrutinizing expenses, revenues, and profitability.

#### 3.2.2 E-commerce platforms in India promoting rural artisans

The government has been ensuring the participation of the rural micro-entrepreneurs on digital channels to reach out to the wider market. This can be through the existing e-commerce platforms that leverage digital distribution infrastructure, can be facilitated through government portals or can be done autonomously by the micro-entrepreneurs through social media.

Uttar Pradesh, one of the most populous states in India, launched a program called, ‘One District One Product,’ (ODOP) programme, under the Ministry of MSME to encourage indigenous craft products from 75 districts across the state promoting one product that a particular district specializes in producing. As a part of ODOP, Amazon India has signed a Memorandum of Understanding (MoU) with the U.P. government to support MSMEs [Ismat, 2020]. ODOP initiative complies with the ‘Atmnirbhar Bharat’ project promoting the production and distribution of indigenous products. As a part of the MoU, “Amazon will provide these entrepreneurs training, account management guidance, marketing tools and world-class infrastructure of storage and delivery network to aid their progress through online selling” (Naik, 2019). Two Amazon programmes that promote rural
artisans across the nation are ‘Kala Haat’ translating to ‘Art Shoppe’ and ‘Amazon Karigar’ translating to ‘Amazon Artisans’ constitutes a niche, which sells authentic crafts by Indian artisans.

Flipkart is another giant e-tailer, an affiliate of Walmart. Similar to the Amazon model in the state of Uttar Pradesh, Flipkart has signed a MoU with the state of Karnataka to promote local art, craft and handloom (Economic Times, 2020). Flipkart called this niche, ‘Samarth,’ which translates to ‘Capable.’ According to Flipkart, the Samarth programme seeks to break entry barriers for artisans by extending time-bound incubation support, which includes benefits in the form of onboarding, free cataloguing, marketing, account management, business insights and warehousing support (Economic Times, 2020). Another major e-tailer is JioMart, with Reliance as a parent company, and affiliated with Facebook, which is also WhatsApp’s parent brand. Facebook has also collaborated with Reliance, which owns multiple businesses that includes Reliance Mall. Reliance is also the parent brand for Jio mobile that provided the lowest recorded prices on mobile data. According to Anand and Phariyal (2020), “Reliance-Facebook combination represents a Goliath-like opponent, especially given Reliance’s track record in decimating rivals when it entered the telecoms market with Jio InfoComm and cut-throat pricing.” It is interesting to observe the market dominance of Reliance and Jio, with JioMart as e-commerce, with WhatsApp and Facebook parent social media channels.

The government is planning to set up an e-commerce portal called ‘Bharat Craft’ for MSMEs with the State Bank of India (SBI) announced by the Chairman of SBI, Rajnish Kumar (Economic Times, 2020). Bharat Craft’s initiative gears toward eliminating the involvement of middlemen and would follow a model similar to that of China’s giant, Alibaba. Moreover, amid COVID-19, the Khadi and Village Industries Commission (KVIC), under the Ministry of MSME, urged e-commerce giants to support khadi mask makers. However, due to onboarding hurdles, the link-up did not materialize. In this situation, the KVIC inaugurated an e-commerce portal on their official site, which gained tremendous popularity. Upon its success, various giant e-commerce wanted to sell Khadi under their name brand. However, the government has trademarked Khadi under KVIC and denied the rights to other e-commerce portals to advertise or sell khadi (KVIC, 2020). KVIC primarily sells khadi, which stands for hand-woven cloth including khadi masks, fabrics, food items, soaps, footwear and more.

Surpassing the formal e-commerce infrastructures, various rural sellers are opting to reach out to the market autonomously through social media. In the article, "Infrastructure as creative action: Online buying, selling, and delivery in Phnom Penh," Jack, Chen and Jackson (2017) state that “the online buying ecosystem takes the rules of the local context as self-evident (i.e., the normal way of working) and “central” to the workings of the ecosystem (p. 6513). This is crucial in understanding the informal ways sellers attempt to sustain themselves in the online marketplaces. To support selling on social media platforms such as ‘Dukaan’ enable local shops to create an account, add items to the catalogue, set product pricing, delivery fee and sell on social media such as WhatsApp, Facebook, Instagram. This platform would assist those micro-enterprises to reach the market directly through various social media channels.

3.2.3 China’s e-commerce giant, Alibaba’s rural expansion program as a role model

China’s e-commerce giant, Alibaba, provides a model for how other e-commerce platforms can strategize the utilization of digital channels to extend e-commerce to rural markets in a large and diverse developing country. Alibaba’s rural expansion program provides rural service centers in the countryside that help entrepreneurs learn to sell online. These connected villages are called ‘Taobao villages’ and have rural retailers who manage online orders (Jain & Sanghi, 2016). The sellers from the villages receive tech support from these service centers. ‘Taobao villages’ act as a hub where e-commerce orders are delivered, instead of home-deliveries where rural users can pick up their orders (Jain & Sanghi, 2016). These rural service centers are run by the youth of the village, who also spread awareness about online shopping among those villagers who are unaware or reluctant.
towards it. Alibaba’s service centers in the countryside exemplify business to customer (B2C) support model.

4. FINDINGS

Keeping the Cube framework in mind, in this research ‘technology’ refers to financial access and inclusion with the help of ICTs and infrastructure. The technology entails both hardware that is infrastructure with network towers and mobile devices and software such as app platforms on the devices. A survey of the Digital India programme and demonetization demonstrate that these recent public policies contribute to the expansion of infrastructure, the rapid growth of mobile usage in rural India and awareness of cashless payments contribute to the basic technology layer of the cube required for e-commerce to function. To address the poor transportation infrastructure for product deliveries in remote regions, India Post comes as a rescue with widespread networks across the nation to even the remotest locations.

The other layer of the cube focuses on human components, their capabilities and skills, however, lack of information knowledge is a hindrance for MSMEs in spite of available technological resources. Despite e-commerce giants signing MoUs and government reform programs in a few states, rural artisan sellers are financially excluded due to the widespread lack of awareness about e-commerce. That means a lack of freedom of choice to choose markets, lack of support in being introduced to and sustain an e-commerce environment. Human capabilities are essential to utilize technology for development to bring about social change. Social change here refers to the socio-economic sectors that are subjected to be changed with digitization. It is vital to note that semi-literacy and illiteracy are restricting users from utilizing available technology. To bring about a social change in the current scenario, human skill for the operability of e-commerce platforms is required. Lack of literacy and technical support dovetails various issues such as restricting sellers from providing professional customer support and increases fear of digital payment transactions. Another layer of the cube delves into the necessary policy instruments that fulfill the purpose of social change. Here the purpose of the social change is a sustainable development of e-commerce for rural artisan sellers. To get rural users on board there should be policies on providing the interface content and support in their vernacular and regional languages. While national languages are English and Hindi in India, each state has its regional language with a distinct written and spoken format. Currently, Amazon seller support services provide tutorials in English, Hindi and Tamil only (Varshney, 2020). Hence, there should be policies on extending the range of regional languages that would give rural artisans control and command over the interface and overall foster the e-commerce sector. The intervening guiding policies are prescribed for the government and the e-commerce giants to facilitate e-commerce in various ways such as raising awareness, providing onboarding and technical support to rural users. These policies are supposed to address the needs of the human components such as lack of tech-savviness, literacy and more.

Based on the survey of the existing e-commerce in India, I recognized 3-tier for a sustainable e-commerce development for the rural user-base: The first tier is rural sellers collaborating with e-commerce giants such as Amazon, Flipkart, Jio Reliance-Mart and others. Collaboration with these giants means the rural users would be receiving onboarding training and technical support with an associated commission fee. The second tier is government initiative and artisan cooperatives such as KVIC and ‘Bharat Craft’ selling directly through their platforms, which might have less or negligible commission fee due to associated government funding and subsidies. Moreover, it is interesting to investigate informal ways sellers adapt to the online ecosystem which would also save them middlemen and other costs to place the products in the appropriate markets. Hence, the third tier is rural sellers arranging sales autonomously through social media which includes marketing and selling products on Facebook, also through Facebook and Instagram live, sending product pictures to individual clients through WhatsApp or creating WhatsApp groups for all the clients.
The third tier is a perfect example of sellers utilizing localized resources, adapting to utilize social media affordances and exercising their freedom to expand outreach to the wider markets.

5. DISCUSSION, STRATEGIES AND SOLUTIONS

5.1 Ensuring accessible e-commerce designs for illiterate users

Semi-literacy, illiteracy and lack of information knowledge are a few factors that refrain rural microentrepreneurs from not sustaining in the online marketplace. Goetze and Strothotte (2001), Huenerfauth (2002), Parikh, Ghosh and Chavan (2003) have proposed the usage of graphics within the design to facilitate usage among illiterate users. It is important to understand that e-commerce was initially originated in the Global North, and Global South adopted the e-commerce platforms as it is with the least number of changes to its basic structure and user interface. An example of this is Amazon, whose interface is the same as amazon.com and amazon.in (India). While the users from Global North and urban India would have comparable literacy to comprehend the e-commerce design principles for those platforms, the users from rural India are socially excluded because those platforms do not match their level of comprehension. Hence, for the financial inclusion of rural users, e-commerce platforms should be designed to be more accessible. In the article, “Text-Free User Interfaces for Illiterate and Semi-Literate Users,” Medhi, Sagar, and Toyama (2006) state that useful platforms for illiterate users should consist of a user interface that novice illiterate users can operate with no guidance or training from anyone. Medhi et al. strongly believe that “if the UI were designed well, users would not require formal literacy, computer skills, or any external assistance in order to operate the application” (p. 72). An on-ground paper prototype experiment seeking to develop an accessible user interface for rural semi-literate and illiterate users by Parikh, Ghosh and Chavan (2003) revealed that most users could recognize the numeric keypad, its purpose, and various icons (p. 17). The users demonstrated strength in associating ideas and actions with highly representational icons relating those to the idea they meant to represent (p. 19). This is critical in recognizing the ease of the users with numbers and graphic elements despite low literacy levels. The users need to be able to operate the e-commerce platforms without formal training because access to a training programme might not always be feasible considering the huge population of rural India. The graphics-oriented user interfaces could be combined with less-text with a choice of vernacular and regional languages to assist users in easy comprehension of the content.

5.2 Opportunities for microentrepreneurs to sell online

The rural artisans generally sell their products within the markets in their villages, or travel outside their districts, and sometimes even travel to cities to sell their products for wider outreach. The market outreach is a tedious process for the sellers due to travel and accommodation costs among other hurdles. Additionally, the COVID-19 situation came across as an environmental intervention encouraging MSMEs to sell online. According to Gopal Pillai, VP of Seller Amazon, COVID-19 has increased customers' demand and seller registration to join online journeys (Naik, 2019). Flipkart adds in a statement that the spread of COVID-19 has urged sellers to re-think their usual mode of operating and realize the value of e-commerce, which extends their outreach to the market amid guidelines to stay away from crowded markets (Abrar, 2020). E-commerce provides the rural artisans with an opportunity to start a new business or to promote an existing one with low investment cost since stocking products in a brick-and-mortar shop is not required, which saves them rent or cost for owning a shop. It provides a merchant autonomy to sell the products based on their production speed. Mainstreaming of e-commerce among rural micro-entrepreneurs can bring a social change by reducing the inefficiencies arising due to shortcomings of the traditional channel intermediaries such as having middlemen buy in bulk for a much cheaper price and sell at high rates in cities. Switching to an online marketplace can eliminate the middlemen, which can help artisans set higher pricing for the same item being sold for a cheaper price earlier. It provides easy access to
markets nationwide and also an opportunity to export internationally in some cases. According to a recent news report in India’s leading newspaper, The Time of India (2020), the sellers registered for Amazon India’s ‘Global Selling’ program noticed a 76\% hike in sales for Black Friday. Hence, the adoption of e-commerce contributes to the financial inclusion of rural micro-entrepreneurs into the mainstream practice and supports poverty alleviation providing more autonomy to the sellers to pick their markets.

As per the 3-tier e-commerce resources explored earlier, it is important to note that amid high commission fees and other onboarding restrictions for rural artisans by giants such as Amazon and Flipkart, the state governments are seeking their support in promoting MSME government initiatives. The government is also promoting their independent initiatives to support rural artisans when it becomes too difficult to get assistance from the e-commerce joints, such as the KVIC Khadi sales portal. To combat the problem of poor transportation infrastructure, KVIC has tied up with India Post for item delivery and provides authority for e-tailers to set their pricing. This eliminates or reduces the commission to the e-commerce giants. This case exemplifies the power of the government in demonstrating solidarity and regulating fair-trade for the rural sellers.

Furthermore, various studies have observed the handloom and handicraft merchants autonomously selling their products by utilizing live streaming affordances of Facebook, and Instagram and sharing product catalogues through WhatsApp, in an attempt to adapt to the available resources without training. However, relying on social media especially for those who are not tech-savvy and from lower-socio economic background might bring their own set of hurdles, such as, transporting the product especially to and from geographically remote areas and digital payments. Jack, Chen and Jackson (2017) share a case of a remote region Phnom Penh in Cambodia that explains how a small firm posts the product on Facebook, the price negotiation takes place in the direct messaging service, once the purchaser agrees on the price, the delivery is coordinated with the purchaser. This tedious process involves coordination between various people, which would be difficult for rural sellers. The availability of the technical, infrastructural and policy interventions would assist the rural handicraft merchants with capacity building and generating livelihood opportunities independently and can be scaled to rural regions across the nation.

5.3 State Policies to provide sustainable environment for micro-entrepreneurs

The policy intervention is required from the central and state governments to further facilitate the prevalence of e-commerce among artisan sellers in rural India. Firstly, the individual states in India signing MoUs with giant e-commerce such as Amazon or Flipkart model has been working well. Hence, the government can incentivize the giant e-commerce firms to promote local artisans and help them onboard. Gopal Pillai, VP at Seller Services, Amazon India, explains that these initiatives offer help to MSMEs with required technical and operational skills, along with considering adding helpful features for those who sell through mobile phones (Naik, 2019). Secondly, the bottom-up model by Heimerl et al. (2013) can involve the local people more with running the e-commerce by leveraging local information and transportation infrastructure, and labour. Thirdly, Alibaba’s rural expansion model with rural service centers helping entrepreneurs learn to sell online is exemplary. This can be scaled with the help of the government policies for the e-commerce giants to have a rural service center in villages, which would help rural sellers onboard, and support dealing with customers post-selling. The hurdles for the sellers such as return on merchandise can increase the business operation cost, while these could not be eliminated, having support can make it easy for the sellers to understand and operate within an online marketplace environment. They can receive support on appropriately fulfilling the orders, provide professional customer support and exercising control over the selling procedure. For the rural sellers “lack of on-ground presence, including poor after-sales services, is a quick way to lose customers” (Bahree, 2018). Also, this model can help overcome the transportation infrastructure difficulty by shipping the goods to a district or village at the center, where the rural population can arrange a pick-up. This complies with the ‘creative infrastructural action’ defined by Jack, Chen and Jackson (2017) as the resourceful and imaginative
development of a homegrown infrastructure to support the ecosystem for the remote population to enjoy the conveniences of online selling (p. 6512, 6519). This also means working through the drawbacks of poor transportation infrastructure in the rural and coming up with makeshift arrangements to utilize e-commerce in the best manner. According to Kalambe (2019), the area that requires improvement includes mentorship programs and the development of a skilled digital workforce. The government has already announced the inception of ‘Bharat Craft’ as a platform for artisans across the nation to sell the products online, which would follow a model similar to China’s Alibaba. The concept of rural service centers can be added to the structure of ‘Bharat Craft.’

The key solutions for sustainable economic development are the availability of an accessible user interface for semi-literate and illiterate sellers, support to onboard and sustain e-commerce with rural service centers, policy interventions to increase the awareness of e-commerce market models. A sustainable e-commerce development would ensure poverty reduction for marginalized communities and will provide a much-needed promotional boost to their intangible cultural heritage. This research provides strategies for stakeholders to encourage rural micro-entrepreneurs to sell online and contribute to the financial inclusion of rural sellers in other nations in both the Global North and South.

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THE DECISION CRITERIA USED BY LARGE ENTERPRISES IN SOUTH AFRICA FOR THE ADOPTION OF CLOUD COMPUTING

Tserwa Bakasa, University of Cape Town, bskste001@myuct.ac.za
Ayanda Pekane, University of Cape Town, ayanda.pekane@uct.ac.za

Abstract: Cloud computing is a technology that has become increasingly popular over the past decade within several enterprises. This popularity can be attributed to its benefits, including lower operating costs, improved computational capabilities, increased flexibility and on-demand storage space. As a result, many enterprises are already in various Cloud Computing (CC) adoption and implementation stages. This study investigates the decision criteria used by large enterprises in South Africa (SA) for the adoption of cloud technology. The majority of large enterprises have comprehensive resources, resulting in established Information Technology (IT) systems and infrastructure set up within their organizations. Though this is the case, the adoption of CC by large enterprises has been on the rise. This may not be a surprise as CC literature points out to benefits and influencers of CC adoption. However, the decision criteria used by large enterprises in SA in adopting CC are lacking in the literature reviewed. The study followed an inductive approach making use of qualitative methods. Findings revealed that large enterprises do not make use of a formalized or standardized decision criteria. However, operational cost, enterprise strategic intent and product efficiency formed key criteria for adopting CC. In addition, security, cloud service provider adoption framework and data sovereignty were the key criteria used to select a CC service provider. The research will contribute towards CC technology adoption literature, particularly for developing countries.

Keywords: Cloud computing, Cloud adoption, Decision criteria, Large enterprises.

1. INTRODUCTION

Cloud computing is a technology that has become increasingly popular within large enterprises in SA. The reason behind this popularity can be attributed to the multiple benefits that are offered by cloud technology. Sharma and Sehrawat (2020) state that the most outstanding benefits of CC include lower expenses, increased flexibility, scalability, green technology, increased computing power, remote access and innovation. Overall, this equates to lower overhead costs, improved computational and information-handling capabilities, and greater convenience. These advantages make CC an attractive option to consider for enterprises in general (Ross, 2010). The significance of large enterprises in SA is evident in that they employ the highest South African populous (StatsSA, 2019). The small business institute of South Africa reports that small and medium enterprises use only 28% of the South African population.

In comparison, 72% of the population is employed by large enterprises (Smallbusinessinstitute, 2018). Additionally, large enterprises are the highest contributors to SA’s government revenue stream. According to StatsSA, the formal business sector realized a total turnover of approximately R2,39 trillion in 2019. Out of this amount, large enterprises contributed the highest percentage of 62%, while small and medium-sized businesses contributed 29% and 10%, respectively (StatsSA, 2019). These statistics clearly illustrate the critical role that is played by large enterprises in the South African economy.

Large enterprises are also characterized by possessing comprehensive resources resulting in established Information Technology (IT) systems and infrastructure set up within their
organizations. Though this is the case, the adoption of CC by large enterprises has been on the rise. This may not be surprising, as the literature points out the benefits of CC adoption. The reviewed literature further outlines additional themes such as the challenges, factors and influences of CC adoption (Johnston, Loot & Esterhuyse, 2016; van Dyk & Van Belle, 2019). These themes have advanced the body of knowledge in the adoption and use of IT in SA. However, the decision criteria used by large enterprises in SA are not explored in the context of enterprises of SA. The objective of this study is to describe the decision criteria used by large enterprises in SA to adopt CC. The study seeks to answer the following research question: What are the decision criteria used by large enterprises in SA to adopt CC?

This study aims at contributing to the current body of literature by promoting an understanding of the decision criteria used by large enterprises to adopt CC in SA. In addition, the study aims to identify the decision criteria used to adopt CC in the South African context without adopting theories developed in the global North. The research will be relevant to the community of practice interested in the decision criteria used in adopting CC.

2. LITERATURE REVIEW

The literature reviewed for this study includes the adoption of CC literature in developing countries, including SA, the decision-making influences in adopting CC as a technology, and enterprises' decision criteria in adopting technologies. Literature on decision making was included due to the close link between decision making and decision criteria.

2.1 The adoption of CC in large enterprises in SA

Cloud computing is a common pool of configurable IT services, including data storage, networks, information processing and software applications rendered as a flexible and scalable service via the internet (Akande, 2014). According to Rahimli (2013), CC is suitable for large enterprises like financial services, government organizations and healthcare facilities. This is because CC provides increased data storage, minimum downtime and improved processing ability to facilitate quicker responses and more reliable security (Rahimli, 2013; Sharma & Sehrawat, 2020). Therefore, the adoption of CC results in lower expenses, increased flexibility, scalability, green technology, increased computing power, remote access and innovation (Sharma & Sehrawat, 2020). This has made CC an attractive option to consider for large enterprises (Ross, 2010). As a result, large enterprises in South Africa have started to gravitate towards cloud adoption to utilize emerging technologies, reduce costs and improve efficiency (Moonasar & Naicker, 2020).

Oliveira, Thomas and Espadanal (2014) elaborates, that large businesses have comprehensive resources, they have maintained and upgraded their IT infrastructure. They can also move on from the traditional way of using in-house IT infrastructure to introducing CC in their enterprise (ibid.). The literature reviewed revealed themes that are associated with the adoption of CC by large enterprises. However, the literature reviewed also showed that publications on CC adoption by large enterprises in SA are under-represented.

The literature on CC adoption in SA by large enterprises is concentrated on descriptive and explanatory contributions. The themes include the level of readiness to adopt CC (Akande, 2014); the business value of CC in organizations (Johnston et al., 2016); the operational requirements for the adoption of CC (Krauss & Van der Schyff, 2014); barriers to the adoption CC (Scholtz et al.,
2.2 Decision-making factors that influence CC adoption in large enterprises in SA

Research shows that several factors can influence decision-makers’ decisions to adopt CC within their respective organizations. These factors consist of competitive market pressures (Alshamaila et al., 2013; van Dyk & Van Belle, 2019), Institutional pressures (Liang, Saraf, Hu, & Xue, 2007; Trope, 2014), Senior management support (Priyadarshinee, Raut, Jha, & Garda, 2017; Sharma, Gupta, & Acharya, 2020), A need for improved IT services (Priyadarshinee et al., 2017) and core business focus (Awosan, 2014). Given all the factors influencing decision-makers to adopt CC, the literature proposes different CC adoption decision criteria frameworks. Most of these frameworks are based on the global north perspective.

2.3 Cloud computing adoption decision criteria and frameworks

Alhammadi (2016) presents a decision-making framework known as the Knowledge Management Based Cloud Computing Adoption Decision Making Framework (KCADF). With this framework, the decision-making process is categorized into three explicit levels. These levels are strategic, operational and tactical decision levels. The main decision as to whether an enterprise should adopt CC or not, is made during the strategic decision level stage. The next decision-making step is the tactical decision-making phase. This decision point involves the decision to select a cloud deployment model. The third and final decision stage is the operational decision level. This level involves deciding on the type of cloud service module to adopt.

Alhammadi (2016), further proposes the analytic hierarchy process (AHP) as a decision criteria tool. This tool aims to support the KCADF. By definition, AHP is “a multi-criteria decision-making approach in which factors are arranged in a hierarchic structure” (Saaty, 1990, p. 9). This decision model has three central pillars: the hierarchical structure of the model: the pairwise comparison of the available options and criteria; and the fusion of priorities. Saaty (1990) states that the problem-solving objective takes priority of the hierarchy. This is followed by the decision-making criteria and lastly, the alternative solutions.

As reported by Kaisler, Money, and Cohen (2012), CC adoption decisions are often made without a stringent analysis. Kaisler et al. (2012) proposed a three-tier decision framework model. These decision levels are the service, system and application architectural decisions. The authors argue that the first step for decision-makers is to ascertain if a CC solution architecture is compatible with the enterprise’s current applications. The next step consists of determining the level of adaptability between the solution’s architecture and the enterprise’s application. The last step is the application architecture stage associated with three decision areas: partitioning, scaling, and integration when it comes to the capabilities of the enterprise.

3. RESEARCH METHODOLOGY

This study adopted an inductive approach with an interpretive perspective. A qualitative methodology was followed using a case study method (Yin, 2018, van Dyk & Van Belle, 2019). The target population for this research was made up of the following; IT infrastructure managers, enterprise and solution architects working in large enterprises in various industries. This target population was selected because it is the population that is primarily responsible for making the decisions that determine an enterprise’s CC adoption strategy. The purposive sampling technique and snowballing were adopted (Etikan, Alkassi & Abubakar, 2016; Yadav, Singh & Gupta, 2019).

This research project used unstructured interviews as a data collection technique. This was the most appropriate data collection technique to use since the research project followed an inductive
approach. According to Woo, O’Boyle and Spector (2017), an inductive approach is not bound by specific hypotheses or theory. This is because the most imperative attribute of inductive research is the identification of a new phenomenon. By following an inductive approach, the researcher was able to identify new phenomena from the data without being bound to any pre-existing hypotheses or theories. Unstructured interviews allowed the respondents to give experiences that were unbiased by any perspectives or past research findings. While the researcher had conducted a literature review, they were careful not to impose their views or previous experience on the respondents.

The interviews were conducted and recorded on the Microsoft Teams online platform. This was because of the COVID 19 pandemic, which resulted in travel restrictions and social distancing regulations. The sample size for this research comprised of a total of eight (8) participants. However, only seven (7) participants were available for interviews. The average duration of the interviews ranged between 45-60 minutes. This small sample size was appropriate for this research because the study was qualitative. Creswell and Guetterman (2019) note that qualitative research studies investigate a few individuals to understand the central phenomenon that is being studied. In addition, a cross-sectional time frame design was applied for this research hence the small sample. A cross-sectional study was the most appropriate timeframe to use as the project was carried out over a short timeframe. The research used the cross-sectional timeframe to capture a snapshot of the characteristics of the research phenomenon over the few months of the project’s duration. The respondents, their roles, industries, and motivation for selecting respondents are summarized in Table 1.

<table>
<thead>
<tr>
<th>Enterprises</th>
<th>Industry</th>
<th>Respondent Position</th>
<th>Reason for respondent selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enterprise A</td>
<td>Government department</td>
<td>Senior Enterprise Architect</td>
<td>The respondent was a member of the cloud adoption decision making team.</td>
</tr>
<tr>
<td></td>
<td>(Research Institute)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterprise B</td>
<td>Mobile telecommunications</td>
<td>Enterprise Architect Lead</td>
<td>The respondent was the team lead of the cloud adoption team.</td>
</tr>
<tr>
<td>Enterprise C</td>
<td>Information Technology</td>
<td>Senior Practice Lead</td>
<td>The respondent was directly involved in the cloud adoption decision process.</td>
</tr>
<tr>
<td></td>
<td>(System Integration)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enterprise D</td>
<td>Private healthcare</td>
<td>Enterprise Architect Lead</td>
<td>The respondent was the team lead of the cloud adoption decision making team.</td>
</tr>
<tr>
<td>Enterprise E</td>
<td>Energy &amp; chemical</td>
<td>Data Architect/Warehouse Lead</td>
<td>The respondent was part of the cloud migration decision making team.</td>
</tr>
<tr>
<td>Enterprise F</td>
<td>Investment and Insurance</td>
<td>Business Strategy Delivery Lead</td>
<td>The respondent formed part of the cloud migration decision making team.</td>
</tr>
<tr>
<td>Enterprise G</td>
<td>Banking</td>
<td>Solution Architect</td>
<td>The respondent was part of the cloud migration decision making team.</td>
</tr>
</tbody>
</table>

Table 1 Breakdown of the respondents

The researcher followed Braun and Clarke’s (2012) six-phase guide to analyze collected data using a thematic analysis approach. The researcher familiarized themselves with the collected data. This was achieved by listening to the audio recordings which were recorded for the interview. The recordings were transcribed, read and notes were made during this process to gain a deeper understanding of the data collected. Initial codes were then generated by identifying common patterns within data (Nvivo was used as the software data analysis tool). The researcher continues the analysis process by searching for themes. According to Braun and Clarke (2012), the creation of the themes needs to be guided by the study’s research question. Therefore, themes were created based on the research question of the study: What are the decision criteria used by large enterprises
in South Africa to adopt cloud computing? The themes were then grouped into two categories, namely; the cloud adoption decision criteria and the cloud service provider decision criteria.

The themes were reviewed and carried out with the coded datasets. This phase amounted to a quality analysis procedure as it checked the created themes against the existing data. The next step involved defining and naming the themes. Lastly, the findings are presented and discussed. The next sections describe the category of themes that emerged from the process of data analysis.
4. FINDINGS

The findings revealed that large enterprises in SA do not use a standardized criteria to adopt CC. Table 2 outlines themes and quotations from respondents.

<table>
<thead>
<tr>
<th>THEME IDENTIFIED</th>
<th>QUOTATIONS FROM RESPONDENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Operational costs</td>
<td>“And that was our biggest frustration is the data centers. So, we have 52 data centers around the country. But there are inherent costs in expanding data center space. That’s where we wanted to expand that one floor in Cape Town was going to be needed nearly 100 million Rand just to do the infrastructure piece, not even the hardware that goes in, but to do the conditioning, and the flooring, and the fires and stuff.” RP02</td>
</tr>
<tr>
<td>2. Enterprise strategic intent</td>
<td>“We knew we needed to go to the cloud, we knew that we were trying to achieve a strategy, which is going digital, we needed a flexible environment, we were in trouble with stability of our data centers. We needed a framework that enables us to get to the digital enterprise, the digital vision.” RP04</td>
</tr>
<tr>
<td>3. Product efficiency</td>
<td>“So, when you’re investing in an infrastructure platform, what’s next? What’re the additional services that are provided? So, stuff on a basic level, for example, with Azure, you get SQL on Azure on a platform layer, you can start integrating with, for example, IoT services, or whatever the case might be.” RP04</td>
</tr>
<tr>
<td>4. Security</td>
<td>“Then outside of that the kind of the broader topics that we had to resolve, there were big security concerns, we had to get at risk, corporate risks to sign off on this, we had to put down very detailed security policy around cloud use.” RP03</td>
</tr>
<tr>
<td>5. Previous industry case studies</td>
<td>“We had to look at a lot of industry case studies. And so basically, because they’re an insurance company, we had to look at how other insurance companies have implemented the strategy, how it worked for them” RP06</td>
</tr>
<tr>
<td>6. Cloud service provider adoption framework</td>
<td>“We looked Amazon. So, Amazon has got a great cloud adoption framework. That’s one of the frameworks that we considered” RP01; “Because, geez, so what we’ve done so far, we’ve set out, okay, we said let’s look at the different providers that are there. What frameworks do they have in terms of informing how their services are consumed?” RP03</td>
</tr>
<tr>
<td>7. Storage scalability</td>
<td>“The ability to obviously, provide the scalable infrastructure that’s immediately available to people, especially if you’ve got a system integration environment whereby you needed to spin up development environments quite quickly for developers…..” RP04</td>
</tr>
<tr>
<td>8. System integration compatibility</td>
<td>“Because from an application point of view, we have to consider the integration requirement” RP01; “Yeah, obviously, does our current infrastructure support the move to cloud? Will the systems be able to communicate well in accessing the data? Reading the data, translating the data?” RP06</td>
</tr>
<tr>
<td>9. Data sovereignty</td>
<td>“You’re going to need to justify when you look into the guise of like, know, the governance and the regulatory, you need to prove to them that whatever that you thought you’d be doing will be not violating their principles or, or their regulations like the POPI, kind of like regulations must be met.” RP04</td>
</tr>
<tr>
<td>10. Time to build</td>
<td>“It’s a four-week process of procuring hardware, plus another two weeks installing or four weeks installing the software, cloud is immediately available once you’ve got that synchronization done.” RP03</td>
</tr>
<tr>
<td>11. Data center location</td>
<td>“...the reason why we ended up implementing the cloud is that Amazon was, was about to build a data station in Cape Town. Yes, and played a very big factor because you don’t want your data sitting offshore.” RP06</td>
</tr>
<tr>
<td>12. Data latency</td>
<td>“And then the second thing was latency. So obviously, we have performance and latency dependent applications. And it’s about 130 milliseconds latency from South Africa to Europe, which can have a detrimental effect.” RP02; RP04: “So if you want if you’re in a hospital, and you have to go to Google in America, or Ireland, Europe, or it could be Australia or Brazil, that hop across the ocean is going to cause a delay. So that was a very, very big deciding factor against Google.” RP04</td>
</tr>
<tr>
<td>13. Latest technology trends</td>
<td>“What we’re looking for this is this is the latest trends in terms of the different applications that are there and so on and so on.” RP01; “And being a leader in the industry is obviously important for us as an IT organization, you need to show it in our technology. We call it you eat your own dog food. You know, you need to know, or somebody else calls or drink your own champagne, but you need to live and understand technologies and being able to showcase it”. RP02</td>
</tr>
<tr>
<td>14. Disaster Recovery strategy</td>
<td>“What happens if the cloud shuts down? Do we have backup? Is it restored onto a different cloud platform? is it? Yeah, there were all of those considerations that we had to take into account.” RP06</td>
</tr>
</tbody>
</table>

Table 2: Decision criteria themes
The finding revealed that the decision criteria are divided into two main categories. Namely, the cloud technology adoption decision criteria and the cloud service provider decision criteria. The cloud technology adoption category refers to the decision criteria used for the adoption of CC. In this category, decision-makers are considering the actual adoption of CC. The themes consist of operational cost, enterprise strategic intent, product efficiency, previous industry case studies, scalability, system integration compatibility, time to build and latest technology trends.

4.1 Cloud computing adoption decision criteria

Operational cost is one of the key determining criteria considered in the cloud adoption decision by large enterprises in SA. This is where a comparison is often made between the operational costs of traditional data centers and CC. Sharma and Sehrawat (2020) note that CC adoption results in a significant reduction of operational costs within an enterprise. An enterprise’s strategic intent is another criterion that large enterprises use. The findings revealed that an enterprise’s IT strategy would shape an enterprise’s decision on whether or not to adopt cloud technology. Findings have also revealed that the efficiency of the cloud product compared to other alternative solutions is a fundamental criterion used during the cloud adoption decision process. These alternative solutions include in-house data centers and applications. Cloud technology comes with a bundle of additional services in comparison to other alternative solutions.

Large enterprises used previous industry case studies as a cloud adoption decision criterion. The case studies consist of enterprises that have similar challenges that operate in the same industry. Previous case solutions would be analyzed, focusing on how CC was used to address challenges. The next criterion is the scalability of storage space. Cloud solution offers more a scalable product which allows an enterprise to increase its storage capacity at any time (Techopedia, 2012). System integration compatibility is a criterion that involves the investigation of the current systems that exist within the enterprise to see whether they would be compatible with the cloud solution integration.

Another criterion is the concept of time to build. This refers to the lengthy time it would take to build up or build new IT applications and infrastructure instead of adopting CC. The last criterion refers to the need to keep up with the latest technological trends. This involves keeping up with the latest software applications, analysis tools and business delivery and applications. This is particularly important for the requirement of IT flexibility in enterprises. The next level of decision-making is the selection of a CC service provider.

4.2 Cloud computing service provider decision criteria

The cloud service provider decision criteria refer to decision criteria used to select the cloud service provider. The findings revealed security, cloud service provider adoption framework, data sovereignty, data latency, data centre location and the disaster recovery strategy as the decision criteria in this category.

Security is one of the key factors considered for the cloud service provider selection criteria by large enterprises in SA. Kaufman (2009) reported that security plays an important role in the adoption of CC. The next criterion in the category is cloud adoption frameworks that major cloud service providers provide to possible users. The cloud adoption frameworks consist of documents that include literature, with cloud adoption steps involved when using a particular cloud service provider. The frameworks outline cloud services that the cloud service provider offers.

Data sovereignty can be described as a government’s control and authority and overall the data stored within that country (Irion, 2012). It was one of the criteria for selecting the cloud service provider. Respondents cited concerns with governance issues like the fact that they need to adhere to regulatory requirements specific to South Africa, like the POPI act. Data latency was
another consideration, Weissberger, McWhirter, Klassen, and Ginsberg (2004) describe data latency as a time delay in the movement of data packets from one point to the next. Depending on the industry, data latency can be a deal-breaker for example; a respondent made an interesting point that “…if you’re in a hospital, and you have to go (connect) to Google in America, or in Ireland, Europe… across the ocean, it’s going to cause a delay. So that was a very, very big deciding factor…” RP04.

Data center location is one of the criteria that large enterprises are considering. Enterprises in SA prefer a cloud service that has local data centers. This is in comparison to cloud service providers that have data centers that are based overseas. The reason for this can be attributed to data privacy and data latency concerns. The last criterion in this category is disaster recovery strategy. A disaster recovery strategy can be defined as a plan to effectively restore IT operations after a service disruption. Several factors have involved this strategy. These factors include the acceptable outage time, the security aspect, the cost of the recovery plan and the system integration logistics (Fallara, 2004).

5. DISCUSSION

This study aims to describe the decision criteria used by large enterprises in SA when adopting CC. A decision criterion is a set of guidelines that make up measurable specifications that often amount to a scoring system (Mar, 2018). This research revealed that large enterprises do not only decide whether to adopt CC but also consider selecting the appropriate CC service provider. The findings further revealed that large enterprises don’t use standardized or formalized cloud adoption decision criteria when adopting CC. Though there aren’t any standardized decision criteria used, formal processes, appointed teams, and individuals form part of the decision-making. The decision criteria fundamentally include operational cost, enterprise strategic intent, product efficiency, previous industry case studies and scalability for CC adoption. This is in line with the literature that was reviewed on the benefits that CC affords larger enterprises (Johnston et al., 2016; Sharma & Sehrawat, 2020). Additionally, Alhammadi’s (2016) KDCAF cloud adoption framework resembles similarities with the CC adoption criteria findings of this study.

The first criterion that is included in the KDCAF framework is the initial strategic decision to adopt CC. Similarly, the findings reveal that one of the key criteria that large enterprises consider when adopting CC is the need to align with their strategic intent. The second and third levels in the KDCAF framework are the operational and tactical decision levels. These levels would include the cloud deployment model and service models, respectively. The decision-making at these levels focuses on on-demand service, flexibility, operational costs, and product quality criteria. The findings of this research also reveal that time to build infrastructure, operational costs, and scalability are the main criteria for adopting CC by large enterprises in SA.

The main difference between the KDCAF cloud adoption framework and the criteria that are revealed in this study is the decision-making level of selecting CC service providers. Findings of this research further revealed that security, cloud service provider adoption framework, data sovereignty, data latency, data center location and the disaster recovery strategy are considered for selecting a preferred CC service provider. Previous literature on the adoption of CC in SA does not expand on enterprises' selection of CC service providers. However, Priyadarshinee et al., (2017) emphasize that each enterprise is different and will have its unique set of variables on a decision framework. In conclusion, the inductive approach that the study followed allowed for these decision criteria to emerge from data without imposing a theoretical framework, particularly from the global north perspective. The criteria used for selecting CC service providers reveal some contextual matters as underlying reasons for this criteria. For example,
at the heart of data sovereignty is the consideration of national security matters which have implications on compliance with South African regulations (Irion, 2012).

Another example is that of data latency and data center location. Enterprises in SA prefer a cloud service that has local data centers. This is because data centers that are based overseas have a time delay in the movement of data packets from one point to the next, this may impact efficiency and productivity in enterprises (Weissberger et al., 2004). This research only focuses on large enterprises in South Africa. This was due to the time constraint of the research project. Future research could broaden the research scope and investigate large enterprises in other developing countries outside of the South African borders. Researchers may also compare the decision criteria used in South African enterprises and those used in other developing economies.

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BOUNDARY SPANNING AND THE SUPPORT OF DIGITAL ENTREPRENEURS: A CASE STUDY OF BAHRAIN

Noora H. Alghatam, University of Bahrain, nhalghatam@uob.edu.bh

Abstract: This paper explores the role of public and private sector teams as they collaborate to form and manage a community and platform for digital entrepreneurs in Bahrain. The paper employed the theoretical concept of boundary spanners to explore the nature of interactions between the two teams as support digital entrepreneurship and the outcomes that emerged from these interactions. The findings present the nature of the inter-sectoral interactions as boundary spanning that contributed to the initiation and formalization of the community and platform.

Keywords: digital entrepreneurs, public-private sector collaboration, ICT for development.

1. INTRODUCTION

Nations around the world have developed policies and institutional structures over the past few years to encourage and support entrepreneurship, and especially digital entrepreneurship. These national initiatives are driven by aspirations to leverage digital entrepreneurship capacities within local contexts in order for small businesses to scale and contribute to socio-economic development. Governments positively view the adoption of ICTs by entrepreneurs, since this is a means for businesses to innovate, scale in size and enter into new regional markets. As such, there are various initiatives to support digital entrepreneurship and many of them involve collaborations between the public and private sector. Such collaboration has led to the proliferation of accelerators, incubators, digital platforms and funding agencies in countries of the GCC region to support entrepreneurship and national development aims. The theme of collaboration processes between the public and private sector to support digital entrepreneurship is not researched enough, particularly from a sociotechnical perspective. This suggests the presence of a research gap that needs to be addressed. This paper explores the case study of Bahrain’s entrepreneurial ecosystem, and particularly the setup of the “Startup Bahrain” community and a digital platform1, which is a combination of a web presence and social media account, for the period of 2016-2019. The purpose of this study is to explore the boundary spanning activities of the public and private sector teams as they initiate, formalize and manage the community and platform, as well as the outcomes of this process.

This paper is structured as follows. First, we present a literature review on themes of digital entrepreneurship and development. We then outline the theoretical concept of boundary spanners. Third, we present the case study of the digital entrepreneurs’ community and platform in Bahrain and the various institutional structures and actors that are involved. In the analysis of the case, we present the process of forming and managing the community for digital entrepreneurship that outlines the various boundary spanning actions taken by both the public and private sector. We then present the outcomes of boundary spanning and emergent outcomes.

2. LITERATURE REVIEW

1 Our case study has some features of a platform, which is a web presence and social media account, that include some interactivity, data and complementary resources from the private sector.
2.1 Digital Entrepreneurship and Development

In recent years, many governments favourably view and support ICT adoption by entrepreneurs and small and medium sized businesses since this is considered as a means to improve economic growth (Boateng et al., 2008). E-entrepreneurship or digital entrepreneurship refers to people or entities that leverage entrepreneurial opportunities that are created from digital technologies (Davison and Vaast 2010). For the purpose of this study, we adopt the concept of digital entrepreneurship as both digital ventures that trade online as well as small and medium sized businesses that sell products and services through a combination of physical and online channels (Quinones et al. 2013). In recent years, there has been considerable interest in exploring the social embeddedness of digital entrepreneurs and how their actions and the socioeconomic context they are part of come to shape their activities and ventures (Agerou and Li 2013). Some of these studies highlight the potential of ICTs to contribute to the performance of businesses and contribute to economic growth (Heeks 2002; Quinones, Nicholson and Heeks 2013; Chipidza and Leidner 2019). Moreover, these entrepreneurs and businesses that adopt ICTs are considered to potentially support in enhancing skills, generating job opportunities and improve innovation processes (Ramdani and Raja 2021). Even though some of the findings have shown diverse results from ICT adoption by SMEs (Rangaswamy and Nair, 2012; Quinones et al. 2013), there is still an overall acceptance of the potential for such projects to support socioeconomic development of countries (Chipidza and Leidner 2019; Sayed and Westrup 2003).

Academics discuss how digital entrepreneurship, scalability and digital platforms carry the potential to positively impact development (Agerou & Li 2013; Neilsen 2017; Walsham 2017). In general, digital platforms are defined as sociotechnical ensembles of social and organizational processes and technical components (de Reuver et. al 2017). They can take the form of transaction platforms that act as marketplaces that facilitate information sharing and online transactions or innovation platforms that offer modular components that can be recombined to develop applications for the platform by third party entities (Cusomano 2019). In some contexts, governments support digital entrepreneurship through introducing platforms as a means to support the co-creation of services and encourage collaboration (Janssen and Estevez 2013). These platforms are often based on open data platforms that can be used to develop services within the public sector or for innovations by other sectors (Bonina and Eaton 2020). These platforms are used by citizens who require services and content, application developers and other government entities to provide content and get feedback from interaction by citizens and other groups (Janssen & Estevez 2013.) For example, Bonina et. al’s (2021) work on innovation platforms that support development and discuss the example of District Health Information Software (DHIS2) as a platform that offers data and software tools that could be used by developers to innovate solutions for platform-based services.

The public sector has also collaborated with various entities to support the entrepreneurial ecosystem as a whole. There have been calls to adopt a community perspective to explore digital entrepreneurship and to consider a broader concept that encompasses a collective of diverse set of actors with different aims and capacities (Nambisan, 2017). For instance, Du et. al ’s (2018) works explores the case study of China adopts the lens of digital entrepreneurial ecosystem as a meta-theory to capture this group of actors involved as an entity. The interactions among actors within these communities or ecosystems are often discussed from a macro-level perspective in order to map out and measure their performance. Some academics also expressed the need to explore the local activities of actors involved in these ecosystems as they interact and engage in cross-boundary collaborations (Goswami et. al, 2018; Du et. al 2018). As such, we find that some studies explore how these actors, who come from different sectors, cross the boundaries of their professional domains and support the ecosystem for digital entrepreneurs (Feldman and Francis, 2006; Davison and Vaast, 2010; Nambisan 2017; Li et. al, 2017; Shen et. al, 2017, Goswami et. al, 2018). We consider the concept of boundary spanning as a useful conceptual lens to explore the interactions between members of the public and private sector team who work to support the digital entrepreneurs in Bahrain through the development of a community and digital platform.
2. THEORETICAL FRAMEWORK

We employ the concept of boundary spanners to explore the interactions of the public and private sector teams who come from different professional domains to collaborate and support digital entrepreneurship. Boundary spanners are individuals who span across boundaries, which can be professional domains, to communicate ideas and link groups with different locations and functions together (Tushman 1977). These spanning activities can link ideas, build relationships and set up fields between different groups.

These boundary spanners can have a bridging role, knowledge brokering role and can draw upon social capital as they engaged with other people across boundaries (Johri 2008; Milewski et al. 2008; Du & Pan 2013; Barner-Ramus sen et al., 2014). For instance, Johri’s (2008) work employs the concept of boundary spanning as knowledge brokerage in the case study of engineers who work with others from different contexts. Other studies explain that boundary spanners are seen to be actors who come from different domains and draw upon cultural skills, social capital and language skills to have a bridging role between different disparate groups (Du & Pan 2013; Barner-Ramus sen et al., 2014). Milewski et al.’s (2008) also explores a case study of system engineers through the lens of boundary spanners who draw upon social capital and also play a bridging role as they work in two different countries.

The boundary spanning lens has been employed in the field of information systems to explore the processes of implementing digital entrepreneurial ecosystems (Milewski et al., 2008; Li et al., 2017). The concept is also relevant in Du et al.’s (2018) discussion of the case of entrepreneurship in China and how a platform offered resources and was a means for boundary-spanning practices. In this paper, theoretical the framework is employed to show nature of interactions between actors from the public and private sector teams as they work to support digital entrepreneurship. The aim is to explore how the team’s engagement in boundary spanning contributes to the shaping of the community and platform for digital entrepreneurs (see figure 1). The paper addresses the following question: How do the boundary spanning activities of the public and private sector teams shape the community and platform for digital entrepreneurs?

![Boundary Spanning by the Public & Private Sector](image)

**Figure 1: Boundary Spanning by the Public & Private Sector**

3. METHODOLOGY

The empirical component for this research project was based on the national initiative to support entrepreneurship, and particularly ICT-based businesses, through the set up a community for start-ups. The research study began with a pilot study was conducted that focussed on the collection of secondary data and two interviews with a manager of an incubator and one of the academics from a think tank. The pilot study identified the key socio-cultural issues faced by digital entrepreneurs and also offered data about key milestones in the development of the community for digital entrepreneurship.
entrepreneurship. The interview process included 17 semi-structured interviews that included managers and staff from both the public and private sector involved in the support of digital entrepreneurship. These interviewees were part of the different phases of developing the community for digital start-ups from planning to implementation and management. The data collection process also included four focus groups with digital entrepreneurs in Bahrain. Each focus group included 5-8 participants and were held at the University campus. The main criteria for the selection of participants in the study was that they were founders of a digital business and transacts online (offers online services) or a business that uses both physical and online channels to transact with customers.

The analysis of data was based on reviewing data from primary and secondary sources in a number of stages and iterations to identify key themes and milestones for the set up of the digital entrepreneurs’ community. The data analysis was an iterative process as we compared concepts from primary data, secondary data and the literature on the topic. The early stages of analysis involved assigning general themes, or descriptive codes (Miles and Huberman 1994), to the data based on important activities of the public and private sector and significant milestones for digital entrepreneurs’ community. The data analysis then shifted to focus on theoretical constructs of boundary spanning and linking them to the data. For example, there were concepts such as bridging roles, knowledge brokerage and drawing on social capital identified. Then as these themes were identified, pattern codes were developed such as “community building” and “information exchange” and “community outcomes”.

4. CASE STUDY

4.1 Institutional Structures for Digital Entrepreneurship

This section presents key milestones to support digital entrepreneurship in Bahrain for the period of a decade from 2008 to 2018. One of the most significant milestones was the development of the “Startup Bahrain” initiative in September 2017. The Startup Bahrain initiative represents a community that included a number of entrepreneurs, key actors from the public and private sector to network, organize events and meetings and support the entrepreneurial community (see figure 2). The Startup Bahrain community included the creation of a leadership team and the articulation of six pillars for the ecosystem to enhance and maintain the growth of the community. One of the most influential actors in the public sector was the Economic Development Board (EDB) which supported the development of this community (www.edb.com). The emphasis on digital entrepreneurs was in line with a study of high potential startups, which were businesses that had the potential to scale globally, especially through digital platforms. These high potential startups were in their early phases of operation and needed opportunities to network in order for them to generate ideas and obtain advice. The aim was to set up a community, and then over time, have the startups themselves take over the organization and management of the community. As the initiative progressed, there was a realization that having a leadership team would be useful to manage the community. The leadership team included members from the public sector, accelerators, incubators and educational institutions. The team’s role was to identify the needs of the community since they were engaged in communication with them through events and this data would help design and improve the community for digital entrepreneurs and the overall entrepreneurial ecosystem. This came in line with the EDB’s six pillars for the ecosystem which included: community, incubators, accelerators, funding, education, corporates, policy and regulation.
4.2 Economic Vision and Regulations:

The efforts to set up a community for digital entrepreneurs is in line with an existing national policy, which is the Economic Vision 2030 (www.bahrain.bh). The policy includes many areas for economic development and there are two themes that are in parallel to digital entrepreneurship. One is the economic pillar that emphasizes the need to diversify income and high potential markets. Second, is the government pillar that includes concepts such as private sector partnerships and outsourcing. Over the years, there were various developments that positively affected digital entrepreneurship such as new regulations and institutional structures to offer funding (Lopez et. al 2020). The regulatory changes included the development of virtual commercial registration, Sijili, which supports the setup of commercial registration for businesses that do not have a physical office, i.e., businesses can be registered based on a virtual office. Another set of regulatory developments include the cloud first policy and the equity crowd funding regulation, which enables the operation of electronic lending platforms and supports Fin-tech startups. In subsequent months there were other regulations that were conducive to the entrepreneurial ecosystem such as competition law, bankruptcy law, the health insurance law and the data protection law. There were also a number of entities that offered financial support for entrepreneurs such as The Bahrain Development Bank (BDB), a semi-government bank that offers financing schemes to entrepreneurs. Another significant government entity is Tamkeen that offers a combination of financial and educational programs to support entrepreneurs.

4.3 Startup Bahrain as a Digital Platform:

Figure 2: Entrepreneurial Ecosystem

![Team Bahrain Model Diagram]

- **Public Sector Agencies**
  - EDB
  - Tamkeen
  - MoITC
  - Incubators

- **Private Sector Agencies**
  - BDB (semi-private)
  - Banks
  - Incubators
  - Accelerators
  - Co-Working Space Providers

- **Start-Up Bahrain**
  - **Community Dimension**
    - Founders of start-ups
    - SMEs
    - Leadership team
  - **Digital Platform Dimension**
    - Information
    - Database of businesses
    - Complementary resources by ecosystem members
    - Social media account

Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021
A significant step in the formation of a community for digital entrepreneurs was the development of the Startup Bahrain digital platform that included information, a database and resources that served the entrepreneurs, investors and other stakeholders. The current digital platform was planned and implemented by the EDB with the support and involvement of some private sector agencies and entrepreneurs. The current platform includes information on investments in Bahrain to encourage foreign investments and international businesses to set up in the country. There is also information about latest laws and regulations that facilitate the deployment of startups and upcoming events hosted by the community. The website also includes a list of important actors in the entrepreneurial ecosystems such as government agencies, IT and management service providers, co-working space providers and funding agencies with links and contact details. Finally, the platform includes a database of digital entrepreneurs and the option of signing up your business to be included in the database.

Even though the digital platform Startup Bahrain was mainly run by a public sector agency, there are a few features that set it apart from existing e-government websites. First, as noted by interviewees, the objective of the community and associated platform was to have a transition from being public-sector run towards being independently managed by the community as the initiative gains momentum. Second, the platform aims to include the community’s involvement and interactivity, and this is depicted in the current blog and social media account that includes live interviews with entrepreneurs and stakeholders. Such an emphasis on encouraging community involvement and interactivity marks a distinct difference with other government websites. Third, the digital platform showcases existing partnerships with the private sector to support entrepreneurship through offering resources that support them such as Amazon Web Services credit and resources that entrepreneurs could apply for. Other supportive resources are offered by financial and public relations agencies involved in the ecosystem.

5. ANALYSIS

5.1 Boundary Spanning to Initiate the Community and Digital Platform

Members of the public sector who were supporting entrepreneurs played a bridging role that brought together various stakeholders from the private and public sectors and this included entrepreneurs as well. As noted during an interview by a manager in the public sector, one of the initial steps taken was identifying the needs of digital entrepreneurs and defining the nature and objectives of the community. The public sector actors realized early on that they needed to focus on high potential startups, many of which were businesses that could leverage digital technologies and platform to scale globally. The establishment of the community included further actions. First, identifying gaps in the existing context for digital entrepreneurs. From this process they decided to establish a community with diverse members and to promote the community in both local and international context. Second, the public sector created a leadership team from various sectors. The public sector assessed the environmental gap that entrepreneurs faced and based on this they formed a leadership team to set objectives and promote the community in society and internationally. This leadership team included businesses and entrepreneurs who were actively participating in digital entrepreneurship early on, as well as businesses and public sector entities that support entrepreneurs through mentoring and funding. The central role of the public sector was evident as they hosted the digital platform, that was a combination of a web presence and social media account, which was developed for Startup Bahrain and included information about policies, upcoming events, blog posts, resources and ecosystem players.

Subsequently, the private sector team involved in the set up of the community were actively playing a knowledge brokerage role as they linked the community with international networks of experts
and businesses to support the entrepreneurs. As noted in an interview with a manager in one of the accelerators, his company invited experts from other international branches of their business to give presentations and act as mentors in community events. The international experts often took part in community-focused conferences, workshops and mentorship events to transfer knowledge. The idea was that transferring knowledge on entrepreneurship would contribute to building the capacities of digital entrepreneurs. The aim was to support the community’s members to scale their businesses and enter into new markets. The vision was that once they gained momentum, the entrepreneurs would take over the management of the community itself. This knowledge brokerage role was also strengthened further with the digital platform that included complementary resources from local and international companies. For instance, there were free credits and supportive material offered by local marketing agencies as well as international platforms such as Amazon web services. Through these resources, the platform reflected and reinforced the public and private partnerships even further.

The formation of the community also led to processes of drawing upon social capital by both the public and private sector to support the scaling of entrepreneurs in the community. Both sectors were drawing upon their understanding of sociocultural institutions such as they role of a business network for high-potential startups. Many of these small businesses were ICT-based and had founders who are fresh graduates or new to the market and needed a community that represents them. This theme was prevalent in discussions during focus groups where participants noted that they valued the social support. The aim was to establish a narrative of entrepreneurial success to ensure values of societal trust was established for the digital entrepreneurs. This was so the concept of an entrepreneur could be reframed in society from being conceptualized as a small local store to a digital business that could scale and contribute to economic growth. This boundary spanning activity of drawing upon social capital that informed the process of creating a narrative was reflected in the platform that included a database of startups, upcoming events and blog posts about entrepreneurs. Moreover, the social media account fostered interaction within the community and included live interview sessions with community members to showcase their businesses and experiences (see Table 1).

<table>
<thead>
<tr>
<th>Boundary Spanning</th>
<th>Actions</th>
<th>Outcomes</th>
</tr>
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<tbody>
<tr>
<td>Bridging Role</td>
<td>Link stakeholders for community building</td>
<td>Develop a formal community</td>
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<tr>
<td></td>
<td>Identifying environmental gaps</td>
<td>Set up a platform with information and</td>
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<tr>
<td></td>
<td>Focus on high-potential start ups</td>
<td>complementary resources. Establish a leadership team</td>
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<tr>
<td>Draw on Social Capital</td>
<td>Identify the need for a supportive network.</td>
<td>Development-focus values for</td>
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<td></td>
<td>Organize events</td>
<td>entrepreneurs</td>
</tr>
<tr>
<td></td>
<td>Discourses for success in events</td>
<td>Reframed entrepreneurship concepts</td>
</tr>
<tr>
<td></td>
<td>Online Interviews</td>
<td>Central role of the public sector</td>
</tr>
<tr>
<td>Knowledge Brokerage</td>
<td>Link experts from other business branches</td>
<td>Intermediary role between the local</td>
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<tr>
<td></td>
<td>Invite experts as mentors and speakers</td>
<td>and global networks. Digital platform as encompassing</td>
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<tr>
<td></td>
<td>Offer complementary resources on platform.</td>
<td>public and private partnerships</td>
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<tr>
<td></td>
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<td>through resources.</td>
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Table 1: Boundary Spanning Activities

5.2 Outcomes for the Community and Digital Platform

The public and private sector teams’ interactions came to shape the community for digital entrepreneurs in two ways. First, the boundary spanning activities of the public sector and drawing upon social capital such as policies and development goals led to the establishment of a
developmental focus for the community. The public sector was keen to enrol high potential start-ups, which were ICT-based businesses that could scale in size and enter into new regional markets. This was considered as a means to support socio-economic growth policies that aims to support Bahrain’s position as an innovation hub in the region. As explained by entrepreneurs during focus groups, a motivational factor for developing a business was to contribute to national socioeconomic growth and job creation.

Second, the boundary spanning activity of bridging between various stakeholders to form the community and platform led to enforcing the central role of the public sector in entrepreneurial activities. From the outset, there was a clear objective to have a transitional role for the public sector until the community grows and takes over the management process. The digital entrepreneurs accepted the public sector’s role since they were in need of a supportive network for ICT-based businesses and also a change in societal narratives to establish of trust of entrepreneurs. The public sector played a pivotal role in setting up events and programs to overcome such challenges to establish and support the community. The public sector also sees themselves as embedded in the community itself and this initiative was more than a short-term project. As noted during interviews, they were working on building a conducive environment for business. The digital platform was used to leverage intermediary roles between local and international experts on entrepreneurship. This was evident in the complementary resources offered on the platform and interviews and events, many of which are currently hosted online.

6. DISCUSSION AND CONCLUSION

The study’s findings highlight the boundary spanning activities of the public sector which bridged different groups, that included the private sector, other government agencies and start-ups, to initiate and formalize the Start-up Bahrain community and platform. Even though this was a collaborative initiative between various sectors, it was evident that the public sector plays a dynamic role in facilitating intersectoral collaboration to support the formation of the digital entrepreneurs’ community. This contributes to existing studies that emphasize the central role of regulatory actors in national ICT initiatives (Du et al., 2018; Li et al., 2018). The process of boundary spanning evolved over time to reflect intersectoral collaboration that included emergent team capabilities of linking local and international networks of experts on entrepreneurship. The organizing of conferences, mentoring sessions and judging panels in events to include entrepreneurship experts from other contexts shows an emergent team capability. This contributes to existing studies of the role of local and global networks in the shaping of digital entrepreneurship (Avgerou and Li 2013; Quinones et. al 2020).

The boundary spanning activities came to contribute to emergent roles and values for the community. This contributes to studies that call for an emphasis of the social embeddedness of digital entrepreneurship (Avgerou & Li 2013). Indeed, the actions of the public and private sector teams were shaped by an understanding of regulations and economic policies, gaps in the entrepreneurial environment and societal discourses on entrepreneurship. As such their bridging and knowledge brokerage role came to support the creation of a network for these high potential start-ups and a reframed discourse of success for start-ups.

In terms of theoretical outcomes, this paper contributes to existing studies of ecosystems, institutional structures and networks that support digital entrepreneurs in order to attain socioeconomic development. The paper’s contribution is adoption of a micro-level approach to explore the interaction between various actors to support the digital entrepreneurs. This comes in contrast to existing studies that adopt a macro-level perspective on factors and antecedents that support the development of a digital business environment. The paper also presents practical contributions that can be translated into suggestions for public and private sector practitioners.
involved in such initiatives. The public sector plays a role in transferring and supporting ICT4D values through interacting with the private sector players and the digital entrepreneurs. The findings suggest that the platform plays a role in supporting boundary spanning activities for cross-sectoral collaboration. One suggestion is to leverage the current platform to include open data sets and modular components that could be offered for entrepreneurs and stakeholders to use to develop further innovations and support their activities and the community as a whole.

REFERENCES


REFLECTIONS, LEARNINGS AND PROPOSED INTERVENTIONS ON DATA VALIDATION AND DATA USE FOR ACTION IN HEALTH: A CASE OF MOZAMBIQUE

Nilza Collinson, University Eduardo Mondlane, University of Oslo, nilzac@ifi.uio.no
Zeferino Saugene, University Eduardo Mondlane, University of Oslo, zeferino.saugene@uem.ac.mz
Jørn Braa, University of Oslo, jornbraa@gmail.com
Sundeep Sahay, University of Oslo, sundeeps@ifi.uio.no
Emilio Mosse, University Eduardo Mondlane, emosse@uem.mz

Abstract: The ideal of a country’s health information system (HIS) is to develop processes that ensure easy collection of relevant data and enable their conversion to useful health indicators, which guide decision making and support health interventions. In many Low- and Middle-Income Countries (LMICs), actively engaged in health reform efforts, the role of HIS is crucial, particularly in terms of quality of data and its ability to inspire trust in decision makers to actively use routine HIS data. Recognizing digital platforms potential to support those efforts, several interventions have been implemented in many LMICs. In turn, while the transition from paper registers to digital platforms carries the promise of improving data quality processes, this promise has been notoriously complex to materialize in practice. The authors draw upon more than 15 years of experience implementing HIS in Mozambique to understand how the potential of digital platforms have been realized with respect to data quality, what are the gaps and required remedial steps.

Keywords: information systems, digital platforms, health data, data use, information for action.

1. INTRODUCTION

One of the drivers for huge investments to Health Information Systems (HIS) implementation is the recognition of power of data to improve health care related informational practices. According to Lohr (2015, p.60) “data should be the vital raw material that strengthens and improves the machinery of decision making”. However, “the data paradox is that a world richer and richer in data has so far yielded little payoff in most fields” (Lohr, 2015, p.60), including in health. Thus, while the supply of data races ahead, its use lags badly for various social-technical and political reasons. In this paper, we explore how this process has unfolded over time in Mozambique, a LMIC country that has, since the 90’s, been using digital platforms to report and analyze health data (Braa et al, 2001). We explore developments and changes in the national HIS, resulting from digital interventions around the implementation of a digital platform known as the District Health Information System (DHIS), aimed at strengthening health care informational practices.

The efforts to introduce DHIS in Mozambique initiated early in 2000s, with its first desktop-based version, after its successful development and implementation in South Africa. The focus of this introduction has been on decentralization, while also attempting to gradually empower local authorities at lower levels of the hierarchy to have more control over their actions (Chilundo, 2004). Although, several studies conducted during this initial implementation revealed multiple challenges...
to guaranteeing quality of data, including technical, social and organizational conditions (Braa et al., 2001; Chilundo, 2004; Mosse & Byrne, 2005). Despite initial efforts and subsequent interventions in the following years, DHIS2 only came to be successfully implemented in the country several years after and scaled up nationwide in 2016. However, the challenge of data use to strengthen interventions remain despite the increasing availability of digital data.

This study was conducted as a formal assessment exercise carried out in 2019 by a joint team of researchers from University of Oslo (UiO) from Norway and Eduardo Mondlane University (UEM) from Mozambique, including representatives from the Ministry of Health (MOH) and several actors from the health sector on the sites visited. We focused on data management processes around the national HIS platform, designated SISMA, which is developed on top of DHIS2, pursuing a deeper understanding on how it has contributed to strengthening data management processes, in particular on data quality.

The aim of this paper was thus to identify the nature of the existing challenges and discuss what remedial steps could be taken to improve the current situation. We report from the findings of this assessment exercise attempting to provide both conceptual and practical contributions that may help strengthen practices and better realize the promise of digital technologies for improving HIS.

2. LITERATURE REVIEW

A national HIS should support the production of data that can be converted to health indicators and, thus support decision making and improve health interventions. A key challenge to realize this ideal is to balance the definition of relevant data set elements, so as to optimize the workload of frontline health workers while supporting their care provision processes (Shaw, 2005). Additionally, information needs of other stakeholders such as programme managers, policy makers and donors also need to be adequately considered (AbouZahr & Boerma, 2005; Cibulskis, 2005).

Latifov and Sahay (2012, p. 1) argue for building a more synergistic relation between data and indicators, suggesting that the stronger the linkage “the stronger will be the actionability of the HIS”. Thus, availability and quality of health data is crucial in improving this link between data and its actionability. In turn, use of data is intrinsically related with its quality, and the more it is used, will push the supply of quality data obtained (Braa et al, 2012).

Aside from their innumerable potential, Digital platforms come with the promise of improving availability and use of data. This potential has been exploited by several organizations, operating in different quadrants, including commercial and public sectors. We take as an example, the engagement of a long-term research and development programme called HISP (Health Information System Programme) in developing a free and open-source digital platform called the DHIS2, now in use in more than 100 LMIC contexts (Adu-Gyamfi et al, 2019). This digital platform was built with basic aims to support essential data collection and validation by lower levels in the HIS, and support calculation of actionable indicators, while also supporting other information systems (Shaw, 2005). The expression “information for local action” was born alongside this digital platform and has grown in “meaning and purpose” over time (Braa & Sahay, 2012, p. iv).

Despite potential of digital platforms several challenges pose as threats to their successful adoption, implementation and furthermore to thrive in same proportion in different settings. Roland et al (2017) discusses challenges faced to ensure their flexibility through design, and several approaches adopted to enable adequate involvement of actors intervening in the process. Participatory Design (PD) as, in this sense, been seen as key to ensure that digital platforms incorporate and adjust adequately to several contexts simultaneously and provide needed and expected support. Although, due to changeable dynamics in the settings where long term developments take place, different PD approaches may be needed. Accordingly, HISP’s PD approaches has gradually changed over time, shifting from single PD to community PD (Roland et al., 2017). And, DHIS2 has improved in its design to incorporate “flexibility, extensibility, and modularity” (Adu-Gyamfi et al, 2019:5) to cope
with ongoing changes between multiple development and implementations, and accommodate incoming requirements.

In turn, as suggested by Krishna & Walsham (2005) the success of strengthening intervention is intrinsically dependent on other than technical aspects of the tool itself, including several aspects coming from the social context. Practices embedded within the organization and other social systems from the setting, existing interests of several groups, inadequate education related to information technology (Krishna & Walsham, 2005), governance approaches for decision making and use of resources (Bevir, 2011), and many others, play a significant role. And, strategies incorporating “tailored and country-specific guidance” and capacity strengthening interventions (Adu-Gyamfye et al, 2019: 5) may be needed. Even though, as Latifov & Sahay (2012) advises, it is not guaranteed that institutional changes occur immediately, as long-term socio-political negotiations within the HIS are involved, This makes it important for Information System (IS) research to go beyond the technical factors and expand the focus on understanding other social related reasons justifying and explaining why this is the case and how these impediments to data use can be better addressed.

3. METHODS

An action research approach, as advocated by HISP (Braa & Nielsen, 2015), have been adopted along the implementation of HIS in Mozambique: to understand the routines and practices of the health staff at every level of the system, and to identify the gaps and challenges related to data use. This study ran as an assessment exercise included in that continuous process. A mixed team was assembled consisting of researchers from UiO and UEM, representatives from the MOH and staff from the provinces studied. And, a combination of data collection techniques was used including field visits, interviews, observations and focus group discussions. Four of the researchers involved as authors in this paper, participated actively in the pilot of DHIS in Mozambique and in subsequent processes until present date, although with different levels of interventions, inputting their personal and valuable experiences from the process into the study. These and the fifth researcher, all participated in the fieldwork visits to the sites in 2019, sometimes split in groups to reach different settings.

3.1. Data collection

The fieldwork, run in a period of one month, covering six provinces, including the three sites where the original pilot was conducted in the early 2000s, as described in Table 1.

<table>
<thead>
<tr>
<th>Provinces visited</th>
<th>criteria for site selection</th>
<th>Nr. Districts visited</th>
<th>Nr. Health Units Visited</th>
<th>Instruments &amp; Processes Observed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maputo City</td>
<td>Headquarters’ site</td>
<td>1</td>
<td>1</td>
<td>Technical support, Data management, training processes</td>
</tr>
<tr>
<td>Maputo Province</td>
<td>Closest to the Headquarters</td>
<td>2</td>
<td>2</td>
<td>Books, charts, reports and official documents &amp; Data collection processes</td>
</tr>
<tr>
<td>Gaza</td>
<td>Pilot site</td>
<td>3</td>
<td>1</td>
<td>Books, charts, reports &amp; a validation Meeting (validation process), a Statistical Meeting (presentation and use processes)</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Pilot site</td>
<td>3</td>
<td>2</td>
<td>Books, charts, reports &amp; a routine program Meeting (to discuss data entry, validation, entry, presentation and use processes)</td>
</tr>
<tr>
<td>Niassa</td>
<td>Pilot site</td>
<td>4</td>
<td>2</td>
<td>Books, charts, reports &amp; Data collection and Data entry processes</td>
</tr>
<tr>
<td>Zambezia</td>
<td>Far from the Headquarters</td>
<td>1</td>
<td>1</td>
<td>Books, charts, reports</td>
</tr>
</tbody>
</table>

Table 1. Overview of the fieldwork: sites visited and processes observed
During the site visits, the team had opportunity to participate in three routine meetings, including a validation routine meeting, a statistical meeting and a routine meeting from a health programme team. In all these meetings, the team observed and at the end engaged in discussions regarding issues reported, either related to technical aspects of the digital platform or to the use of other technological resources available for daily operations.

In all of these opportunities, the team was able to gather sensibilities from different stakeholders involved in data management processes. For instance, in the statistical meeting, which is organized at the District level and led by the head doctor of the District, the participants reached a number of 20 people including the head statistician from the district, representatives from several health programs and the head doctor of the main Hospital of the District.

During the visits to health facilities, the team discussed with doctors and technicians, while also observing the environment and practices in course was able to engage with the nurses during their activities and data collection. These visits were also used as an opportunity to consult some of the paper-based instruments (books and charts) being used to collect and present daily registries, and see some of the digital instruments received as part of support provided by particular programs to collect specific data. The overall fieldwork enabled the team to gather an overview of data related processes: collection, validation, entry (capture), presentation and use, while also to access various data reports and official documents that were included in the study. Table 2 provides a resume of this process.

<table>
<thead>
<tr>
<th>Data related Process (What)</th>
<th>Site (Where)</th>
<th>Data collection method (How)</th>
<th>Source of information (From what)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collection</td>
<td>Health Facilities District Health Management sector</td>
<td>Observation of process on site Observation of instruments Discussion with nurses, statistical and health program officials on site</td>
<td>Consult paper-based instruments (books, charts fixed on walls) Picture capture View of tablets used to collect data</td>
</tr>
<tr>
<td>Validation</td>
<td>Health Facilities District Health Management sector</td>
<td>Observation of process in meetings Discussion with statistical and health program officials on site</td>
<td>Participation in meeting Annotations Picture capture</td>
</tr>
<tr>
<td>Entry (Capture)</td>
<td>District Health Management sector</td>
<td>Observation of process on site Online Questionnaire (spread by WhatsApp and email) Observation of instruments Discussion with administrator, Head Doctors, statistical and health program officials</td>
<td>Annotations Picture capture View of computers being used</td>
</tr>
<tr>
<td>Presentation and Use</td>
<td>District Health Management sector</td>
<td>Observation of process in meetings Observation of instruments Discussion with administrator, Head Doctors, statistical and health program officials</td>
<td>Participation in meeting, Consult paper-based instruments (Reports) Annotations Picture capture</td>
</tr>
</tbody>
</table>

Table 2. Summary of the data collection process: methods and sources.

3.2. Process of Analysis

Our data analysis was based on a social-technical perspective, which examined the interconnected nature of technical and social challenges influencing data use processes. The information gathered was systematically organized into categories of issues to be analyzed afterwards, and, by adopting
a social-technical perspective, we searched for different aspects in need of revision either from the instituted procedures perspective or from the software platform design itself. Thus, taking into account that this perspective “recognizes data, its utilization and software designed to support data processing is a product of institutional processes and practices” (Latifov & Sahay, 2012, p.2).

The analysis process involved five steps described as follows. In step 1 we organized the data collected on the field by categories (themes) of data related processes linked directly to DHIS: entry (capture), validation and use. We also created two categories related to activities and stakeholders involved; capacity strengthening; and governance. Step 2 was basically to identify existing limitations and suggested interventions for each process and the third step was dedicated to interpret the results and summarize them into four key findings. The following step included the preparation of the field report, to be shared afterwards with different parts interested in the process. The fifth and last step was dedicated to present the report in DHIS2 annual meeting, in order to consolidate and enrich some of the approaches raised by the team.

3.3. Findings

Normally, at the District level the health sector includes in its structure a District Service of Health, Women, Social Action (SDSMAS). This unit is responsible to coordinate all the processes related to the HIS from the setting, and includes within its team a statistical officer and a representative officer for each health programme. In this section we provide the overall findings summarized around data entry, data validation, data use, capacity strengthening, and governance themes. Where, under each theme, we discuss some of the practices, existing limitations and suggested interventions. Where possible, examples are provided to give the basis for our interpretations.

Data entry

We were able to witness different experiences and practices during the data entry process in the Provinces visited. While in the majority of the Districts visited the responsibility for data entry is from the statistical officers, in some this responsibility is shared with the programme officers (Cuamba district, in Niassa province) and in others is also delegated to nurses (Bilene district, in Gaza province, and Cumbane district, in Inhambane province).

In all places visited, for these processes, the health workers rely on some kind of technological device such as computers, tablets and smartphones to capture and entry data into SISMA. Although, not all of these belonged to the SDSMAS, some were provided by programme partners and in most cases the officers used personal devices to ease and accelerate their work. It was also noticed that in all the provinces, personal smartphones were being used to interact with other colleagues, share data and information, particularly using WhatsApp functionalities. For instance, we learn that almost everywhere two or three work groups were created in different levels, provincial, district and technical. One example of WhatsApp use, to receive data and shorten distances, we take from Cuamba, where the epidemiologic data was being shared using this tool to speed up the reception of data, coming from Health facilities that were located far from the SDSMAS, to be entered in SISMA.

We also noticed that data was entered in DHIS2 only after the monthly validation had taken place, which was conducted all based-on paper. The implication of this was, one, the validation process became extremely time consuming and work intensive; two, this process meant none of the DHIS2 features for data validation (like validation rules and data ranges) were being used.

Data validation

Overall, we found the practice of data validation to be quite robust and taking place on a systematic routine basis. MOH has given guidelines on the timeframe for the preparation of the resumes from the books, validation of data, data entry and use of data. There were monthly meetings in every district for validating the data. This meeting took place in the district, and sometimes at the health facility. We witnessed such meeting at Bilene district taking place in Mazivila health facility.
Officials from the districts met with staff from district health facilities who had gathered there, representing different health programmes. The entire meeting was based on the paper forms which the staff carried, questions were raised, the staff attempted to answer them and, in some cases, a need was identified to make changes. Sometimes, if anomalies were identified in the data, a phone call would be made to the health facility to seek clarifications and make changes, as seen in the Caronga district (Niassa province) office. In another district from the same province (in Sanga), one of the data entry officers who had a motorcycle, would often drive down to the more distant facilities, to collect the copies of the form that were to be submitted, to accelerate the reception of data to be discussed with other facilities on data issues, and make required correction. This practice was probably due to the large distances between the district office and the health facility.

The staff from many of the health facilities and districts told us that the time given for data entry in the DHIS2 was very small, and they should be given more time. Even though some other officials counter posed that this shortage of time was verified because the data received from the health facilities was first entered in excel files, validated in the meetings and later on introduced in DHIS2. No data was entered in DHIS2 prior to validation and then the time to the introduction becomes short. In their opinion, if the period is extended the officials would relax and the problem would remain. We were interested to understand why this process was used to validate data, and how we could strengthen this practice. In one district the users said that they believed that once the data was entered into the DHIS2, it would get locked, and also become visible to the levels above. To avoid this, they preferred to do all the validation process on paper, prior to data entry, and only once that was completed, they would enter the data into DHIS2. To ensure completion, we were told in Sanga that they have the standard list from MOH of the indicators they needed to report to on a monthly basis. The district responsible would then compare the data reported from the facilities with the MOH list, to identify gaps and take corrective action. In some cases, Excel sheets were used for the data validation process. They use the Excel and target approach both to review data before capturing in DHIS2 and to discuss and analyze the data. The procedure includes: collect and summarize monthly data by facility and then enter in Excel, then look up data from the same month last year in DHIS2 and enter that manually. We saw how in Chibuto district (Gaza province) staff used tables with colored cells, red when under and green on or above the target, and discussed the achievements and possible causes with the facilities representatives, followed by exchange of personal experiences and lessons learned on the ground.

We found nearly all provinces to have at least two sets of institutionalized processes of meetings. One, the monthly meeting for data validation, described previously, and the second was a data use related meeting also taking place monthly, called Statistical Meeting, where the head Doctor of the District would meet with the district facilities heads and district managers of the health programs, to show the monthly data, present its analysis, identify areas of improvement, and provide recommendations for action. When we went to Mazivila health facility, we encountered several officials gathered in a Validation Meeting. On site, without many commodities, different officials representing health programs were gathered to discuss data reports received from all the district facilities. In turn, the Statistical Meeting occurring at the SDSMAS in Chibuto and Cuamba districts was organized in a more formal manner. We participated in the meeting in Chibuto and observed pictures and official documents from the last, as they ran in the same period.

We were also told that apart from these two monthly meetings, there was also a third meeting taking place which is for administrators. However, we did not get an opportunity to witness such a meeting. In addition to the monthly meetings, there were also quarterly meetings being held to look at the data over the time period at the provincial level and annual meetings led by the central level to share experiences and good practices between the provinces and define new strategies for the sector.

From what we perceived, though these different processes unfolded in different ways, the underlying theme evident was that health data is being taken seriously, and is seen as a basis for identifying action.
Data use

During the visits, we learnt that the conduct of these monthly meetings has been mandated by MOH for all provinces, and having seen these meetings taking place in all the sites visited, we infer it is relatively well-established practice nationally. We also found all districts and provinces visited to have incorporated relatively systematic processes around data use, even if they were manual or based on Excel. Although, nearly no districts or provinces were using DHIS2 visualization tools.

We were invited to participate in the Statistical Meeting in Chibuto district as guests. The meeting started with the presentation of Dashboards produced in PowerPoint displaying graphics with arrows and balloons with legends, highlighting comparisons of data from previous year and current year for the same period. For each health program, data were presented in tables with monthly resumes, with some data extracted from DHIS2 and tables formatted in Excel sheets. Facility results were highlighted denoting increases and reductions, emphasizing the results for each health program. After this initial presentation, the head Doctor discussed the results: questioning, demanding for answers and justifications, while also providing recommendations for action and improvement.

The question arises why this is the case and what can we do about it. Many reasons were identified, such as DHIS2 visualizations being seen as rigid and inflexible, inability to combine text and charts in Word document reports and PowerPoint presentations, infrastructure limitations and inadequate capacity.

Capacity strengthening

The Health sector has a mobility policy that allows and promotes reallocation of the professionals in this sector within the different provinces. While at the same time faces the challenges of losing professionals that shift to the partners, go for studies or even leave the sector. Those shifts are probably the biggest challenges for the statistical offices in the province, where the staff is constantly shifting and new staff comes to fill the gaps left behind.

We saw in almost every District that we visited new staff in the statistical sector that did not have participated in any specific training in using DHIS2, being only capacitated while at work performing the daily tasks. For example, in Maxixe district (Inhambane province), the three officials were newcomers and in Metarica district (Niassa province), the only official of the District learning at work. In this sense, even for the district head Doctors the training would be very relevant, as they stand as the lead of statistical departments at district and provincial levels. When we talked to the Head Doctor in Metarica this was one of his requests and according to him, one of his “crazy dreams” to have a device with DHIS2 that would allow him to monitor the indicators from the district on his hands.

Governance

We had the opportunity to see in the field the existing attempts to have qualified people to deal with data analysis and prepare information in a comprehensive manner to the health workers in the settings, while easing this responsibility from the other health workers. Although, these efforts are seen as being insufficient due to the limitations to hire public personnel within the Health Sector, where priorities are to incorporate more people with curative training and skills. For instance, we take the example of Niassa province where few statisticians are allocated: at the health facilities level 4 statisticians are allocated to the four Rural Hospitals from the Province, at the District level only 3 of the 17 Districts have statisticians allocated to the District Nucleus of Statistics (NED), and the Provincial Directorate (DPC) at provincial level with only 1 Statistician. In the other NED, to deal with statistics the province recruits preventive medicine technicians, as they receive some training in statistics during their formative training.

In terms of technical support for the system, in most of the sites visited we were told that the technical support teams are centralized at the province level providing remote support and, eventually if conditions are settled, they go to the districts to perform corrective and technical
specific tasks related to the equipment allocated there. Regarding the support to digital platform, it was mostly given at distance by the statistician located in the NEDs at District and Province levels, and if this support is shown to be insufficient, then the technical teams allocated at the Ministry are involved. Regarding other system related issues, such as registry of new users and configuration of services and health facilities, interventions are conducted centrally at the MOH. Further support is also provided locally by an external team, supported and linked to the digital platform owner under the agreement and strict coordination with the Ministry.

4. DISCUSSION
While the current design of the HIS in Mozambique still unfolds in existing four levels of management, it is being perceived to have improved: from the ways data is being collected, to the flows of information till the availability of data to action. Though, the current assessment enabled the research team to observe and identify both positive outcomes and some aspects that may need further interventions. The key findings from this research study, so far, are summarized as follows:

1) DHIS2 primarily used for data storage and not for data use: The rationale behind the successful adoption of the DHIS2 adoption by LMICs has been its determination on providing data to empower lower levels. This has received very little attention by many health information systems. The current assessment has demonstrated how DHIS2 has democratized access to data in Mozambique. Despite these potentials we have observed that the system is primarily used as a data storage. The vast analytic tools developed to facilitate data visualization are barely used by lower levels. Instead DHIS2 users prefer to download data to excel and make charts and tables. These could have been easily generated from within DHIS2 system. Main problems are related to visualization features that are not flexible enough or not fitting use cases. MoH and district level people are using Excel and not DHIS2 for analyzing DHIS2 data. This makes it recognize the importance of functionalities that makes offline use of data possible, having data ‘locally’ is important and the key reason why people prefer Excel. Therefore, offline apps such as ‘My Datamart’, where data can be analyzed while offline, is much needed.

2) Continued use of existing tools of Excel and paper: Since DHIS2 is not being used to prepare data reports discussed either in the routine meetings or in the statistical meetings, we discovered also that it is not being used for data output. Instead, other tools are playing this role and providing these functionalities. The design of such generic instruments needs to be adjusted to local needs, and sometimes providing adjusted templates for reports that are automatically updated or introducing better ways to produce and share useful district and facility dashboards would make dashboards more useful. We acknowledge in this process, the need to also understand how the indicators are being produced, as for instance in Mozambique the standard is to use the targets as denominators, which is not supported in DHIS2 and poises as a must to be included.

3) Ambiguity in what population data to use: One aspect that should be recalled as well is related with the indicators being used as key to promote good data use and achieve intended goals. As such, we identified that in Mozambique at district level key indicators are being used to monitor data reported since the Facility level. In this case, adjustments in the instrument should be configured accordingly, introducing facility-based indicators with the inclusion of parameters such as, for instance, Facility population. We have seen that good district level data use relies upon indicators by facility, which again relies upon facility-based target population. Being able to compare facilities – monitoring facility-based indicators - is important for using data at district level. It is important to mention that the source for these parameters is already available in Mozambique, as facility populations are distributed and included at district level. These facility populations, however, are not included in DHIS2. In fact, population data is not included at all making it difficult to use DHIS2 for calculating coverage indicators.

4) Poor mechanisms of technical support, particularly in remote areas: This study revealed another issue that is constantly underestimated, provision of support and continuous capacity building for
the practitioners in the field. In order to keep the system flowing there is a need to establish stronger bridges between different teams providing support at all levels of the HIS. The focus should be on local levels, in particular to districts and facilities, maintaining field visits on a routinely basis to better understand local needs and requirements, as part of the participatory design approach. For instance, the DHIS2 teams could easily have noticed that targets were used as indicator denominators by visiting a district and a province, but this was not done before. More generally: assessment of system status should be implemented as seen from the field not only from headquarters and needs to be carried out continuously, as part of a continuous participatory approach. Continuous capacity building should be encouraged within the teams supporting the implementations of any software platform. Space and time for recycling and update of knowledge is critical to maintenance of the systems. At the moment, for instance, we identified weaknesses in this component in the field, as the supporting team is facing difficulties managing metadata and keeping their database ‘clean’. Ultimately to reduce some of these routine tasks and provide additional support to the teams to sensible tasks the system may incorporate this as functionalities. Indeed, these types of initiatives are in place and an app for help managing metadata is being developed by providing a way to manage and navigate between data sets, services and data elements. In DHIS2 categories of metadata are viewed as lists with a hierarchy within them, but not within them, making it difficult to manage and clean the metadata.

5. REFLECTIONS AND CONCLUSION REMARKS

In Mozambique, DHIS2 has been implemented and it is being used in a different manner from the initial intents, to support data evaluation, data visualization and data use. These probes the flexibility of the tool but reveals another insight to the developers that need to rethink the needs to take the whole workflow and social system in the targeted context into account. Here, some approaches such as the User participation and Participatory design are perceived to meet the task and need to be applied along the development and implementations. The information system is best understood as a social system – not a technical system. DHIS2 implementation has so far been carried out as a ‘technical’ implementation of software and needs to change to address the whole targeted context of use; the social system and relevant work practices.

Moreover, routine data use meetings in place are key to institutionalization of good data use. These meetings occur on a routine basis following a monthly calendar scheduled at the national level and followed at district and province level, using data collected at facilities and are seen as key to institutionalized data use practices. We perceive more generally, that data use indeed needs to become a natural part of all routine procedures such as routine data review, planning and M&E meetings and various quarterly and annual meetings and reporting procedures. We also found that DHIS2 was not customized to support these meetings and data use situations with appropriate dashboards, score cards and reporting templates. In this scenario we oversee a potential insight from a practice to the redesign of the instrument in such a way to support and improve these data use practices.

In general, any software platform is required to be flexible in various forms to accommodate adjustments and incorporate solutions to identified issues in the actual design. We have seen from the case that some of the main problems reported during the field visits are related to metadata management and difficulties in cleaning the database, making it problematic to run the system. In such cases, if the system does not provide internal functionalities, one option would be to suggest the incorporation of external apps developed to provide those functionalities inside DHIS2, like metadata management and metadata navigation apps for instance. This made possible also, through the existing portfolio of external apps being developed in other countries, which can be reviewed to elicit design ideas and requirements.
REFERENCES


CLOUD COMPUTING ADOPTION: OPPORTUNITIES AND CHALLENGES FOR SMALL, MEDIUM AND MICRO ENTERPRISES IN SOUTH AFRICA

Simphiwe S. Sithole, University of Witwatersrand, South Africa, sssithole@hotmail.com
Ephias Ruhode, Cape Peninsula University of Technology, South Africa, RuhodeE@cput.ac.za

Abstract: The purpose of the paper is to determine the opportunities and challenges that lead to cloud computing adoption by SMMEs in South Africa by looking at the factors that influence adoption. The TOE framework is used to contextualize the factors that influence cloud computing adoption and evaluate the opportunities and challenges that are presented by cloud computing to SMMEs in South Africa. An online survey questionnaire was used to collect data from leaders of SMMEs from all geographical regions and business industries in South Africa. A quantitative research approach was adopted to investigate the objectives, and descriptive analysis was used to evaluate the relationships and present the results. The findings of the study show that relative advantage is an important factor in the consideration of cloud computing adoption by SMMEs, while government and regulatory support is perceived as a barrier. Top management support, which has been previously found by other studies to be a significant factor has been found to be insignificant in this study. The study has revealed that cloud computing presents opportunities to SMMEs and improves their competitiveness.

Keywords: Cloud computing adoption, SMME, Small business, South Africa, TOE framework

1. INTRODUCTION

Small, medium and micro enterprises (SMMEs) are critical to the success of the economies of many countries around the world. They contribute to the creation of employment, the growth of the gross domestic product (GDP), the development of professional skills and the reduction of poverty. However, in South Africa SMMEs face many challenges that result in their failure or stagnation which causes an increase in the unemployment rate, poverty and inequality. A 2018 report by the Small Enterprises Development Agency (SEDA), an agency of the Department of Small Business Development with a mandate to develop small businesses, shows a year-on-year decline in the number of SMMEs in South Africa (Small Enterprises Development Agency, 2018). There are many contributing factors to the failure of small businesses, including a lack of information and communication technology (ICT) infrastructure, a lack of access to credit or financial support and inadequate managerial and employee skills and knowledge, among other factors.

In South Africa, the definition of an SMME is provided in the National Small Business Act (Act 102 of 1996), which defines a small business as “a separate and distinct entity, including cooperative enterprises and non-governmental organisations … which can be classified as a micro, a very small, a small or a medium enterprise” (The DTI, 2003). The National Small Business Act classifies an SMME by means of a matrix of business sector on the y-axis and size of full-time paid employees, total annual turnover and total gross asset value on the x-axis. In the classification of a small business, the number of employees is the same across all sectors: less than 5 for micro enterprises, less than 10 for very small enterprises and less than 50 employees and less than 200 for medium-size enterprises (except for the Agriculture sector where a medium-size enterprise has less than 100
employees). The values for total industry turnover differ according to sector. Stats SA, South Africa’s national statistics agency, adjusts the total annual turnover cut off points for inflation to classify enterprises (Small Enterprises Development Agency, 2018). Table 1 shows the cut-off points – using the Rand currency – for enterprise turnover, as of December 2018.

SEDA (2018) segments SMMEs into either formal or informal. Enterprises operating in the formal sector are registered with the Companies and Intellectual Property Commission (CIPC), South Africa’s companies’ registration agency, and submit their annual tax returns to the South African Revenue Services (SARS); and SMMEs operating in the informal sector are not registered with the CIPC and comprise largely a single worker who is the owner. According to SEDA’s SMME Quarterly Update report (2018) for the 1st quarter of 2018, out of the 2,443,163 SMMEs in South Africa, 73% are in the informal sector and 27% are in the formal sector.

The SMME sector is critical for the development of South Africa’s economy: alleviating poverty, unemployment and inequality. The government’s National Development Plan (NDP) recognizes that to achieve the objectives of the plan, among other initiatives, it needs to provide support for small businesses by easing rules for and procuring from small businesses, as well as improve access to finances for SMMEs (National Planning Commission, 2012). According to Stats SA’s Quarterly Financial Statistics (QFS) for March 2018, SMMEs (excluding those with a turnover of less than R2 million) contributed 35% of South Africa’s total turnover for the quarter (Statistics South Africa, 2018). And although the SMME Quarterly Update report (2018) indicates a 1.4% year-on-year decline in the number of SMMEs and 15.9% year-on-year decrease in the number of jobs they provide, this sector is still the larger provider of employment in the South African economy with the 8,886,015 jobs provided constituting around 55% of South Africa’s total workforce.

There is a small number of studies about cloud computing adoption by SMMEs (Kumar et al., 2017). In South Africa, there exists limited research about the opportunities and challenges of cloud computing adoption for SMMEs. Hinde & Belle (2012) recommended that a study with a more representative and larger sample be conducted in future to enrich the knowledge of the benefits and challenges of cloud computing for South African SMMEs. Kumalo & Poll (2015) recommend further research on cloud computing to address the challenges experienced by SMMEs. This research uses the TOE (technology-organisation-environment) framework to determine the challenges and opportunities of cloud computing for SMMEs in South Africa. The seeks to find the factors that represent opportunities and challenges of cloud computing adoption by the SMMEs. Formal SMMEs were selected for participation in the study as they are more likely to know about and use cloud computing and, due to the data collection method chosen, are more likely to be reachable for participation. The goal of this paper is to provide leaders of SMMEs an empirical study and resulting information about factors to take into consideration when making the decision whether adopt cloud computing.

<table>
<thead>
<tr>
<th>Industry Turnover</th>
<th>Medium (in millions)</th>
<th>Small (in millions)</th>
<th>Very small (in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mining and Quarrying</td>
<td>R 125</td>
<td>R 50</td>
<td>R 2</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>R 163</td>
<td>R 63</td>
<td>R 2</td>
</tr>
<tr>
<td>Electricity, Gas and Water</td>
<td>R 163</td>
<td>R 64</td>
<td>R 2</td>
</tr>
<tr>
<td>Construction</td>
<td>R 75</td>
<td>R 38</td>
<td>R 2</td>
</tr>
<tr>
<td>Retail and Motor Trade Services</td>
<td>R 238</td>
<td>R 50</td>
<td>R 2</td>
</tr>
<tr>
<td>Wholesale Trade, Commercial Agents and Allied Services</td>
<td>R 400</td>
<td>R 50</td>
<td>R 2</td>
</tr>
<tr>
<td>Catering, Accommodation and other Trade</td>
<td>R 75</td>
<td>R 64</td>
<td>R 2</td>
</tr>
<tr>
<td>Transport, Storage and Communication</td>
<td>R 163</td>
<td>R 38</td>
<td>R 2</td>
</tr>
<tr>
<td>Real Estate and Business Services</td>
<td>R 163</td>
<td>R 38</td>
<td>R 2</td>
</tr>
<tr>
<td>Community, Social and Personal Services</td>
<td>R 75</td>
<td>R 13</td>
<td>R 2</td>
</tr>
</tbody>
</table>

Table 1: Stats SA: Cuff-off points for enterprise turnover to determine their size (December 2018)

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2. RELATED LITERATURE

This section discusses the definition of cloud computing, followed by the benefits and the opportunities presented by cloud computing, then discusses the Technology, Organisation and Environment (TOE) framework.

2.1 Definition of cloud computing

The concept of cloud computing has been in existence for some time. It started in the 1950s when dumb terminals connected to and accessed a complex and expensive mainframe computer over a network (Neto, 2014). The idea of cloud computing can be traced back to 1961 when Professor John McCarthy, an American computer scientist at Stanford University who created the computer time-sharing theory (McCarthy, 1983), said that “computing may someday be organised as a public utility…” (Garfinkel, 2011). In 1966, DF Parkhill further explored the forms and models – virtualization and grid computing – and benefits – latency of IT complexity and reduction in IT costs – of utility computing (Parkhill, 1966). Between the 1970’s and the 1980’s, cloud computing as a concept was advanced by the creation of the World Wide Web and the emergence of virtual machines (VMs) and virtual private networks (VPNs) by telecommunications companies (Neto, 2014). Salesforce is credited to be one of the first movers into cloud computing by delivering enterprise applications over the Internet in 1999 (Tripathi & Jigeesh, 2013).

2.2 Benefits of cloud computing for SMMEs

Enterprises must adapt to the constantly changing business environment by using cutting-edge technology that provide competitive advantage. Following are some of the main benefits that SMMEs can derive from cloud computing.

**Ease of management of IT systems.** Depending on the service model – IaaS, PaaS or SaaS – cloud computing reduces or eliminates the need for SMMEs to manage information technology systems. On a SaaS subscription, the cloud customer is not concerned with how or where the software is run and managed as those are hidden from them; the cloud service provider ensures that the software is always available to the customer. Thus, companies do not rely on internal infrastructure and footprint with regards to facilities (Vargas et al., 2017).

**Reduction of IT costs.** Cloud computing is cost-effective for SMMEs (Adane, 2018). Affordability is the most attractive aspect of cloud computing for SMMEs, particularly in developing economies, as found by a survey conducted by Rath et al. (2012).

**Centralized working environment.** Cloud computing provides a centralized platform for development, testing, deployment, data storage and IT management for decentralized teams (Bartoletti, 2017). This improves team collaboration and resource sharing and removes duplication through integrated product teams that focus on creating customer-centric products. Korongo et al. (2013) asserted that cloud computing enables collaboration between cross-functional teams through resource sharing and increased usage of hardware, and that businesses can be conducted from any geographical location and at any time.

**Improve application delivery.** Cloud computing provides access to advanced middleware and data services that improve application delivery by increasing developer productivity and code quality through the reduction of errors, testing costs and an increase in accuracy (Vargas et al., 2017).

**Scalability.** The scalability of computing resources is an important aspect of the cloud to businesses (Tripathi & Jigeesh, 2013). Cloud computing allows an SMME to scale up and down according to the computing requirements of the business and offers great opportunities to enable growth.
**Improved security.** Cloud computing removes the need for physical security required to protect IT infrastructure (Lalev, 2017). AWS (2017), in asserting that it has comprehensive security capabilities, explains six advantages of cloud security: 1) integration of compliance and security; 2) economies of scale where all AWS customers benefit from security innovation and improvements; 3) customers don’t have to be concerned about managing security; 4) system configurations can be infused with all security features; 5) information about security issues are included; and 6) and using the cloud to protect the cloud service. Nedelcu et al. (2015) argue that although cloud computing may not be ideal for storing highly sensitive data, it is safer than on-premises systems.

**Improved performance and high availability.** Cloud computing enables easy and convenient anytime, anywhere access to data and applications using any type of device that has an internet connection (Khan, 2014), and therefore is always available.

**Competitiveness.** Sheedy (2018) found that enterprises are using the public cloud to be more competitive and rapidly create new customer value by leveraging the ecosystem of partners and independent service providers (ISVs) in cloud computing.

### 2.3 Theoretical background for cloud computing adoption

There are several theories used in studying the determinants of the adoption of technology by organisations: Technology Readiness (TR), Task-technology Fit (TTF), Technology Acceptance Model (TAM), TAM2, TAM3, Theory of Planned Behaviour (TPB), Decomposed Theory of Planned Behaviour, the Unified Theory of Acceptance and Use Technology (UTAUT), and Diffusion of Innovation (DoI) and Technology-Organisation-Environment (TOE) framework (Lai, 2017; Tarhini et al., 2015). Lai reviewed the different technology adoption theories and concluded that different models and theories can be used based on the research problem, variables and measurement.

The DOI and the TOE models are the most popular theories is studying the factors that influence the adoption of technology. Diffusion of Innovation (DOI) was developed by Everitt Rogers (2003) to help the acceleration of the adoption and diffusion of new technological ideas through communication over time to remove uncertainty about the innovation. Cloud computing has been diffused and has been growing since the mid-2000s (Fabel, 2018). Low et al. (2011) found that factors that affect the adoption of cloud computing can be explored using the TOE framework, which, although different industries may show different determinant, covers all aspects of adoptions issues.

### 2.4 The TOE Framework

The TOE framework has been used in many studies to determine the factors that influence the adoption of cloud computing. Low et al., (2011) used the framework to examine eight factors that determine the adoption of cloud computing: relative advantage, complexity, compatibility, top management support, firm size, technology readiness, competitive pressure, and trading partner pressure. Alshamaila et al. (2013) used TOE to study the cloud adoption process for SMEs in the north east of England. Li et al. (2015) explained the drivers of cloud service transformation in SMEs using the framework. Gangwar et al. (2015) integrated the TOE framework with the TAM (technology acceptance model) to understand cloud computing adoption. And many more other studies have been conducted using the TOE framework (Alshamaila et al., 2013).

### 3. RESEARCH MODEL AND HYPOTHESIS DEVELOPMENT

This section proposes a research model based on the TOE framework and then presents the developed hypotheses. The model includes the technological, organisational and environmental contexts for factors that pose challenges and present opportunities of cloud computing for SMMEs. Figure 1 depicts the model, derived from Low et al. (2011), with the TOE drivers that determine the adoption of cloud computing.
3.1 Technological context

The technological context includes both internal and external technologies that are relevant to the firm (Louis G. Tornatzky, 1990) and influence its decision to adopt a new technology. These refer to technology systems that are already being used by the enterprise – which determine the scope of its capabilities – and those that are available on the market and are relevant to the enterprise to improve its capabilities.

Relative advantage hypothesis

\[ H1: \text{There is a relationship between relative advantage and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

Compatibility hypothesis

\[ H2: \text{There is a relationship between compatibility and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

Complexity hypothesis:

\[ H3: \text{There is a relationship between complexity and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

3.2 Organisational context

The organisational context refers to the characteristics – the firm’s size, degree of centralization, degree of formalization, managerial structure – and resources – human resources, number of slack resources, and linkages among employees – of the firm (Louis G. Tornatzky, 1990).

Top management support hypothesis:

\[ H4: \text{There is an association between top management support and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

Firm size hypothesis:

\[ H5: \text{There is an association between firm size and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]
Firm scope hypothesis:

\[ H6: \text{There is an association between firm scope and opportunities and challenges of cloud computing adoption by SMMEs in South Africa} \]

Technology readiness hypothesis:

\[ H7: \text{There is an association between technology readiness and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

3.3 Environmental context
The environmental context refers to how the industry in which the firm does business is composed. Enterprises operate in a highly competitive environment where many other businesses offer similar and substitute products.

Competitive pressure hypothesis:

\[ H8: \text{There is a relationship between competitive pressure and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

Government and regulatory support hypothesis:

\[ H9: \text{There is a relationship between government and regulatory support and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

Trading partner pressure hypothesis:

\[ H10: \text{There is a relationship between trading partner pressure and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.} \]

4. DATA COLLECTION
Data was collected through an online survey questionnaire that comprised a formalized and prespecified list of close-ended questions with the option of entering free-text in some questions where the provided possible answers do not satisfy the survey participant. The questionnaire had two sections: company profile information and questions to evaluate the factors that affect cloud computing adoption. See appendix for the online survey questionnaire. The survey took was designed and tested to take approximately 10 minutes to complete.

To ensure that the questionnaire measures the objectives of the research and that consistent responses are obtained, the questionnaire was validated through face validity and content validity. Face validity will be performed by having two professional cloud computing subject matter experts who have before conducted research in any field read through the questionnaire to assess whether it effectively measures the topic it is intended to investigate. This will help eliminate poor-quality questions or add more relevant high-quality questions. Content validity was used determine whether the content of the survey is consistent, and effectively and expansively measures what the research purports to measure.

5. DATA ANALYSIS AND RESULTS
The purpose of this study is to identify how cloud computing adoption can benefit small, medium and micro-sized enterprises (SMMEs) in South Africa. A quantitative research approach was adopted for this study to investigate the objectives.

5.1 Hypotheses of the study
Based on the conceptual model discussed in the literature review, there were ten hypothesis that were evaluated for their relationship.
5.1.1. **Nominal variables hypotheses**

There was a total of three nominal variable hypotheses that were tested, and these variables were Q9_5 (Hypothesis 4), Q5 (Hypothesis 5) and Q8 (Hypothesis 6). The relationship for the nominal variables was investigated using Chi-square, with the strength with Cramer’s V (φ) and the contribution to the significance with adjusted residual (Adj. residual > ±1.96).

Relationship between top management support and opportunities and challenges of cloud computing adoption

\( H4a = \text{There is an association between top management support and opportunities of cloud computing adoption} \)

The analysis was conducted to describe the relationship top management support using lack of access to finance as variable and opportunities of cloud computing adoption. The chi-square test was low with a value of 1.728, results show no significant relationship between the two variable, \( \chi^2 = 1.728 \) and a \( p \)-value of 0.189.

<table>
<thead>
<tr>
<th>Opportunities (Binned)</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Total</th>
<th>Chi-square</th>
<th>Sig</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of access to finance</td>
<td>Count</td>
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<td>11</td>
<td>22</td>
<td>41</td>
</tr>
<tr>
<td></td>
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<td>-1.3</td>
<td></td>
</tr>
<tr>
<td>Agree</td>
<td>Count</td>
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<td>10</td>
<td>13</td>
<td>41</td>
<td>66</td>
</tr>
<tr>
<td></td>
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<td>1.5</td>
<td>-0.2</td>
<td>0.0</td>
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</tr>
<tr>
<td>Neutral</td>
<td>Count</td>
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<td>6</td>
<td>15</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Adjusted Residual</td>
<td>1.1</td>
<td>-0.5</td>
<td>0.3</td>
<td>-0.5</td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>Count</td>
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<td>0</td>
<td>4</td>
<td>18</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Adjusted Residual</td>
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<td>1.4</td>
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<tr>
<td>Strongly Disagree</td>
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<td>1</td>
<td>1</td>
<td>10</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Adjusted Residual</td>
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<td>-0.4</td>
<td>-1.2</td>
<td>1.1</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2: Relationship between top management support and opportunities to adopt cloud computing**

\( H4b = \text{There is an association between top management support and challenges of cloud computing adoption} \)

The association between top management support as measured by the lack of access to finance challenges and is presented on Table 3. The results show that there was no statistically significant association between challenges and lack of access to finance (\( \chi^2 = 3.347 \), \( p=0.067 \)).
In summary, there is no relationship between the top management support and the opportunities nor the challenges to the adoption of cloud computing.

Relationship between Firm size and opportunities and challenges of cloud computing adoption

\( H5a = \text{There is an association between firm size and opportunities of cloud computing adoption} \)

Table 4 presents the results that were conducted to understand the association between full-time employee and opportunities. The results show that there is no statistically significant relationship between the two models \( (\chi^2 = 0.053, p = 0.818) \).

Table 4: Relationship between and firm size and opportunities of cloud computing adoption

\( H5b = \text{There is an association between firm size and challenges of cloud computing adoption} \)

The analysis was conducted to describe the relationship between number of full-time employees and challenges, a chi-square was used to test the relationship. The chi-square test was low with a value of 0.008, results show no significant relationship between the two models \( (p>0.05) \), with \( \chi^2 = 0.008 \) and a \( p \)-value of 0.928.
Cloud Computing Adoption: Challenges and Opportunities for SMMEs

How many full-time people does your company employ?

<table>
<thead>
<tr>
<th>Less than 5 (micro)</th>
<th>Count</th>
<th>Adjusted Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>-1.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Between 5 and 9 (very small)</th>
<th>Count</th>
<th>Adjusted Residual</th>
</tr>
</thead>
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<td></td>
<td>0</td>
<td>-0.7</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Between 10 and 49 (small)</th>
<th>Count</th>
<th>Adjusted Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>0.5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Between 100 and 199 (medium)</th>
<th>Count</th>
<th>Adjusted Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2.2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>200 or more (large)</th>
<th>Count</th>
<th>Adjusted Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>-0.3</td>
</tr>
</tbody>
</table>

Table 5: Relationship between firm size and challenges of cloud computing adoption

In summary, there is no relationship between the firm size and the opportunities nor the challenges to the adoption of cloud computing.

Relationship between firm scope and opportunities and challenges of cloud computing adoption

\( H6a = \text{There is an association between firm scope and opportunities of cloud computing adoption} \)

Table 6 presents the results of relationship between the firm scope using the footprint of the clientele (location) and the opportunities; the results show a significance (\( p<0.05 \)) for this model with \( \chi^2 =7.588 \) and a \( p \)-value of 0.006. The strength of the association was measured with Cramer’s V (\( \phi \)) which was found to be 0.193, which indicate a weak association. Adjusted residual was conducted to understand the groups that contributes towards the significant association and the results show that the major contributor are organisations with international footprint and opportunities for adoption of cloud computing.

<table>
<thead>
<tr>
<th>Opportunities (Binned)</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Total</th>
<th>Chi-square</th>
<th>Sig</th>
<th>( \phi )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local (suburb, town or city)</td>
<td>0</td>
<td>0</td>
<td>5</td>
<td>13</td>
<td>18</td>
<td>7.588</td>
<td>0.006</td>
<td>0.193</td>
</tr>
<tr>
<td>Adjusted Residual</td>
<td>-1.2</td>
<td>-1.5</td>
<td>0.8</td>
<td>0.9</td>
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<td></td>
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<tr>
<td>Regional (province)</td>
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<td>3</td>
<td>12</td>
<td>19</td>
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<tr>
<td>Adjusted Residual</td>
<td>-0.2</td>
<td>0.8</td>
<td>-0.5</td>
<td>0.1</td>
<td></td>
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<tr>
<td>National (South Africa)</td>
<td>3</td>
<td>6</td>
<td>18</td>
<td>50</td>
<td>77</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Residual</td>
<td>-1.2</td>
<td>-1.1</td>
<td>0.8</td>
<td>0.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>International (Africa only)</td>
<td>0</td>
<td>3</td>
<td>4</td>
<td>11</td>
<td>18</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Residual</td>
<td>-1.2</td>
<td>0.9</td>
<td>0.2</td>
<td>-0.1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>International (Global)</td>
<td>7</td>
<td>6</td>
<td>5</td>
<td>20</td>
<td>38</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted Residual</td>
<td>3.4</td>
<td>1.2</td>
<td>-1.3</td>
<td>-1.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6: Relationship between firm scope and opportunities to adopt cloud computing

H6b = There is an association between firm scope and challenges of cloud computing adoption

The association between challenges and company’s clientele location is presented on Table 7. The results show that there was no statistically significant association between challenges and company’s clientele location ($\chi^2 = 3.101, p=0.078$).

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Where is your company’s clientele located?</th>
<th>Strongly disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly agree</th>
<th>Total</th>
<th>Chi-square</th>
<th>Sig</th>
<th>$\phi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local (suburb, town or city)</td>
<td>Count</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>3</td>
<td>13</td>
<td>18</td>
<td>3.101</td>
<td>0.078</td>
<td>0.146</td>
</tr>
<tr>
<td>Regional (province)</td>
<td>Count</td>
<td>0</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>10</td>
<td>19</td>
<td>0.5</td>
<td>0.078</td>
<td>0.0</td>
</tr>
<tr>
<td>National (South Africa)</td>
<td>Count</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>12</td>
<td>54</td>
<td>77</td>
<td>0.1</td>
<td>0.078</td>
<td>0.0</td>
</tr>
<tr>
<td>International (Africa only)</td>
<td>Count</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>14</td>
<td>18</td>
<td>0.5</td>
<td>0.078</td>
<td>0.0</td>
</tr>
<tr>
<td>International (Global)</td>
<td>Count</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>32</td>
<td>38</td>
<td>1.9</td>
<td>0.078</td>
<td>0.0</td>
</tr>
</tbody>
</table>

Table 7: Relationship between firm scope and challenges of cloud computing adoption

In summary, there is no relationship between the firm scope and the opportunities nor the challenges to the adoption of cloud computing.

5.1.2. Continuous variables hypotheses

There were seven continuous variable which were formed in constructs and used to test the relationship with opportunities and the challenges to the adoption of cloud computing. The hypotheses were analysed using Pearson correlation where they are normally distributed or Kendall’s tau b where they are non-normal.

5.1.2.1. Reliability and Normality of constructs

Table 8 presents the reliability and the normality of the constructs. Based on the guidelines of George and Mallery, the reliability of compatibility and trading partner pressure were poor, and these were not used further in the study, as such hypothesis 2 (compatibility) and hypothesis 10 (trading partner pressure) could not be tested. The other constructs showed acceptable to excellent reliability as they were all higher than 0.7. In addition, these constructs were also normally distributed as their Skewness and Kurtosis were within the guidelines of ±2 by Hair et al (2010).

<table>
<thead>
<tr>
<th>Constructs</th>
<th>Cronbach’s Alpha</th>
<th>N of Items</th>
<th>Reliability</th>
<th>Skewness</th>
<th>Kurtosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative advantage</td>
<td>0.912</td>
<td>11</td>
<td>Excellent</td>
<td>0.235</td>
<td>0.381</td>
</tr>
<tr>
<td>Compatibility</td>
<td>0.592</td>
<td>3</td>
<td>Poor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 8: Pearson correlation for opportunities of cloud computing adoption

<table>
<thead>
<tr>
<th>Complexity</th>
<th>Opportunities</th>
<th>Relative Advantage</th>
<th>Complexity</th>
<th>Technology Readiness</th>
<th>Competitive Pressure</th>
<th>Gov Regulatory Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology readiness</td>
<td>0.750</td>
<td>2</td>
<td>Acceptable</td>
<td>1.297</td>
<td>0.512</td>
<td></td>
</tr>
<tr>
<td>Competitive pressure</td>
<td>0.880</td>
<td>2</td>
<td>Good</td>
<td>0.857</td>
<td>0.154</td>
<td></td>
</tr>
<tr>
<td>Government and regulatory support</td>
<td>0.754</td>
<td>3</td>
<td>Acceptable</td>
<td>1.553</td>
<td>1.827</td>
<td></td>
</tr>
<tr>
<td>Trading partner pressure</td>
<td>0.569</td>
<td>2</td>
<td>Poor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Opportunities</td>
<td>0.908</td>
<td>8</td>
<td>Excellent</td>
<td>0.367</td>
<td>0.303</td>
<td></td>
</tr>
<tr>
<td>Challenges</td>
<td>0.878</td>
<td>11</td>
<td>Good</td>
<td>-0.075</td>
<td>-1.054</td>
<td></td>
</tr>
</tbody>
</table>

Table 5.2.2. Pearson correlation and linear regression

Opportunities of cloud computing adoption

Table 9 presents the Pearson correlation for opportunities, relative advantage, complexity, technology readiness, competitive pressure and government and regulation support. The results show that the constructs have a significant relationship with opportunities $p<0.05$, except for government and regulation support which does not have a significant relationship with the opportunities ($p>0.05$). Relative advantage has a strong positive Pearson correlation with the opportunities $r (170) =0.698$, $p<0.01$ based on the guidelines of Pallant (2010). Furthermore, complexity had a medium positive and significant relationship with the opportunities $r (170) = 0.308$, $p<0.01$, there was also a strong positive significance between technology readiness and opportunities, $r (170) = 0.561$, $p<0.01$. 
Table 9: Pearson correlation for opportunities of cloud computing adoption

<table>
<thead>
<tr>
<th>Gov Regulatory Support</th>
<th>Sig. (2-tailed)</th>
<th>0.145</th>
<th>0.228</th>
<th>0.391</th>
<th>0.000</th>
<th>0.017</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>172</td>
<td>170</td>
<td>172</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).

Table 10 presents the linear regression analysis for opportunities and relative advantage, complexity, technology readiness, competitive pressure and government and regulation support. The model summary significant and stable with \( F = 50.39, p < .001 \) with R-square of 0.550 and the adjusted R-square of 0.539 with a standard error of the estimate of 1.00917. This implies that the significant variables which are relative advantage (\( \beta = 0.510, p < .001 \)) and competitive pressure (\( \beta = 0.265, p < .001 \)) explained 55.0% of the variance for the organisation for opportunities for adoption of cloud computing. This model is stable with no autocorrelation as the Durbin-Watson was 1.912 and no multicollinearity (VIF<10).

**Model Summary**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.742*</td>
<td>.550</td>
<td>.539</td>
<td>1.00990</td>
<td>1.895</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Competitive Pressure, Complexity, Technology Readiness, Relative Advantage

**ANOVA**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>205.578</td>
<td>4</td>
<td>51.394</td>
<td>50.392</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>168.283</td>
<td>165</td>
<td>1.020</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>373.861</td>
<td>169</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: Opportunities

b. Predictors: (Constant), Competitive pressure, Complexity, Technology Readiness, Relative advantage

**Coefficients**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>-1.218</td>
<td>.578</td>
</tr>
<tr>
<td></td>
<td>Relative Advantage</td>
<td>.587</td>
<td>.077</td>
</tr>
<tr>
<td></td>
<td>Complexity</td>
<td>.103</td>
<td>.079</td>
</tr>
</tbody>
</table>

Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021
Table 10: Regression of continuous variables and opportunities for adoption of cloud computing

5.2 Challenges of cloud computing adoption

The Pearson correlation between relative advantage, complexity, technology readiness, competitive pressure and government and regulation support with challenges is presented on Table 11. The results show that there was a negative significant correlation between challenges and complexity, $r (170) = -0.339, p<0.01$, while the relation between challenges and government and regulation support was weak but positively significant, $r (170) = 0.169, p<0.05$. Furthermore, the relationship between relative advantage, $r (170) = -0.042, p>0.05$, technology readiness $r (170) = 0.119, p>0.05$ and competitive pressure, $r (170) = 0.063, p>0.05$ with challenges were not significant.

**Table 11: Correlation between continuous variables and challenges**

<table>
<thead>
<tr>
<th></th>
<th>Challenges</th>
<th>Relative Advantage</th>
<th>Complexity</th>
<th>Technology Readiness</th>
<th>Competitive Pressure</th>
<th>Gov Regulatory Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Challenges</td>
<td>Pearson Correlation</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relative Advantage</td>
<td>Pearson Correlation</td>
<td>-0.042</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.582</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>170</td>
<td>170</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complexity</td>
<td>Pearson Correlation</td>
<td>-0.339*</td>
<td>0.396**</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.000</td>
<td>0.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology Readiness</td>
<td>Pearson Correlation</td>
<td>0.119</td>
<td>0.145</td>
<td>0.022</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.123</td>
<td>0.059</td>
<td>0.772</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td></td>
</tr>
<tr>
<td>Competitive Pressure</td>
<td>Pearson Correlation</td>
<td>0.063</td>
<td>0.526</td>
<td>0.102</td>
<td>0.188*</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.413</td>
<td>0.000</td>
<td>0.185</td>
<td>0.014</td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>170</td>
</tr>
<tr>
<td>Gov Regulatory Support</td>
<td>Pearson Correlation</td>
<td>0.169</td>
<td>0.093</td>
<td>0.066</td>
<td>0.644*</td>
<td>0.183</td>
</tr>
<tr>
<td></td>
<td>Sig. (2-tailed)</td>
<td>0.028</td>
<td>0.228</td>
<td>0.391</td>
<td>0.000</td>
<td>0.017</td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>170</td>
<td>170</td>
<td>170</td>
<td>172</td>
<td>172</td>
</tr>
</tbody>
</table>

**. Correlation is significant at the 0.01 level (2-tailed).
*. Correlation is significant at the 0.05 level (2-tailed).
Table 11: Correlation between challenges and five dimensions

Table 12 presents the linear regression analysis for complexity and government regulatory support as they had a significant relationship based on the results of Pearson correlation. The overall model was significant, $F = 14.901$, $p < .001$, though the variance explained was low with $R^2 = 0.151$ (15.1%). This low variance indicated that this model results must be treated with caution, even though there was no multicollinearity (VIF $\sim 1.00$) and Durbin Watson for autocorrelation was 2.093, showing not autocorrelation. Complexity ($\beta = -0.351$, $p < 0.01$) contributed negatively to the variance explained while government regulatory support ($\beta = 0.192$, $p < .01$) contributed positive to the challenges for the adoption of cloud computing.

**Model Summary**

<table>
<thead>
<tr>
<th>Model</th>
<th>R</th>
<th>R Square</th>
<th>Adjusted R Square</th>
<th>Std. Error of the Estimate</th>
<th>Durbin-Watson</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>.389a</td>
<td>.151</td>
<td>.141</td>
<td>2.43890</td>
<td>2.093</td>
</tr>
</tbody>
</table>

a. Predictors: (Constant), Gov Regulatory Support, Complexity
b. Dependent Variable: ChallengesY2

**ANOVA**

<table>
<thead>
<tr>
<th>Model</th>
<th>Sum of Squares</th>
<th>df</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Regression</td>
<td>2</td>
<td>88.632</td>
<td>14.901</td>
<td>.000b</td>
</tr>
<tr>
<td></td>
<td>Residual</td>
<td>167</td>
<td>5.948</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>169</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

a. Dependent Variable: ChallengesY2
b. Predictors: (Constant), Gov Regulatory Support, Complexity

**Coefficients**

<table>
<thead>
<tr>
<th>Model</th>
<th>Unstandardized Coefficients</th>
<th>Standardized Coefficients</th>
<th>Collinearity Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
<td>Beta</td>
</tr>
<tr>
<td>1</td>
<td>(Constant)</td>
<td>8.046</td>
<td>.758</td>
</tr>
<tr>
<td></td>
<td>Complexity</td>
<td>-.853</td>
<td>.173</td>
</tr>
<tr>
<td></td>
<td>Gov Regulatory Support</td>
<td>.304</td>
<td>.113</td>
</tr>
</tbody>
</table>

a. Dependent Variable: ChallengesY2

Table 12: Regression of continuous variables and challenges for adoption of cloud computing
6. DISCUSSION

The study was conducted to test whether each variable in the hypotheses presented either an opportunity and/or challenge of cloud computing adoption for SMMEs in South Africa.

6.1 Technological context

The strong positive relationship between relative advantage and opportunities of cloud computing adoption is consistent with findings by Low et al. (2011), Alshamaila et al. (2013), (Oliveira & Martins, 2011), Kumar et al. (2017). A study by Senyo et al. (2016) for cloud computing adoption in a developing country (like South Africa) also found the relationship to be significant, but, contrary to the finding of this study, with a negative relation. Consistently, there is no significance for the relationship between relative advantage and challenges of cloud computing adoption, which leads to the conclusion that relative advantage, which represents benefits and opportunities such as cost reduction, competitiveness, scalability, etc. of cloud computing, has a strong significance in influencing cloud computing adoption for SMMEs in South Africa.

The positive significance of the relationship between complexity and opportunities and the negative significant of the relationship between complexity and challenges indicate that complexity is a factor in cloud computing adoption. The result of complexity having a negative significance on cloud computing adoption by SMMEs in South Africa is consistent with Louw et al. (2011) and conflicting with studies by Oliveira & Martins (2011) and Gutierrez, Boukrami, & Lumsden (2015) who found complexity to be a barrier. The possible reason the SMMEs that participated in this study do not link cloud computing with complexity is because cloud computing is deemed to be easy to use and it simplifies IT systems management and application development and delivery. The cloud compatibility variable was not tested on the results of the study as they were found to have poor reliability.

6.2 Organisational context

The study found top management support to be insignificant to either opportunities and challenges of cloud computing adoption by SMMEs in South Africa. While Gutierrez et al. (2015) congruently found top management support to not be a driver of cloud computing adoption, the finding of this study is inconsistent with other previous studies (Low et al., 2011; Alshamaila et al., 2013; Senyo et al., 2016; AL-Shboul, 2018). This study viewed top management support from only a financial support perspective while knowledge and skill was assessed from the perspective of the enterprise compatibility. This could be reason for the finding being inconsistent with earlier studies.

Firm size was found to not have any significance on opportunities and challenges of cloud computing adoption, consistent with Senyo et al. (2016) and AL-Shboul (2018) and inconsistent with Low et al. (2011). Out of the 174 study participants, only 3.4% firms had more than 200 employees and 8% had between 100 and 199 employees. 88.6% of the participants are small, which could explain why firm size had no significance in the study. Firm scope showed a weak positive significance with the opportunities of cloud computing adoption, contrasting findings by Senyo et al. (2016). This indicates that the wider the geographical scope of an SMME, the more likely it is adopt cloud computing as it is seen as an opportunity to reach more customers, centralize IT systems and improve collaboration among other benefits.

The study also found technology readiness to have a weak positive significance with the opportunities of cloud computing adoption. This finding is consistent with Oliveira and Martins (2010), Zhu et al. (2003), Senyo et al. (2016), while being inconsistent with Louw et al. (2011) who unexpectedly found this factor to be insignificant. Technology readiness refers to the readiness of the people in the organisation and the required infrastructure to adopt cloud computing. This study shows that the SMMEs have the required capabilities to adopt cloud computing.

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<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Relationship</th>
<th>Finding</th>
<th>Navigation</th>
<th>Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>H1a</td>
<td>Relationship between relative advantage and opportunities</td>
<td>Significant (p&lt;0.05)</td>
<td>Positive</td>
</tr>
<tr>
<td>H1</td>
<td>H1b</td>
<td>Relationship between relative advantage and challenges</td>
<td>Not significant (p&gt;0.05)</td>
<td></td>
</tr>
<tr>
<td>H3</td>
<td>H3a</td>
<td>Relationship between complexity and opportunities</td>
<td>Significant (p&lt;0.05)</td>
<td>Positive</td>
</tr>
<tr>
<td>H3</td>
<td>H3b</td>
<td>Relationship between complexity and challenges</td>
<td>Significant (p&lt;0.05)</td>
<td>Negative</td>
</tr>
<tr>
<td>H4</td>
<td>H4a</td>
<td>Relationship between top management support and opportunities</td>
<td>Not significant (p&gt;0.05)</td>
<td></td>
</tr>
<tr>
<td>H4</td>
<td>H4b</td>
<td>Relationship between top management support and challenges</td>
<td>Not significant (p&gt;0.05)</td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td>H5a</td>
<td>Relationship between firm size support and opportunities</td>
<td>Not significant (p&gt;0.05)</td>
<td></td>
</tr>
<tr>
<td>H5</td>
<td>H5b</td>
<td>Relationship between firm size and challenges</td>
<td>Not significant (p&gt;0.05)</td>
<td></td>
</tr>
<tr>
<td>H6</td>
<td>H6a</td>
<td>Relationship between firm scope and opportunities</td>
<td>Significant (p&lt;0.05)</td>
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</tr>
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<td>H6</td>
<td>H6b</td>
<td>Relationship between firm scope and challenges</td>
<td>Not significant (p&gt;0.05)</td>
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<tr>
<td>H7</td>
<td>H7a</td>
<td>Relationship technology readiness and opportunities</td>
<td>Significant (p&lt;0.05)</td>
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<tr>
<td>H7</td>
<td>H7b</td>
<td>Relationship between technology readiness and challenges</td>
<td>Not significant (p&gt;0.05)</td>
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<td>H8</td>
<td>H8a</td>
<td>Relationship between competitive pressure and opportunities</td>
<td>Significant</td>
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<td>H8</td>
<td>H8b</td>
<td>Relationship between competitive pressure and challenges</td>
<td>Not significant (p&gt;0.05)</td>
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<td>H9</td>
<td>H9a</td>
<td>Relationship between government and regulatory support and opportunities</td>
<td>Not significant (p&gt;0.05)</td>
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<td>H9</td>
<td>H9b</td>
<td>Relationship between government and regulatory support and challenges</td>
<td>Significant (p&lt;0.05)</td>
<td>Positive</td>
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Table 13: Results of the relationships

6.3 Environmental context
The study found competitive pressure to have a positive significance on the opportunities of cloud computing adoption, consistent with studies by Louw et al. (2011) and Senyo et al. (2016). This finding could be attributable to the fact that SMMEs want to be competitive through the attraction of new customers and retention of existing customers by improving service levels and customer experience. Also, if SMMEs think or know that their competitors are adopting cloud computing in order to derive the advantages it offers, they are more likely to adopt the same technology. In the study competitive pressure was not seen by SMMEs as a challenge to cloud computing adoption.
Government and regulatory support had showed a weak positive significance on the challenges and no significance on the opportunities of cloud computing adoption by South African SMMEs, according to the study, meaning that government and regulatory support is perceived negatively. This is consistent with Zhu et al. (2003) and AL-Shbou (2018) who also found regulatory support to have significance. However, it is incongruent with Senyo et al. (2016) who found that this factor had no significant. In South Africa, this could be due to the fact that government is perceived to not be supportive to the success of SMMEs in regard to technology. Regulations, such as affirmative action and labour laws, are generally perceived to be barriers to the success of SMMEs because they make it hard to easily hire and fire, in the case of labour laws, and for SMMEs get certain work contracts, in the case of affirmative action.

7. CONCLUSION

This study sought to investigate the factors that factors that represent opportunities and challenges of cloud computing adoption by the SMMEs. A literature review on cloud computing to provide a definition, benefit and opportunities and challenges of cloud computing and on the theoretical framework, the TOE framework, was performed to contextualize the factors that impact cloud computing adoption opportunities and challenges. The factors of the TOE framework was used to develop the research model and formulate 10 hypotheses that postulated the relationship between each of the factors and the opportunities and challenges of cloud computing adoption by SMMEs in South Africa: relationship between relative advantage and opportunities and challenges of cloud computing adoption by SMMEs in South Africa; relationship between complexity and opportunities and challenges of cloud computing adoption by SMMEs in South Africa; relationship between top management support and opportunities and challenges of cloud computing adoption by SMMEs in South Africa; relationship between firm size support and opportunities and challenges of cloud computing adoption by SMMEs in South Africa; relationship between firm scope and opportunities and challenges of cloud computing adoption by SMMEs in South Africa; relationship technology readiness and opportunities and challenges of cloud computing adoption by SMMEs in South Africa; relationship between competitive pressure and opportunities and challenges of cloud computing adoption by SMMEs in South Africa; and relationship between government and regulatory support and opportunities and challenges of cloud computing adoption by SMMEs in South Africa.

The results of the study found six factors to have significance on the opportunities and challenges of cloud computing adoption by SMMEs in South Africa: relative advantage, complexity, technology readiness, firm scope, competitive pressure and government support. Relative advantage, firm scope, technology readiness and competitive pressure were found to favourably represent opportunities of cloud computing adoption, while government support was found to present a challenge for cloud computing adoption. The complexity of cloud computing was significant as both an opportunity and a challenge; however, negatively as a challenge and positively as an opportunity, indicating that SMMEs did not find complexity as a problem for cloud computing adoption. Two variables – top management support and firm size – were found to be in insignificant. SMMEs consider relative advantage – the benefits and opportunities – to be a strong significant factor for cloud computing adoption.

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GENDERING OF SMARTPHONE OWNERSHIP AND AUTONOMY AMONG YOUTH: NARRATIVES FROM RURAL INDIA

Renza Iqbal, Erasmus University Rotterdam, renza@esphil.eur.nl

Abstract: This study delves into the research question: how does gender influence smartphone ownership and autonomy in using the internet among the youth in rural India? This paper explores the influence of local culture on smartphone ownership and autonomy through an ethnographic study among rural Indian youth by analysing the intersection of gender with other identity axes. The findings show that young people’s smartphone ownership and autonomy is shaped by their social and cultural setting, and could lead to various inequalities in their internet usage. This study shows that gender paves way for various disparities with regard to smartphone ownership and internet usage. Decolonisation of the understanding of smartphone ownership and internet usage patterns of the youth in the Global South suggests a reconsideration of the user experience designs and platform policies.

Keywords: smartphone, autonomy, privacy, ICT, Global South, gender and ICT

1. INTRODUCTION

In 2016, the UN declared access to the internet as a basic human right (Sandle, 2016). GSM Association (2020) estimates that 600 million new subscribers will access the internet globally through mobile phones by 2025. In most low-and-middle-income countries, a smartphone is often the only device affordable to a vast majority to access the internet. The launch of cheap data plans by Reliance Jio Services in 2015 led to an increased number of mobile phone users in India (Sengupta, 2017). This paper argues that access to devices or the internet alone does not meet the needs of a diverse range of users across the globe. Several cultural underpinnings are involved in deciding the availability and accessibility of the internet on smartphones.

This study is informed by ethnographic fieldwork undertaken in rural Kerala, a state in the South of India, in 2019. This paper explores the understanding of smartphone ownership and internet usage among young people and how their understanding and notions of autonomy influence their internet usage and online behaviour. Across most communities in India, senior family members keep a constant watch over their womenfolk for what is perceived to be in the interest of their safety. Localized gendered narratives of autonomy significantly impact the degree of access available to young women in rural India.

This study on young users in rural India who access and consume the internet through their smartphone reveals that autonomy is defined variably across communities and is deeply gendered in everyday accessibility and usage. It is essential to analyze the different factors that influence a community's culture of usage to draw connections between traditions, norms, and understanding of digitality. Cultural factors such as rurality, gender, religion, and class play an important role in influencing such habits and aspirations. Studies have shown that cultural norms control and limit women's use of technology in South Asia (Sambasivan et al., 2018). This paper calls for the need in understanding localized narratives of autonomy catering to the needs of the individual user.
2. LITERATURE REVIEW

The major obstacles to internet adoption in South Asia are a large gender gap and a lack of adequate skills (GSM Association, 2020). Compared to men, women in low-and-middle-income countries are 23% less likely to use mobile internet; in South Asia, the mobile internet use of those living in rural areas is 45% less than those in urban areas (Rowntree et al., 2020). Many communities in the Global South impose strict regulations restricting women's access to public spaces in the interest of their safety. These restrictions are now transcending the physical social space they occupied and slowly moving into the digital space. There is a systemic denial of digital access to women in India, which involves both economic and normative barriers (Barboni et al., 2018).

Most rural digital exclusion studies point to the lack of motivation and skills as a hindrance to digital engagement (Salemink et al., 2017). Digital inclusion is to be comprehended as more than access and look into class formation, stratification of information, structural systems of power, local cultures, and their influence on the user's autonomy. Digital inclusion does not just pertain to the have's and have nots; the uneven access reveals the existing social stratification. The global privacy narrative focuses on concerns regarding data collection, data control and third party sharing (Mahmoodi et al., 2018; Van Dijk et al., 2018) and fails to acknowledge local privacy narratives influenced by culture.

In many parts of the Global South, cultural expectations dictate that women should share their mobile phones with family members and that their digital activities be open to scrutiny by family members (Sambasivan et al., 2018). Therefore, understanding the cultural substructures that lead to this situation is imperative in comprehending these obstacles. This paper draws attention to how localized notions of autonomy lead to the differences in users' privacy, skills and ability to access, thereby demanding recognition of the gendered definitions of autonomy in underrepresented contexts.

3. METHODOLOGY

The study seeks to answer the research question: how does gender influence smartphone ownership and autonomy in using the internet among the youth in rural India? using ethnographic methods. Ethnography creates contexts through which the researcher delves into the participants’ lives using interventional and observational methods to reveal what matters to the participants (Pink & Morgan, 2013). In-depth interviews in the native language help capture individual experiences and cultural practices (Schensul et al., 1999). The researcher engaged first-hand with the participants in a deliberate attempt to understand their lives and experiences. For the purpose of this study, youth has been defined as those who are between 15 to 25 years of age. This study looks into the nuanced negotiation between smartphones and gender.

Observation and in-depth interviews were engaged in fields across nine Panchayaths in the rural areas of Wayanad district, in the north of Kerala, India, during June 2019. The study consisted of a focus group discussion (FGD) and twenty-five in-depth interviews conducted in person by the researcher. The respondents were chosen through purposive sampling to include diverse age, gender, religion, caste, educational qualification, and economic condition. The respondents included students, working people, and homemakers. The income groups include respondents belonging to the low to upper-middle-class; the religious backgrounds included Hinduism, Islam, and Christianity; and both male and female participants. The respondents were identified with the help of grassroots level ASHA (Accredited Social Health Activist) workers from various localities across Wayanad. The ASHA workers form a close network and maintain a strong bond with all the families in their purview. They carry the most updated demographic information regarding the households in their region. Approaching households via ASHA workers and being accompanied by a local helped gain the trust of the respondents and their families.
The data collection attempted to understand their smartphone ownership and autonomy: the devices used, ownership of the device, the autonomy exercised, skills acquired, restrictions associated with usage imposed by kin, and the frequency of use, among others. Focus group research helps identify pertinent issues, areas for further investigation, meanings, values, opinions, behaviours, and explanations for cultural or physical phenomena (Schensul et al., 1999). Students from the Calicut University Centre at Wayanad were invited to participate in the focus group discussion. An equal representation of male and female students was ensured. The participants were from four different Panchayats and had diverse religious and economic backgrounds. Permission for the FGD was obtained from the authorities at the Centre. The Centre chose students from those who were interested to participate after being informed about the purpose of the FGD. The group consisted of eight members who were familiar with each other and shared a level of comfort. Consent was obtained from the participants, and the confidentiality of the participants has been safeguarded. Names of the participants have been changed to protect identities.

Face to face, semi-structured in-depth interviews were conducted at the respondents’ residence in their local language to make the respondents comfortable. Locals accompanied the interviewer during the process to validate the authenticity of the interviewer to the respondents and help build a rapport. Being introduced by locals helped build trust, ensuring genuine research participation. The interviews and the FGD were audio recorded with the respondents' oral consent, and the recordings were later transcribed. This was followed by thematic coding and analysis. The coding involved: development of a coding scheme, applying the coding scheme, ensuring consistency of its application (Schensul et al., 1999). The themes were identified from a combined understanding of the data and literature.

4. FINDINGS AND ANALYSIS

A smartphone is the most commonly used device to access the internet, affordability being the prime reason. Of the ten people that did not have a personal smartphone, seven were female. It was also observed that most of the respondent's fathers had smartphones, but not all mothers did. There is a gendered difference in sharing devices, autonomy over devices, leisure time, and conduct in public spaces. An interplay of social and cultural factors constantly influences rural women's narrative and definition of autonomy over their devices. They perceive and interact with multiple meanings of autonomy and differentiate it as essential or inessential and determine its significance in their day to day lives.

The respondent's narratives on their ownership and use of the internet on smartphones reflected a stark gender difference. The findings were organized based on the recurring themes identified from the narratives. The various gendered themes brought out were: age of ownership – male users owned a smartphone significantly earlier than female users, code of conduct – there were expectations from female users regarding how to or not to use the internet through devices, lack of autonomy over personal devices – female users' devices were expected to be shared or monitored, social media usage was guided by societal expectations, nothing to hide – young women's internet usage was monitored in the interest of their safety, and therefore they were expected to cooperate with the same, repercussions in the event of deviance – if the woman breaks the prescribed code of conduct her smartphone was withheld from her. Women in the community are expected to follow a code of conduct in public places. The study shows that these regulations transcended into their private space of internet usage and mobile phone accessibility. The study reveals that in predominantly patriarchal rural Indian societies, young women are deprived of autonomy in internet usage over safety concerns. Autonomy and privacy thus took a different meaning for young women in rural India while navigating through these cultural contexts.

4.1. First time ownership
“Boys get smartphones much before girls,” Hasna (20, f) was visibly upset with the imbalance. In 96% of the households, the male child got a personal smartphone much earlier than the female child. The average age at which a male user first gets ownership of a smartphone is 15, while it is 18 for female users. Habeeb (21, m) explains that “parents are apprehensive about giving a phone to a girl; they are sceptical about their security. Boys grow up in a freedom-oriented atmosphere.” “When we ask our parents for a phone, they ask us ‘what is the need?’ proposing that ‘if you need to call friends there is a phone in the house,” shared Ramitha (21, f). When boys are free to go outside, do things they like, girls are expected to explain and justify their need to go out.

4.2 Financial independence & ownership

“Many of my male classmates made money and bought a phone for themselves,” shares Ansiya (18, f). Boys tend to seek part-time jobs and other forms of employment during the summer school break, making enough money to buy themselves a phone, whereas girls are not free to do the same owing to cultural barriers. For young women from well to do families, engaging in employment is seen as a disgrace on the family, as the incapacity of the primary breadwinner to provide sufficiently; therefore, they have to rely on the decision-makers in the households to receive a personal smartphone. Rural areas suffer from conservative social contexts that influence digital disengagement (Sora & Kim, 2015; Salemink et al., 2017). Women carrying out paid labour was understood to harm their domestic work and to the essence of femininity - along with which there is a fear of being exposed to sexual harassment when working outside, and women who challenge these norms are often ostracised (Devika, 2019).

However, it was observed that it was acceptable for women belonging to economically backward tribal communities to engage in employment. However, those among them who do not have the opportunity to work often never have a phone for themselves, owing to financial constraints. Surya (20, f) is a young mother belonging to Paniya, a tribal community in Wayanad. She does not generate any income, own a personal device, or engage with the internet. Her only engagement with the internet is, “when he (her husband) shows me things, I look at it.” Shidusha (22, f) and Sruthi (22, f) belong to Kuruma, a tribal community in Wayanad. While the former bought a phone for herself when she started working as a teacher, the latter used her scholarship funds to get a personal smartphone. Nimisha (26, m) – another respondent from the Kuruma community, has been unable to go for a job as she has been taking care of her toddler and does not have a personal phone.

4.3 Leisure

Young women have less leisure time than their male counterparts, which translates to comparatively less time spent on the internet. "Girls don't get to spend much time on the internet. They come to college in the morning, go back home and study, engage in household chores. Unlike us, they are scolded by family if they overspend time on the phone," says Arunjith (18, m). Patriarchy constrains women’s leisure through social structures (Shaw, 1994). Female respondents stated that the internet is only to be used in a time of need, as opposed to the male respondents who relied on it primarily for leisure. Abhijith (22, m) loves the internet, "I have two sim cards and consume 2.5 GB a day, which often falls short. I recharged again on my way home now." Arunjith (18, m) claims that he is on his phone all the time and replies instantly to all messages. With male respondents spending significantly more time on various platforms through their devices, it is not surprising that young men are more skilled at the nuances of using a smartphone.

The cultural expectation defines that a good woman does not engage in a lot of leisure, as she is busy with her chores; thus women often feel that they are not entitled to leisure (Harrington et al., 1992; Shaw, 1994). Young female respondents attempted to sound compliant to the local moral codes associated with digital usage. Dheeraj (17, m) does not shy away from admitting that he uses
the internet whenever possible, playing video game’s such as Player Unknown's Battlegrounds (PUBG) and being active on Facebook, TikTok, and Instagram. He shared an incident from their neighbourhood, where a young woman fled home after being restricted from using Facebook as she pleased. For female users, their right to leisure is also restricted, as is their right to autonomy.

### 4.4 Likelihood of Intervention

Rama’s (23, f) family knows the password to her smartphone, and she thinks it is okay if they are observing and enquiring about her activities in a friendly manner. When asked if a personal smartphone increases one’s privacy, Jancy (23, f) says, “we (Jancy and her brother) share everything. I have not felt a need for privacy.” However, the sharing does not involve Jancy looking into her brother’s smartphone. All respondents agree that if the user is careful, they will be free from trouble, subtly pointing at the pertinent victim-blaming culture.

Most of the participants likened the perspective that autonomy over the smartphone was a privilege reserved for men. Keeping women’s devices open to be used by family members and having nothing to hide was considered culturally appropriate. “Unlike girls, we use our phones all the time. We use apps and other techniques to protect our device from being hacked. They (girls) would know little about the technicalities,” Arunjith (18, m) explains why female users are more at risk. The primary concerns and risks around a female user’s online safety are centred on the probability of them making uninformed decisions while interacting with strangers, being unable to protect the information on their devices, leading to a misuse of the same, and engaging in romantic affairs.

### 4.5 Autonomy

Nimisha’s (25, f) mother often watches over what she is doing on her mobile phone and asks whom she is talking to or chatting with. Rama’s (23, f) parents question her when she spends long hours on her smartphone. Asfeena’s (25, f) mother-in-law took a seat with us to listen to the entire interview where Asfeena told us that she does not have a smartphone. She briefly mentioned that she occasionally watches videos on YouTube on her husband’s phone but then said that she does not use the smartphone. She was told that she does not have a smartphone. She briefly mentioned that she occasionally watches videos on YouTube on her husband’s phone but then said that she does not use the smartphone. Fasna (19, f) got a smartphone after her marriage. She is happy that now she can use WhatsApp freely; earlier, she used it on her father’s phone, “my husband occasionally scrolls through my phone, not that he is checking or anything.” The monitoring of women’s smartphones by family members is dictated by culture, and they are expected to keep their digital activities open to scrutiny (Sambasivan et al., 2018).

None of the male respondents was subjected to such monitoring; they enjoyed absolute autonomy over their internet usage and smartphones. “Parents hear about various issues arising from the use of the smartphone at awareness sessions and thus develop a fear,” says Shruti (22, f). The usage of female respondents was being monitored regardless of their age or marital status. “Boys’ phones have locks, on top of that a fingerprint lock, over that a pattern lock,” says Amal (22, m). Female users are not free to secure their phones or apps as they are expected to have nothing to hide. He suggests, “parents don’t give phones to their daughters because then they will have more freedom which could get them into trouble. Boys can save themselves from any problem.” The nothing to hide argument is subtle oppression in disguise (Devika, 2019).

Abhijith (22, m) shared insights on how male users often get into trouble by befriending women online. “At first, she will ask for a mobile phone recharge. Stupid boys would do it for them. This would keep repeating. Then these girls will go out with these boys. Then the boys end up spending over that – at movies, coffee shops or otherwise. I have personal experience, and it is not just me. I
know many who have been trapped similarly. The girl ghosts later,” however such incidents do not affect their autonomy over their devices.

Jancy’s (23, f) family told her not to talk on the phone when outside and to restrict phone conversations to when she is within the house. Otherwise, people in the locality would assume that she is in a relationship. She shares that female friends whose families did not provide them with a smartphone were sometimes given one by their boyfriends, which they used without the knowledge of their family. Strict cultural norms limit the public spaces to men, and women are often expected to recede indoors.

4.6 Honour

Traditional gatekeepers of social morality keep a check on the social customs and conventions, regulating what is allowed and for whom. However, these restrictions are bound only to female users, and male users act as gatekeepers. These gatekeepers could take away the autonomy of a woman who breaks social norms. When young people in these communities engage in romance, it is most often in secret as it is not socially acceptable. Hasna’s (20, f) smartphone was confiscated by her family when her romance with a fellow college-mate was ‘caught’. Local observers fear that women occupying public spaces would engage in sexual or romantic relationships outside marriage (Kaya, 2009), which continues to be one of the prime fear factors concerning women’s digital access and usage, especially in inherently patriarchal communities. Romance itself is belittling in these communities, and elopement would put the girl’s family to shame. The family-withholds women’s autonomy as women are destined to uphold the family’s virtue (Arora, 2019).

These norms do not apply to male users. “I spend over four hours on my smartphone,” shares Abhijith (22, m), whose internet usage is seldom interfered with and never monitored. “Only half of my female classmates have a phone. They are often not given one by their families as there is a concern about them making new friends over Facebook,” says Amal (18, m). Amal (18, m) shares that “a girl from my school was caught bunking class and hanging out with some friends she made online. The teachers and the parents believe that it was her phone that led her ‘astray’. Post this, girls at our school are now denied access to phones. School authorities and their parents confiscated their phones”. An authoritarian society adopts a paternalistic role when it comes to the autonomy of women and girls if it identifies autonomy to be at odds with the social harmony of the society. “They (parents) wouldn’t want their daughters to be trapped in love. They might refuse to get a phone for their daughters to protect them,” opines Arunjith (18, m). Social norms can overtake consent where privacy and morality is dominantly a gendered space (Arora, 2018).

4.7 Social media

Social media use of female users is highly regulated and closely observed by gatekeepers in the community. There is a constant fear among young women about their photos on social media being used in fake pornographic content or personal messages being publicized (Arora 2019). The female users carry the burden of keeping themselves safe from the troubles online. Jancy’s (23, f) brother warned her against the possible misuse of photos in one’s phone if taken in compromising positions such as nudes or intimate images - if the phone needs to be repaired, the person repairing it can get hold of such pictures. Rama (23, f) was instructed by her elder brother not to post any of her personal pictures on Facebook. Such restrictions often lead to the abstinence of women from the digital worlds.

A recurrent comment from the female respondents was, “if we are careful, everything will be fine,” which shifts the focus from the perpetrator to the victim. The most commonly faced issue on social media was of being approached by strangers seeking friendship which they then attempt to convert
into a romantic relationship. Women who decline bear the brunt of offensive messages, comments, or the threat of having their number shared with several others who constantly send disturbing messages. Shilpa (19, f) received several inappropriate messages from strangers when she was on Facebook – she would immediately block them on the platform; she quit Facebook after getting married. Facebook has a poor reputation in the community.

5. DISCUSSION
A dominant narrative identified during the fieldwork is that female users were less concerned about the popular global privacy narrative regarding data being scooped by companies or Governments. They claim that autonomy over their smartphone was not necessary for them and the constant monitoring of their mobile internet usage was in their best interest. Most young women approve of this action and therefore are less assertive of a need for autonomy while using a personal device. The study suggested that this void of autonomy and monitoring for safekeeping were hardly applicable to men. While women claimed that they had nothing to hide, male respondents claimed to be adept at protecting their data from the surveillance of their family members. Young women in rural India are claiming that they do not need autonomy, presenting an alternative narrative to that of their counterparts in the West, who may take autonomy in using and accessing the internet through a personal device with non-interference from family members for granted.

However, during the focus group discussion, in the absence of their family, the female respondents shared in unison that this gendered monitoring is unfair and that “we know how to overcome it as we use the phone more than our parents.” In the presence of kin, female respondents sounded indifferent to the need for autonomy over their devices. They tried to portray this indifference as a virtue, while male respondents proudly proclaimed how they use various security mechanisms to keep everyone else out of their devices. “All apps on my phone are locked and shall unlock only on detecting my face,” Abhijith (22, m). User privacy for smartphones is designed based on the understanding that one device shall be used by one user. However, the lack of autonomy of the users challenges this definition and seeks to rethink the available privacy control options.

6. CONCLUSION
The study shows that the notions of autonomy in using smartphones are vastly gendered, both in terms of meaning and access. It was evident that the skillset, peer support, and freedom to use the internet on smartphones vary remarkably based on gender. The responses from the participants indicated that no female respondent had absolute autonomy over their smartphone; their devices were either shared with other family members or closely monitored by their kin. This owes to cultural restrictions and the hierarchies existing in the society, which puts male members before the female members - owing to the inherently patriarchal nature of these societies - as seen in the rural areas of developing countries in the Global South. Decolonising the inherent understanding of privacy and autonomy is essential in ensuring that everyone gets equal access and opportunity in the digital space. The study shows that penetration of the ICT's alone does not ensure equal participation. The findings emphasise the need for developing design and policy with the local culture and local user's needs in mind, thus deviating from making universal design/policies based on the preferences, requirements and needs of the Global North. The findings of this study are limited to users' perceptions in rural Wayanad and encourage future research to replicate this study in diverse contexts by including the perspectives of other stakeholders such as designers and policymakers.

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The aims of this study are to identify risk factors and develop a composite risk factor of initial stage of COVID-19 pandemic in regency level in Indonesia. Three risk factors, i.e., exposure, transmission and susceptibility, are investigated. Multivariate regression, and Canonical correlation analysis are implemented to measure the association between the risk factors and the initial stage of reported COVID-19 cases. The result reveals strong correlation between the composite risk factor and the number of COVID-19 cases at the initial stage of pandemic. The influence of population density, percentage of people commuting, international exposures, and number of public places which prone to COVID-19 transmission are observed. Large regencies and cities, mostly in Java, have high risk score. The largest risk score owned by regencies that are part of the Jakarta Metropolitan Area.

Keywords: mapping risk, hazard, transmission risk, exposure risk, susceptible risk, COVID-19

1. INTRODUCTION

A group of cases of pneumonia with unknown cause occurred in Wuhan Hubei Province, China at the end of December 2019, and it was reported to China’s National Health. In early January 2020, the virus was termed as the 2019 novel coronavirus (2019-nCoV), and it has been reported to WHO for the whole genome sequence.\(^1\)–\(^3\)

The 2019-nCoV cases not only occurred in Wuhan, in a short time nine cases were discovered in Thailand, Japan, Korea, the United States, Vietnam, and Singapore which is suspected of spreading by air travel. The rapid spread and the increasing number of cases were expected due to the celebration of the Chinese Lunar New Year. In addition, it is also predicted to around 15 million trips in Wuhan during the spring festival. These possibilities that make the virus quickly reached other places then become a pandemic.\(^4\) The real-time updating for the distribution of the confirmed cases in the world can be seen in COVID-19 dashboard by Center for Systems Science and Engineering (CSSE) at Johns Hopkins University.\(^5\)

The virus transmits from one individual to another via water droplets and physical contact. Coronaviruses are not airborne, these viruses spread rapidly through water droplets caused by sneezes and coughs. Inhalation of the water droplets transmits the virus into the human body. Physical contact is a common way of how the virus spreads.\(^6\)

Touching a surface or an individual that is affected by COVID-19 could also transmit the virus through our body if mouth, eyes, and nose are touched after touching the Covid-19 affected surface.\(^7\) Another study related to the transmission of coronavirus through human to human was also investigated by Ralph, R. et al.\(^8\)
Population mobility plays an important role in the transmission rate of COVID-19. Demographics have changed, the mobility of people has increased, travel from foreigner and domestic countries has increased significantly, making it a challenge to mitigate the spread of the virus. Initial cases in many countries such as Thailand, Japan, Korea, and Italy are from travelers from China. Higher people mobility within and between regions increases the transmission of COVID-19. In high mobility regions, people are more likely to interact with other people thus transmitting the disease more quickly. Furthermore, the movement of asymptomatic people are a potential source of corona virus infection with dynamic transmission. Huang, R., was found that the infection spread of COVID-19 was spatially dependent, which largely spread neighboring areas from Hubei Province in Central China. Population density is also a key factor to the spread of COVID-19. People in areas with high population density have greater risks of being affected. Higher density means less room for physical distancing. Places with high density and mobility such as religious places, minimarkets, hotels, and schools are considered hazardous because the risk of getting COVID-19 is high. Population aging shows the risks for each age. Risks for older people tend to be higher than young people. This is likely associated by chronic conditions at older ages. Comorbidity also could increase the chances of getting infected by COVID-19.

In Indonesia, the government announced the first case of the corona virus in early March, 2020. On May 24, 2020, the Government of Indonesia declared 22,271 COVID-19 cases, 1,372 confirmed deaths and 5,402 cases recovered from 404 districts in 34 provinces. Some areas have higher cases may due to their characteristics which can lead to higher risk of COVID-19. Knowledge understanding the risk factors can help to contain the spread of COVID-19 and lower the number of affected people. Lummen & Yamada, (2014) and Welle & Birkmann (2015) indicate four main components (hazard, exposure, vulnerability, and capacity) for developing a disaster risk index. The goals of this research are to identify the COVID-19 risk factor sets, construct a composite risk index, and map the cities and regencies in Indonesia based on the risk factor sets. The composite risk index is an indicator that reflects the risk degree of a region toward disaster including pandemic/epidemic. It is derived from three components, i.e., exposure, transmission, and vulnerability. The exposure factor indicates degree of exposure before pandemic occurred in a region. Transmission factor indicates degree of probability of a disease is being transmitted in a region. This index is related to the number of public facilities in a region. The vulnerability factor reflects degree of sensitivity in a region toward pandemic.

2. METHOD

2.1 Data

All risk factor variables/indicators are obtained from several survey carried out by BPS-Statistics Indonesia. The data is in regency’s level, and there are 514 regencies all over Indonesia. Three risk factors were considered. First, the exposure factor which composes population density, proportion of commuters, and the number of foreign tourists. BPS Statistics Indonesia recorded number of tourists in several gates (airports, harbors, etc.) and border check points across Indonesia. For generating data in regency level, the buffering method of 25 km is used from the gates or check points. If the boundary of a regency is intersecting with the buffer, the number of foreign tourists in regency is the same as number of foreign tourists from gates of arrival, otherwise the number of foreign tourists is 0.

For both Ngurah Rai and Soekarno-Hatta airports, we use buffer of 50 km instead of 25 km. The second factor is transmission and the indicator for this factor were worship places, number of mosques, churches, minimarkets, department stores or supermarkets or malls, banks, hotels, restaurants, and schools. The third is the susceptible factor. The indicators are age proportion above
50 years, proportion of people with morbidity, the proportion of the population who do not know to wash their hands properly, the proportion of the population who are commuting and sex ratio. Table 1 shows the variables used to calculate the composite risk factor of the COVID-19 pandemic.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Variables</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of foreign tourist (January and February, 2020)</td>
<td>BPS Official Release Paper (February, 2020)</td>
</tr>
<tr>
<td>Transmission</td>
<td>Number of religious places</td>
<td>Indonesia</td>
</tr>
<tr>
<td></td>
<td>Number of minimarkets</td>
<td>Village Potency (2018)</td>
</tr>
<tr>
<td></td>
<td>Number of traditional markets</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of supermarkets or malls</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of banks</td>
<td></td>
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<tr>
<td></td>
<td>Number of hotels</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Number of restaurants</td>
<td></td>
</tr>
<tr>
<td>Vulnerability</td>
<td>Proportion of population who 50+ years old</td>
<td>Population Projection (March, 2020)</td>
</tr>
<tr>
<td></td>
<td>Proportion of people have comorbidity</td>
<td>National Socio-economic Survey (2019)</td>
</tr>
<tr>
<td></td>
<td>Proportion of population who do not have wash their hand well</td>
<td>Community Health Development Index (2018)</td>
</tr>
<tr>
<td></td>
<td>Sex Ratio</td>
<td>Population Projection (2016)</td>
</tr>
<tr>
<td></td>
<td>Percentage of household with house area &lt; 8m²</td>
<td>National Socio-economic Survey (2019)</td>
</tr>
<tr>
<td>Covid-19 Initial Cases</td>
<td>Number of confirmed cases</td>
<td>Indonesia National Covid-19 Rapid Response Task Force</td>
</tr>
<tr>
<td></td>
<td>Patients under surveillance (PDP)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>People under monitoring (ODP)</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. The Risks Factors and the Initial Stage Covid-19 Hazard

2.2. Risk Composite Index

In building a composite Index18 discussed several steps need to be performed. After theoretical framework and variable selection, normalization and, multivariate analysis and weighting and aggregation are the most crucial steps. Normalization is required prior to any data aggregation as the indicators in a data set often have different measurement units. It is done to render the indicators comparable and to account for extreme values and skewed data. There are several normalization methods exist.19,20 Welle and Birkmann (2015) transformed all indicators in dimensionless rank levels between 0 and 1 17. In this study as the data are in different unit and variability at the first stage all variables are normalized into values between 0 and 1 using the following equation:

$$z_i = \frac{(x_i - x_{\text{min}})}{(x_{\text{max}} - x_{\text{min}})}$$  \hspace{1cm} (1)

The main challenge in building a composite index is to find the optimal weight for each indicator in the factors. Several weighting methods are available, principal components analysis (PCA) or factor
analysis (FA) could be used to group individual indicators according to their degree of correlation. In this study, the weights are calculated in two steps, first the weights of each indicator within factors using confirmatory factor analysis (CFA). The second is obtaining the weight of each factor in constructing the composite risk index. To get the weight that can optimal the correlation between the risk index and the number of COVID-19 cases, Canonical Correlation analysis is carried out.

Confirmatory factor analysis (CFA) is a method used to investigate and verify the shared variance of indicators that is believed to be attributable to a factor. CFA is used to examine the hypotheses of the relationship between a set of variables with the latent variables. CFA model is constructed in advance specifies the number of latent factors and the patterns of loadings factors. CFA Model is defined:

\[ x = A\xi + \delta, \]  

(2)

Where \( x \) = (q x 1) vector of indicator variable, \( A = (q x n) \) matrix of factor loadings, \( \xi = (n x 1) \) vector of latent construct (factors), and \( \delta = (q x 1) \) vector of errors of measurement. In this study, there are three factors with their corresponding indicators as defined in Table 1.

Before conducting the CFA, Bartlett’s test of sphericity and Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy test are carried out to check whether the data is eligible for CFA analysis. The KMO indicates the proportion of variance of the variables/indicators that might be caused by underlying factors. High values (close to 1.0) generally indicate that a factor analysis may be useful with your data, whereas the value is less than 0.50 show that CFA is not very useful. Bartlett’s test tests if correlation matrix is an identity matrix. It indicates if the variables are unrelated and therefore unsuitable for structure detection. Small values (less than 0.05) of the significance level indicate that CFA may be useful.

To construct exposure, transmission, and susceptible factors, the weight of each indicators within the factors is obtained using formula:

\[ w_{ik} = \frac{\lambda_{jk}}{\sum_{j=1}^{J} \sigma_{jk}^2} \]  

(3)

Where \( w_{ik} \) is the weight for \( i-th \) indicator of the \( k-th \) factor, \( \lambda_{jk} \) and \( \sigma_{jk}^2 \) respectively are the CFA loading and the explained variance of the \( j-th \) indicator of the \( k-th \) factor.

After the risk factors have been obtained, the weight for each factor for constructing a composite risk index is calculated using Canonical Correlation Analysis (CCA). CCA is the analysis of association between two groups of variables. These variables are then used to construct Canonical Variates which are the weighted sum of the variables in the analysis. Correlation is then being calculated between these variates and between the variables with the variates. For multiple \( x \) and \( y \) the canonical correlation analysis constructs two covariates (equation 4 and 5):

\[ CV_{x1} = a_1x_1 + a_2x_2 + a_3x_3 + \cdots + a_nx_n \]  

(4)

\[ CV_{y1} = a_1y_1 + a_2y_2 + a_3y_3 + \cdots + a_my_m \]  

(5)

In this case, the X are all risk factors and Y are the number of confirmed cases, PDP, and ODP. The canonical weights \( a_1 \ldots a_n \) and \( b_1 \ldots b_n \) are chosen so that they maximize the correlation between the canonical variates \( CV_{x1} \) and \( CV_{y1} \).

The composite risk index is derived from three risk factors, i.e., Exposure, Transmission, and Vulnerability. The weight for each risk factor is calculated by the equation:

\[ w_k = \frac{a_k}{\sum_{k=1}^{K} a_k} \]  

(6)
where, $a_k$ is the canonical weight of the $k$-th factor. Furthermore, early-stage hazard index is constructed from the number of confirmed cases, PDP, and ODP with their corresponding weight obtained from CCA.

The regencies are then grouped into five groups based on 1D K-means method of the risk index. The group is arranged so that it represents the ranks of the region. The higher rank the higher the risk. The risk rank of the regions is visualized in a map.

2.3. Multivariate Multiple Regression

The study also investigates the association between the numbers of cases at initial stages of COVID-19 with all indicators. The initial cases as the dependent variable consist of three variables, number of confirmed cases, ODP, and PDP, hence the most suitable method for this purpose is the multivariate linear regression. Multivariate multiple regression is a technique that estimates a single regression model with more than one dependent variables, i.e., the number of confirmed cases, PDP and ODP. The predictor variables are all risk factor variables. Procedures for statistical inference in the multivariate linear model, however, take account of the fact that there are several, generally correlated, responses. Multivariate multiple regression is the development of multiple regression in which the dependent variable consists of many dependent variables. Multivariate multiple regression is the development of multiple regression in which the dependent variable consists of many dependent variables. We consider modeling the relationship between multiple response variables and predictor variables. Every dependent variable is supposed to follow its own regression model in the same predictors.

$$Y_1 = \beta_{01} + \beta_{11}Z_1 + \cdots + \beta_{r1}Z_r + \epsilon_1$$

$$Y_2 = \beta_{02} + \beta_{12}Z_1 + \cdots + \beta_{r2}Z_r + \epsilon_2$$

$$Y_m = \beta_{0m} + \beta_{1m}Z_1 + \cdots + \beta_{rm}Z_r + \epsilon_m,$$

where $\epsilon = [\epsilon_1, \epsilon_2, \ldots, \epsilon_m]'$ is an error term which has $E(\epsilon) = 0$ and $\text{Cov}(\epsilon) = \Sigma$, the terms of error related with different responses might be correlated. In order to test the hypothesis of no overall effect of each predictor to all dependent variables, multivariate analysis of variance (MANOVA) is carried out. To perform the analysis, and visualization several python packages, such as numpy, pandas, Mapclassify, statsmodels, and seaborn are used.

Statsmodels, a python package utilized for multivariate analysis. The calculation of Canonical and Multivariate Analysis of Variances (MANOVA) had been conducted using this packages. Geopandas, an extension of Pandas modules that had been developed for spatial data manipulation and visualisation. This package had been developed using the Pandas as base packages and enhanced with Python spatial packages (i.e. shapely, fiona, and pyproj). Seaborn, a statistical data visualisation based on matplotlib. This package had been used for visualization and ease the exploration data analysis. In addition, Mapclassify, a python package for enhancing the classification process/data binning for choropleth mapping. This package is a part of PySAL the Python Spatial Analysis Library.

3. RESULT

3.1. Composite Risk Index

The result of Bartlett test ($\chi^2 = 6387.04$, p-value < 0.0001) and KMO (0.84) shows that CFA suitable to be used for capturing the structured of the data. The weights of each indicators on the corresponding factor obtained from CFA is shown in Table 2.

The result shows that all indicators seem to have similar weights. The weight of each factor in constructing a composite risk index resulted from CCA in shown in Table 1. The highest weight is
for the transmission factor, followed by exposure, whereas vulnerability factor has relatively small weight. The weights for early-stage hazard for Positive cases is 0.4285, for PDP is 0.0451 and for ODP is 0.5265.

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Weight (CCA)</th>
<th>Indicators</th>
<th>Weights (CFA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure</td>
<td>0.3994</td>
<td>Population density</td>
<td>0.3328</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of commuters</td>
<td>0.3356</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of foreign tourists</td>
<td>0.3317</td>
</tr>
<tr>
<td>Transmission</td>
<td>0.5434</td>
<td>Number of religious places</td>
<td>0.1452</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of minimarkets</td>
<td>0.1444</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of traditional markets</td>
<td>0.1410</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of supermarkets or malls</td>
<td>0.1437</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of banks</td>
<td>0.14195</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of hotels</td>
<td>0.14194</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of restaurants</td>
<td>0.1417</td>
</tr>
<tr>
<td>Vulnerability</td>
<td>0.0572</td>
<td>Proportion of population &gt;50 years old</td>
<td>0.2026</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of people have comorbidity</td>
<td>0.1938</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Proportion of population who do not have wash their hand well</td>
<td>0.1996</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sex Ratio</td>
<td>0.2130</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Percentage of household with house area &lt; 8 m2</td>
<td>0.1909</td>
</tr>
</tbody>
</table>

Table 2. Weight for Indicators and Risk factors

3.2. Risk Factors Associated to Initial Stage of Reported Cases

Many capitals of provinces such as Jakarta and surrounding cities, and Surabaya have high exposure risk because of higher population density, probability of incoming foreign tourists, and risk of commuter worker. For the transmission risk factor, southern regions of Jawa Barat (West Java) have a high transmission risk, such as Bogor, Sukabumi, and Cianjur. This higher transmission risk occurs because the regions have many public facilities compared to the other regions. This transmission risk can indicate a probability of higher transmission of virus or other pandemic sources. Meanwhile, on the vulnerability risk factor, several regions have higher susceptible degree if pandemic occurs. Several regions located in western of Jawa Timur (East Java) and eastern of Nusa Tenggara Timur.

The map of the regencies based on the rank of composite risk index Figure 1. Note that the choropleth map is created using the cluster of the index values. Values in each bin have the same nearest center of 1D k-means cluster. Hence, the higher the rank (dark red colored), the higher the risk. It can be seen that the higher risk areas are mostly in Java and some parts of Sumatra. Several regions, mostly are province’s capitals, have higher risk score such as Jakarta, Surabaya, Bandung, Makassar, Medan, and Denpasar. Moreover, their neighboring cities such as Bogor, Bekasi, Tangerang, Sidoarjo, Cianjur, and Garut have a moderate risk score.
Figure 1. Mapping of Composite Risk Factor

Figure 2 present scatter plot of Covid-19 hazard against the risk factor all over Indonesia. It shows moderate correlation (0.695) between the composite risk factor and the initial reported cases (hazard). We observed that most of the initial confirmed cases are in Java. If we focus only for Java, the result show higher correlation 0.794. This is due the fact that at early stage of COVID-19 pandemic, regencies in Java are mostly affected with more cases compared to other regions.

Figure 2. Scatter plot of risk factors against initial stage of covid-19 hazard in Indonesia

Figure 3 shows the composite risk factors of regencies in Java. The areas with higher exposure are the Jakarta Metropolitan (Jakarta, Bogor, Bekasi, Depok, Tangerang, and Tangerang Selatan) followed by other capitals such as Bandung, Semarang, Yogyakarta and Surabaya. These regions are business and governments area with high population density, large number of commuters, and international exposure. Whereas, the transmissions and vulnerability factors are more widespread, not only centered at the capitals or main cities. Higher risk regencies or cites are mostly located in the western part of Java.
3.3. Multivariate Regression Analysis

Some variables affect response variables differently. For example, confirmed: number of traditional markets and mini markets seem do not significantly related to the number of confirmed cases. Whereas, the number of ODP is only significantly related to the number of traditional markets, number of malls, and the proportion of population >50 years old. In addition, the number of PDP is not affected by the number of malls and mini markets. The results of MANOVA to test the overall effect of each indicator to all three dependent variables are presented in Table 3.

It shows that most of the variables of exposure risk factor are significantly associated with the number COVID-19 initial cases (confirmed cases, ODP and PDP). For the transmission factor, most of the indicators are also significant. Whereas, for the vulnerability factor only the proportion of households with house area < 8 m² is in statistically significant, and the proportion of population >50 years old is on border line.

4. DISCUSSION

The study shows that the highest composite risk score is Bekasi city, followed by Bandung, South Jakarta (Jakarta Selatan), Jakarta Barat (West Jakarta), and Surabaya. The top 10, except Bandung and Surabaya, are regencies included in the Jakarta Metropolitan Area. This shows substantial influence of international exposure on causing initial cases. This is why Jakarta Metropolitan area have the first outbreak and became the epicenter of the COVID-19 pandemic. Moreover, as the main region, with more densely populated and better ability to test and report cases, the number of reported cases grow sharply.
Table 3. Results of MANOVA testing for overall effects

<table>
<thead>
<tr>
<th>Vulnerability</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of population &gt;50 years old</td>
<td>0.0526*</td>
</tr>
<tr>
<td>Proportion of people have comorbidity</td>
<td>0.7442</td>
</tr>
<tr>
<td>Proportion of population who do not have wash their hand well</td>
<td>0.1323</td>
</tr>
<tr>
<td>Sex Ratio</td>
<td>0.8752</td>
</tr>
<tr>
<td>Percentage of household with house area &lt; 8 m²</td>
<td>0.0403*</td>
</tr>
</tbody>
</table>

*Significant at α=5%, ** Significant at α=10%

Notably, Bandung, Yogyakarta and Surabaya are cities that exhibit relatively high composite risk factor score. However, they have not seen the high levels of reported cases. This may show two possible explanations, the relatively effective efforts to contain the spread of the virus, or lagged reporting of cases. These regions are the main regions of five COVID-19 pandemic hotspot provinces in Indonesia, namely, Banten, DKI Jakarta, West Java, Central Java, and East Java reported by Eryando et. al. (2020).

Furthermore, multivariate regression analysis shows that the number of reported cases (confirmed, ODP and PDP) for the onset of COVID-19 in Indonesia are mostly affected by the exposure factor (international exposure, population density, and people mobility), and transmission factor (e.g., number of banks, hotels, and restaurants).

Population density has been reported to be influence the propagation of COVID-19 in several countries such as Bangladesh and Turkey. Furthermore, several studies in different countries shows that people mobility is one of the key factors for the transmission. In addition public spaces, such as offices and other places are reported to be key of transmission. Hence reduction of people mobility and number of visits to public places is substantial in reduction of the spread of COVID-19.

In this study, the number of reported cases may only reflect part of the visible problem, as it depends on the number of COVID-19 testing. The unidentified and unreported cases of COVID-19 may be more widespread as reported. It is either due to the lack of staff confidence in the initial handling of the reports or because of the overwhelmed data management structure at the local governments.

Furthermore, the composite index score was correlated with number of COVID-19 cases in different cities and regencies in Indonesia. The number of cases could vary across the regions depending on the level of restrictions imposed (mobility, lockdown etc.), COVID-19 surveillance system (testing, tracing, treatment facilities etc.) in the country.

Our study is focused on the early stage of pandemic where there are lack of pandemic management and policy. The result may not be directly applicable for currently situation where the pandemic management have been greatly improved and the policy is also much better. Our finding can be used as a basic of current or future risk factors development by updating the data and also adding more variables into the risk composite index. The inclusion of other more granular and real-time variables such as weekly mobility based on mobile phone, and GPS tracking (from volunteer with informed-consent) can greatly improve the quality and timeliness of the risk index.
5. CONCLUSION

The study has shown strong correlation between the exposure, transmission and vulnerability risk factors and the number of COVID-19 cases at the initial stage of pandemic in Indonesia. The influence of population density, percentage of people commuting, international exposures, and number of public places which prone to COVID-19 transmission are mostly affecting higher number of cases. Large regencies and cities, mostly in Java, have high risk score. The largest composite risk score are regencies included in the Jakarta Metropolitan Area. However, the number of reported cases and people under surveillance may be driven by the testing capacity and ability to trace the suspects. The subsequent phases are likely to include people mobility, the impact of large-scale restrictions in some areas, the local government actions, and also health capacity, such as number of COVID-19 referral hospitals, number of paramedics, number of ventilators, number of laboratories and its testing capabilities. The areas with low health capacity may suffer severe outbreaks. It is important to not only focus on regencies with high composite risk (e.g., densely populated cities), but also to the area where people tend to move from the epicenter due to economic reasons.

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CONNECTING THE DOTS IN NUTRITIONAL REHABILITATION: A QUALITATIVE STUDY ON ICT AND COMMUNITY BASED CARE

Deepa Austin, International Institute of Information Technology, Bangalore, deepa.austin@iiitb.ac.in
Amit Prakash, International Institute of Information Technology, Bangalore, amitprakash@iiitb.ac.in

Abstract: ‘Fragmentation in care’ continuum is often considered as a shortcoming of Health system whereas, ‘Integration of care’ is widely acclaimed as a viable solution to fragmentation. In last two decades, Information and communication technologies (ICTs), by virtue of their ability to integrate information for action, has been extensively used in addressing many public health problems like malnutrition. Tackling the public health challenge of malnutrition demands attention to interconnectedness and interactions between multiple systems. In this paper, using a case study of an ICT application used by community workers for malnutrition management in Karnataka, we argue that lack of recognition of interconnectedness and interactions among stakeholders and context can pose a challenge to integration of care. ICTs can be key enablers to overcome fragmentation, provided it recognizes the inherent complexities of malnutrition and its management. We argue that for an effective ICT enabled integration of Severe Acute Malnutrition (SAM) management, a thorough understanding of perspectives of multiple stakeholders together with rich picture of the contextual dynamics should not be ignored at design and implementation phase.

Keywords: Fragmentation, Integration, Complexity, ICT, Malnutrition

1. INTRODUCTION
Information and communication technologies (ICTs) are considered as key catalyst for change towards integrating information for action(Walsham, 2020). In the last two decades, ICTs has had a profound influence on health system, by connecting the otherwise fragmented system into a more integrated one(Srivastava et al., 2015). ‘Fragmentation in care’ often cited as one of the shortcomings of current health system, has been defined as “systemic misalignment of incentives, or lack of coordination, that spawns inefficient allocation of resources or harm to patients, adversely impacting quality, cost, and outcomes”(Enthoven, 2009). The advancements in science and technology has led to greater specialization and a “silio approach” in health system, weakening its inherent integrated nature. While fragmentation in care arises from lack of interaction among stakeholders and systems, ‘integration of care’ on the other hand acknowledges this and appreciates the inherent complex nature of health systems(Braa et al., 2017). However, the distorted understanding of dependencies and interactions among multiple systems embedded in their respective contexts poses a challenge to integrated care continuum. This research is focused on understanding the usage of ICT applications in attending to challenges in integrating the health services for managing Severe Acute Malnutrition (SAM) in Karnataka, India.

Public Health challenge of Malnutrition has a complex nature, characterized by interconnectedness and interactions among many systems. Management of malnutrition demands attention to the ‘Whole’ calling for a perspectival change from a fragmented to a more holistic approach(SPRING, 2015). A recent study has shown that COVID-19 crisis has aggravated the scenario resulting in an
estimated increase of 14.3% in child wasting globally (Headey et al., 2020). It is therefore estimated that with 47 million children globally (under 5 years of age) affected by wasting before pandemic, an additional 6.7 million children would be added during the first 12 months of the pandemic accounting to an estimated 10,000 additional child deaths per month during this same period. According to this study, Sub-Saharan Africa and South Asia could be the worst affected region. Condition is no better in India, as NFHS-5 data (2019-20) showed that state of Karnataka has 35.4% of stunting, 19.5% of wasting, 32.9% of underweight and 8.4% of severe wasting among children under 5 years of age (National Family Health Survey (NFHS-5), n.d.). India is yet to assimilate the immediate, intermediate and long term effects of this pandemic on malnutrition status, however, building up resilience in all spheres of intervention strategies remain crucial. The interwoven nature of people, resources and organizations that are characteristic to health systems should possess resilience to cope up with such unprecedented situations. Under such circumstances, it becomes more relevant to strengthen the call for a multi-sectoral approach initiated by Indian National Nutrition Mission to ensure a holistic continuum of care with an ICT enabled Nutrition Information System for tracking and monitoring the entire process (POSHAN Abhiyaan, 2018).

A participatory action research (PAR) coupled with an agile methodology to design and develop software applications for nutritional rehabilitation was taken up at E-Health Research Centre of IIIT-Bangalore from September 2018, in collaboration with a technology team (CSTEP) and Nutritional Rehabilitation Centre (NRC) at a medical institution in state of Karnataka. The overall objective of this project is to ‘Track and Manage Severe Acute Malnourishment’ (SAM) through community-based care centers (Anganwadi(AWC) and Primary Health Centre(PHC)) and facility-based care centers attached to hospitals(NRC). The initial phase of this research (Sept 2018 till Dec 2019) studied two processes—referral process of SAM children from AWC to PHC/NRC (using ethnography) and follow-up process from NRC (using in-depth interviews). The findings are used in the design and development of an integrated digitized platform for SAM management connecting community and facility centers. By June 2020, a web-based platform for NRCs across the state of Karnataka was successfully launched and is functioning at its best. For this paper, we have put together the findings from the referral processes. The findings of this study contribute to the knowledge that ICTs can be key enablers to overcome fragmentation, provided it recognizes the inherent complexities of malnutrition and its management. We argue that for an effective ICT enabled integration of SAM management, a thorough understanding of perspectives of multiple agents together with rich picture of the contextual dynamics should not be ignored at design and implementation phase.

2. THE COMPLEXITY OF HEALTH SYSTEM

Before we delve into the problem of malnutrition, it is essential to understand the complexity science of health system in general. World Health Organization defines a health system as a “system that consists of all organizations, people and actions whose primary intent is to promote, restore or maintain health”. It aims at improving health and health equity in ways that are responsive, financially fair making the best use of available resources (de Savigny et al., 2009). The components of health system interact non-linearly over multiple scales, rendering the system more dynamic nature with unpredicted outcomes. This is in contrast to mechanical systems with well-defined boundaries, in which component parts interact linearly and manipulation of each part is expected to produce a predictable output (Plsek & Greenhalgh, 2001). Kuipers et al. conceptualized the health system complexity under three main headings: Medical Complexity encompassing the spectrum of illness to wellness, Situational complexity that takes into consideration personal factors (age, gender, race, Socioeconomic status, Education, cultural factors), physical, social and other environmental factors influencing health (Pim Kuipers, Elizabeth Kendall, et al., 2011). The complex interplay of medical and situational complexities leads to geometric progression of system complexities. System complexities include service fragmentation, critical decision making, uncoordinated practice management, ethical dilemmas, commercialisation and commoditisation, improper budgeting, unparalleled prioritization, over impacting technological determinism, inappropriate health policies
and regulatory framework and most importantly, lack of humanitarian values (Greenhalgh & Papoutsi, 2018; Safford et al., 2007).

Complexity in health systems is attributed to interconnectedness and interactions between multiple agents acting across systems (Braa et al., 2017). Considering the intertwined nature of health system, it is appropriate to consider it as a complex adaptive system in which a collection of individual agents (human and non-human) with freedom to act in ways that are not always totally predictable, and whose actions are constitutively entangled so that its influence on each other is mutual (Orlikowski, 2007; Plsek & Greenhalgh, 2001). Such thinking in systems perspective can offer a thorough understanding of multiple interacting agents together with their contexts in a comprehensive way, thus helping to anticipate synergies and mitigate negative emergent behaviors.

3. THE PROBLEM OF FRAGMENTATION AND ITS SOLUTION

World Health Organization recognizes fragmented care as one of the five common shortcomings of current healthcare delivery system. (World health report, 2008). Fragmentation in care continuum fails to acknowledge the interconnectedness and the resultant interactions in complex health system.

Stange in his interactive series on ‘the problems in fragmentation’ narrates a situation in which a patient is moved from specialist to specialist, each of them studying in-depth the organ in which s/he is an expert, passing through the latest of the tests, prescribing the best medicine, ultimately feeling desolate and fragmented ending with fatigue. He then quotes “Healing requires relationships—relationships which leads to trust, hope, and a sense of being known. Increasingly our health system delivers commodities that can be sold, bought, quantified, and incentivized. While the whole—whole people, whole systems, and whole communities—gets worse”(Stange, 2009).

Hence, due acknowledgement of these interconnectedness and relationships becomes indispensable.

The problems of fragmentation in care identified by Stange includes ‘inefficiency’ in rendering wholesome efforts to prioritization of needs using available resources, ‘ineffectiveness’ in achieving a comprehensive, universal, equitable and affordable healthcare service to all. This paves way to health ‘inequality’ and inequity favoring the inverse care law by Hart (Hart, 1971). When thick strands of relationships woven on trust and care are replaced by thin strands of profit and gain, healthcare systems struggle to survive. Short term goals increase ‘Commoditisation’ and ‘Commercialisation’ leading to ‘deprofessionalization’ and ‘depersonalization’ further weakening our health system. The end result would be ‘despair and discordance’ with the system.

A viable solution to fragmented care is ‘Integrated care’ as it has the potential to facilitate interconnectedness. Integrated care drives the health system from a disease-oriented to a more person-oriented service sector, integrating the right mix of innovations and social care, coordinating and administering it through strategic management approaches. Though there is no unifying definition for Integrated care, it is often used synonymously to terms like coordinated care and seamless care(Kodner & Spreeuwenberg, 2002; World health organization, 2016). Such integrations can be brought about at organizational, functional, service or clinical level.

4. NUTRITIONAL REHABILITATION SERVICES

Government of India (2018) targets to reduce stunting, under-nutrition, anaemia and reduce low birth weight by 2%, 2%, 3% and 2% per annum respectively by year 2022. Nutrition rehabilitation requires a life cycle approach rooting in early preventive action, supplementary nutrition, sanitation and education on health and hygiene. At community level, greater emphasis on valuing, recognizing and enhancing contribution of Anganwadi workers(AWWs), and their empowerment is envisaged in POSHAN Abhiyaan. Under the flagship of Integrated Child Development Services by Ministry of Women and Child Development (MWCD), Screening for malnutrition and Supplementary Nutrition programme is being implemented through Anganwadi Centres(AWCs) for addressing under-nutrition in pregnant and lactating women and under-6 children. The Nutritional Rehabilitation Centres(NRC) are facility-based care units that can be fitted into the chronic care
model of integrated care where, SAM children below six years are admitted with their mothers for treatment, stabilization and rehabilitation. Timely interventions and continued monitoring can prevent deaths due to SAM (Aprameya et al., 2015). This requires a continuum of care streamed through NRCs for SAM children with medical complications and community-based care for those without medical complications.

5. THE INTEGRATED MODEL OF SAM CARE

AWWs carry out regular growth monitoring at AWCs. If the child falls low on nutritional indicators consecutively for 3 months, they are referred to nearest PHC. For patients with no associated co-morbidities, treatment and medication are given from PHC. In case, In-patient care is required then they are referred to NRC. After the condition improves, the patient is sent back to the community. In ideal case, follow-up should occur until the child is out of malnutrition cycle. The Figure 1. depicts the integrated model of care in Karnataka.

![Figure 1. Nodes for Integrated SAM care in Karnataka](source.jpg)

6. RESEARCH DESIGN

This research is part of a larger action research project trying to address the problem of SAM through an ICT enabled continuum of prevention, cure, rehabilitation and follow-up by connecting and integrating various service locations like AWCs, PHCs and NRCs. Although PAR is the methodology for entire project, ethnography was used in this study for two reasons- firstly, it was part of academic requirement for the researcher (a female doctoral student at IIIT-B), secondly, a multi-sited and comparative ethnography was the best choice of methodology towards the objective of understanding daily work practices of AWWs towards addressing malnutrition as well as understanding the perceived and the actual role of ICT in facilitating and integrating the care continuum[here, a mobile based application used by AWWs - SNEHA (Solution for Nutrition and Effective Health Access)]. The field observations were conducted from March 2019 to May 2019.
The findings from this study were later incorporated in the framework on ‘challenges in integrating nodes of care delivery’ and were considered during design, development and implementation of the entire project. The Institutional Review Board approval for the study was granted by IIIT- B. Prior to commencement of the study, permission was sought through email from respective authorities.

Informed oral consent: The interviews were conducted in person by the researcher under oral consent, in preferred language of participants (with the help of an interpreter for those participants not eloquent in English/ Hindi). The purpose of the study was explained in a manner that they could understand. Audio and video recordings were done with permission. Participants were informed that they were free to withdraw from interviews or from study whenever they wished. In this study, no one refused.

Sampling: A purposive sampling was done and four AWCs were selected as study settings. One anganwadi where SNEHA application was first piloted in Karnataka (May 2018) was selected for two reasons—provided sufficient time to understand the functioning of SNEHA and had large beneficiary numbers that allowed us to understand challenges in data handling. Three other AWCs working in conventional way without using SNEHA but within the vicinity of the first chosen AWC allowed us to have better comparison as the contextual dynamics almost remained the same. Observations and interviews were carried out until data saturation achieved.

<table>
<thead>
<tr>
<th>Data collection techniques</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immersive participant observation (12 weeks)</td>
<td>The daily work practices of AWW teachers (4 in number aged between 35 to 50 years) and helpers (4 in number aged between 30 to 40 years) were observed by the researcher through the study period. Other participants observed included beneficiaries of ICDS, Auxiliary Nurse Midwife (ANM) and Accredited Social Health Activist (ASHA), Male health workers and beneficiaries of Anti-natal and post-natal services, who visited the AWCs</td>
</tr>
<tr>
<td>Informal interviews (15 to 30 mins, 20 interviews)</td>
<td>wherever required for better clarifications relating to work practices</td>
</tr>
<tr>
<td>Intensive interviewing using interview guide (90 to 120 mins, 7 interviews)</td>
<td>Of AWW teachers and helpers to understand their roles towards malnutrition and their perceptions on SNEHA application. Interviewing of technology developer to understand the challenges during/after roll out</td>
</tr>
<tr>
<td>Archival enquiry</td>
<td>walked through manual registers and SNEHA application to understand the recording and maintenances practices.</td>
</tr>
<tr>
<td>Physical traces</td>
<td>of growth charts, posters were assessed to understand the work practices.</td>
</tr>
</tbody>
</table>

Table 1. Data collection techniques used

A field journal was maintained to note down observations and reflexivity of the researcher on a daily basis. All the interviews were transcribed in English along with notes of observation. Major findings were orally discussed with the participants. The field journals were sifted systematically through close reading by researcher, manual open coding, memos and thereafter focused coding and integrative memos to arrive at final themes from the data. For this paper, we have used only those findings relevant to challenges in integration.
7. **SNEHA application**

SNEHA is an android application for AWWs launched by Centre for Study of Science, Technology and Policy (CSTEP) under the expert guidance of Department of Women and Child Development (DWCD), Karnataka. The application currently works on Samsung J5 Series Android 7.1.1 provided by DWCD whereas mobile SIM card is given by CSTEP. The front end is pure native Android with the middleware Java programming language. Current back end is Postgres, but considering the scalability in future, discussions are on to move with Microsoft SQL server. Data base is currently local to CSTEP, but discussions are on to move it to cloud owned by Government of India.

<table>
<thead>
<tr>
<th>User interface of SNEHA mobile application (at the time of the study)</th>
<th>Objectives of SNEHA mobile application</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Child services</strong> include daily attendance, daily nutrition, height, weight, Middle upper arm circumference (MUAC), immunization details and other derived parameters for identifying stunting, wasting and severe acute malnourishment (SAM) which are colour coded for easy identification.</td>
<td>1. Maternal and child health management (connecting the health registries of mother and child and integrative referral services made accessible across the country)</td>
</tr>
<tr>
<td><strong>Mother service</strong> includes Mathru-poorna, Thaayi card details, RCH id, Growth status, ANC/PNC, incentives (Mathru-Vandana), tracking options.</td>
<td>2. Multi-sectoral process integration (integrate the activities of DWCD and Ministry of health and family welfare)</td>
</tr>
<tr>
<td><strong>Special services</strong> include census survey details, any special national program related details like pulse polio</td>
<td>3. Multi-system data entry (digital solutions to multiple registers maintained by an AWW)</td>
</tr>
<tr>
<td><strong>Anganwadi corner</strong> details out priorities to be carried out day to day as well as monthly basis and a trouble ticketing system, where an AWW can voice out their concerns</td>
<td>4. Inclusive solutions for AWW which intends to ease out their daily activities and voice out their concerns</td>
</tr>
</tbody>
</table>

| Table 2. Domains in user interface of SNEHA and Objectives of SNEHA application |

8. **MAJOR FINDINGS**

8.1 **The social proximity and acceptance of AWWs in the community they serve and their role in mediating the activities towards health in general.**

The researcher observed the daily work routine of AWWs like imparting informal education through songs, acts and games, their interactions with children, record keeping, use of digital devices, inventory maintenance, growth monitoring, nutritional supplementation for children and pregnant ladies, information transfer on government schemes to adult beneficiaries, conducting awareness sessions etc. Major findings from researcher’s observations were

1. Being selected from the local community and designated as ‘community worker’, an AWW has close social ties with the community they serve.
2. This helped them to gain better acceptance among the community in terms of understanding their medical needs and appropriately directing them to avail medical services.
3. An AWW could bridge the gap between the culture of community and culture of medicine by mediating and exercising information transfer in terms of health check-ups/referrals/follow-ups and nutrition awareness sessions.
4. It was observed that reminder calls and oral alerts were given to those who missed out routine immunization services, growth monitoring services and ante- and post-natal care. The data from an AWW would serve as an alert for health department to plan for preventive strategies.
5. By virtue of their social proximity and community acceptance, an AWW could offer the best foster care for a SAM child.

8.2 Diverse roles to be exercised

An AWW maintains around 11 prescribed paper-based registers centered around their job responsibilities.

One of the AWW’s who never used SNEHA remarked that her time was mostly wasted in finding the right register to enter the details. Some of these entries were often postponed and carry forwarded to home, so that she could give more attention to children at AWC. At home, she could do the entries with minimal disturbance and limited errors. But, while doing so, there were chances that some details get missed out. Issues of duplication of data entry for immunization was observed as both AWWs and ANM recorded and maintained the same details in two different registers- for AWC and PHC. Another concern was repeated entry of details especially, when a child/ pregnant lady reports back after a long period of absence (generally happens when family migrates to other places of work). Thus, most of the man hours seemed to be spent on manual data entry and back tracking the records. Also, it was observed that a good amount of time was spent on explaining the documents required for various government schemes like Thaayi card, Aadhar card etc. and their follow up with adult beneficiaries. Information exchange was also carried out over telephonic conversations. There were challenges as to inadequate space to maintain the registers safe, issues of power outage and poor network connectivity for making phone calls.

When asked about the use of SNEHA to a regular user, she replied “Overall, the app is good and easy to use. I can choose the language according to my comfortability, many are using Kannada. But to me, I like to use English. That way, I can learn some new words in English. When I type, I feel error is less and that makes me confident. I just need to enter the height and weight. It shows some colored graph. I don’t have to go after the papers (referring to growth chart).” It is interesting to note that while most of HCI researchers advocate the use of different languages in the interface for better accessibility, it may not be the only value attached to it. According to this AWW, SNEHA application not only has made her data entry easy, but also instilled confidence in her by reducing the errors in recording data and helped her to use a language that she wanted to learn.

Here is an excerpt of an interview with technology developer of SNEHA, “99% of the AWW’s are happy with the application. They say it is easy to use. Within seconds they get access to the data pertaining to their AWC. One of the greatest challenges that we faced was the internet connectivity. Later, based on the signal strength, the best network service provider was chosen. We are planning to go offline too.”

While SNEHA has eased out some of the daily tasks like attendance, back tracking of data, yet some challenges were observed by the researcher pertaining to the context in which the application was to function like infrastructural inadequacies and need for digital skilling. SNEHA was generally handled by Anganwadi teacher. In case the teacher goes on leave, daily activities may not be updated due to two reasons- mobile phone with application was not made available with helpers and lack of knowledge of data entry by helpers.

8.3 Activities towards SAM assessment- Anthropometric measurements

Growth monitoring is an essential activity towards nutritional status assessment of a child. The field visits gave the researcher a grim picture of inaccuracies in anthropometric measurements (weight and height measurement). A spring hanging scale (SALTER) that can weigh up to 25 kg and is graduated by 0.1kg (100g) increments was used to weigh children. Out of four AWCs, three of them lacked calibrated weighing scales, had torn weighing pant bags in which children were placed to be weighed. Two AWCs had torn height scales on their walls. None of the AWCs had infantometer
and electronic weighing scales to measure weight of infants. These challenge the very purpose of active screening of children below 2 years.

AWWs who were not using the mobile application did not record the main diagnostic criteria of SAM- the weight/height ratio. When asked, an AWW replied “This is relatively new measurement, we are used to weight-for-age criteria. Our supervisors have not asked us to use the new standards. Wt/Ht ratio requires some calculation (dividing Wt/Ht to find ‘Z’ scores).” It is important to make a note here, that three AWCs without mobile application did not report any case of SAM, whereas AWC using SNEHA reported 4 children falling under SAM category. It can be inferred that SNEHA has been instrumental in making use of right indicator towards right diagnosis.

When asked to demonstrate, all four AWWs showed height measurement process by making the child stand straight. Two of them made the child lean against the wall. Others did by making them stand wherever they were. When the researcher took the measurement in the WHO prescribed way, by making the child lean against the wall with head, shoulder, buttocks and heels touching the wall, their measurements differed by 2 to 4 cm. This would alter the weight/height ratio (Wt/Ht), a strong indicator of SAM. Wrong measurements led to wrong entry and diagnostic errors in identifying SAM children and adversely affecting the health of such children. Again, this brings us to the understanding that mere digitization cannot rule out wrong diagnosis.

8.4 Referral of SAM

When enquired about the referral processes to PHC, an AWW replied, “..if the child remains underweight for three months, then we refer. We take the paper records of last three months (ht, wt recorded and food given) along with us to PHC. If a child doesn’t need hospitalization, then a counselling session is given to parents on diet related matters by PHC doctor. Medicines are delivered through AWC, and parents collect them. Earlier they had to wait for Rs.2000/- to be sanctioned from DWCD and then buy medicine. The entire process used to take 3 to 4 months’ time. Till then, we would manage the child with food alone. Now medicines are given by the government, still it is a slow process. Takes about three to four weeks’ time. Some vitamins and deworming tablets are provided from PHC. Till we get medicines, we manage by feeding the child with healthy food like egg and milk. If hospitalization is essential, then doctor refers them to nearest NRC.”

When enquired, “Has any of your beneficiary gone to NRC for treatment?” an AWW replied, “Yes, one child had gone to NRC. She used to get flu and fever often. She was referred to NRC from PHC. But, don’t know why? they sent her back. Even the PHC doctor doesn’t know the reason. No instructions given to me regarding her health. She is still weak. I feed her egg and milk daily.” This excerpt clearly shows the current state of disconnect among the AWC, PHC and NRC further leading to fragmentation in services.

8.5 Other issues

Children belonging to APL (above poverty line) category hardly visited the AWCs. In one of the centres, it was told that out of 10 APL children, only 3 had enrolled in AWC. Due to time constraints, this study has not gone in-depth on such issues.

Based on the observations and interviews, a summary of challenges in integration is given below (Table 3.)
<table>
<thead>
<tr>
<th>Challenges in integration</th>
<th>Nodes of integrated care delivery</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Process challenges</strong></td>
<td>AWC: gaps in referral, follow ups, Duplication of activities, inadequate active screening, APL category not recorded, issues with migration</td>
</tr>
<tr>
<td></td>
<td>PHC: gaps in referral, follow ups, Duplication of activities, no data base of APL</td>
</tr>
<tr>
<td></td>
<td>NRC: Inadequate community referral, gaps in screening, monitoring and follow ups</td>
</tr>
<tr>
<td><strong>Lack of resources (Physical and technical)</strong></td>
<td>Physical space constraints, time constraints, lack of digital devices to connect with PHC/NRC and integrate data (for those not using SNEHA), network connectivity issues, lack of calibrated devices for Ht, Wt measurements, financial constraints</td>
</tr>
<tr>
<td><strong>Challenges in integration</strong></td>
<td>AWC/NRC to monitor and provide feedback, time constraints, network connectivity issues</td>
</tr>
<tr>
<td><strong>Individual level inadequacies</strong></td>
<td>Difficulty in connecting with AWC/NRC to monitor and provide feedback for the discharged patients</td>
</tr>
<tr>
<td><strong>Policy gaps</strong></td>
<td>Difficulty in connecting with AWC/NRC to monitor and provide feedback for the discharged patients</td>
</tr>
<tr>
<td><strong>Regulatory challenges</strong></td>
<td>Difficulty in connecting with AWC/NRC to monitor and provide feedback for the discharged patients</td>
</tr>
<tr>
<td><strong>Functional challenges</strong></td>
<td>Inadequate trainings resulting in errors in measurement, Incorrect awareness about significance of nutritional indicators, Need for digital skilling</td>
</tr>
<tr>
<td></td>
<td>Inability to carry out follow ups (attributed to lack of resources)</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
<td>No uniformity in the standards used for assessment of malnutrition, Changing indicators, inadequate follow-up policies</td>
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<td></td>
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</tr>
</tbody>
</table>

Table 3. Summary of Challenges in integration

8.6 Perceptions about SNEHA held by AWW’s not using the application

“Heard that she (AWW with SNEHA) is been given a better phone and sim card. The other day she showed me that and was telling it was easy to use. She marks the attendance in the phone. The best thing is... You just need to put the height and weight. You don’t need to do any calculation or cross checks with growth charts. It automatically gives the color tab to show the SD. It is time saving. We are waiting to use this phone with app.”
From this study, it can be understood that the perceived usefulness (PU) [the degree to which they consider this application can improve their performance] and perceived ease of use (PEOU) [the extent to which physical efforts required to use this application] seemed to be relatively high. For those who were not given this application, they considered it to be time saving and less of effort. The amount of time spent on finding the right book, drawing separators on it, maintaining and replicating it to consolidate for monthly reports and safeguarding them in their limited space was a great concern for AWWs. However, they feel that the chance of erring while cross checking with the growth chart also would be minimal when they use SNEHA app (PU). If they need to be using the new standards, then this mobile app could ease out their work as they were told that they need to input only height and weight (PEOU). Rest would be taken care by the device. To these AWWs who were using simple feature phones, android phone with all these applications was a matter of pride (A). However, it was also brought to the notice of the researcher that senior AWWs were slow on their input skills on mobile keypads. According to Davis Technology acceptance model (TAM), the actual system use is determined not only by PU and PEOU but together with the interplay of external variables in the context of functioning (Davis & Davis, 1989; Venkatesh, 2000). In this use case, effective and sustained use of SNEHA by any AWW is dependent on the external variables identified through ethnography and listed in Figure 2.

![Figure 2. Applying TAM model](image)

It can be inferred that the intention to use of such digital applications does not solely lie on usability and functionality features, rather the context in which they are to function also deserves special consideration in design, development and implementation. Nonetheless, such application in itself end up as yet another fragmented service.

9. DISCUSSION

We began with the premise that integrated care is the solution to overcome fragmented care and ICTs can be key enablers for integration of services. The use case of SNEHA in community-based SAM management throws light on the fact that digitization of an exact replica of paper-based system would not support integration of care unless the complexities in the context are not addressed. For an effective integration of care, there should be means of communication and information exchange of quality data between the nodes of care delivery, in this case between AWC, PHC and NRC. Ethnographic approach used in this study helped to understand the dynamics in natural settings and work practices of AWWs towards malnutrition management. Being the representatives of local community and the social proximity of the AWWs with their beneficiaries, they do exercise a significant role in understanding the community health needs, mediation of information exchange.
between health authorities and ensuring appropriate community based mitigatory measures. This finding is in agreement with another study on positive and impactful role of AWWs in articulating people’s voice in the design and implementation of government policy and program (Prakash, 2015). The study has identified some of the contextual disconnects that results in ‘fragmentation in care’ for SAM management, even when the digital system is in place as listed in Table 3. Although, SNEHA anganwadi application has considerable achievements ‘in silos’ towards its objective of easing out daily activities of AWWs, its potential ability to address a complex problem like malnutrition can be harnessed by acknowledging the contextual dynamics like infrastructural deficiencies, resource constraints, ways and means to fix up process gaps, flexibility to accommodate the changing standards and appropriate trainings and skilling as required. Each of these contextual variables add to disconnectedness, thereby resultant fragmentation ensues. The qualitative data from this study is in alignment with the quantitative Quick Test Check Study (QTCS, 2014) conducted by NITI Aayog, the results of which says that 24.3% of 10,92,877 AWCs studied presented with problems in manual record maintenance and 41% with inadequate infrastructures. While we acknowledge that perceived usefulness and perceived ease of use of SNEHA application appeared to be impressive, it is imperative to understand that the intention to use would be largely influenced by contextual dynamics. SNEHA application does have the potential to serve as a simple decision support tool for assessment of nutritional indicators, but, with wrong inputs provided, it ends up with misdiagnosis for SAM. Lack of right/ quality data and right connect of care delivery points can disrupt the continuum of care.

During the time of this study, the scope of SNEHA application was limited to Anganwadi only thereby limiting its functionality to mere screening purposes, as there was no information exchange with PHC or NRC for further referral and follow up. Hence, the service offered would still remain fragmented. Moreover, at the PHC and NRC levels, delays in mitigation in terms of functional (procuring medicines) or regulatory (getting sanctions for medical reimbursement) and lack of feedback mechanisms further adds to fragmentation in care. Disconnects between the doctor’s advice during the convalescent period especially after discharge from NRC may cause the child to fall back to SAM category.

Therefore, ICTs when used in such interventions requiring continuum of care should be able to appreciate interactions between the recognized nodes of service delivery. Unless efforts are made to understand the perspectives of the interacting agents at each nodes of care delivery together with contextual dynamics in which such applications are to function, effective integration of care cannot be ensued. Such integrated systems must strengthen their resilience at three levels: a) Human system- in this study, training and skilling essential to AWWs to adapt to changing situations b) ICTs and Information systems- to be agile and accommodative of contextual requirements c) Organizations- to facilitate healthy interactions (Heeks & Ospina, 2018).

Limitation of the study: The research was carried out at a stage where only two domains of the SNEHA application (Child and Mother services) were active. Also, it was rolled out only to limited centres of the state of Karnataka. An overall evaluation of the application was not possible at this phase.

10. CONCLUSION

Integrated care is suggested as a viable solution to overcome the problem of fragmentation in care, one of the shortcomings of complex health systems. ICTs can be a key enabler to such integrations by virtue of their ability to integrate and coordinate information across multiple systems. This qualitative study on AWWs and ICT in Nutritional management, has brought to light the contextual dynamics that can challenge effectiveness of ICT enabled integrated care. Mere digitization of paper-based systems cannot address the larger problem of fragmentation. The findings of the study contribute to the knowledge that unless efforts are made to understand the perspectives of the
interacting agents at each nodes of care delivery together with contextual dynamics in which such ICTs are to function, effective integration of care cannot be ensued.

REFERENCES


AN INTERACTIVE DASHBOARD FOR REAL-TIME ANALYTICS AND MONITORING OF COVID-19 OUTBREAK IN INDIA: A PROOF OF CONCEPT

Arun Mitra, Achutha Menon Centre for Health Science Studies, SCTIMST, India, dr.arunmitra@gmail.com
Biju Soman, Achutha Menon Centre for Health Science Studies, SCTIMST, India, bijusoman@sctimst.ac.in
Gurpreet Singh, Achutha Menon Centre for Health Science Studies, SCTIMST, India, drgurpreet_amc@sctimst.ac.in

Abstract: Data analysis and visualization are essential for exploring and communicating findings in medical research, especially in epidemiological surveillance. Data on COVID-19 diagnosed cases and mortality, from crowdsourced website COVID-19 India Tracker, Census 2011, and Google Mobility reports have been used to develop a real-time analytics and monitoring system for the COVID-19 outbreak in India. We have developed a dashboard application for data visualization and analysis of several indicators to follow the SARS-CoV-2 epidemic using data science techniques. A district-level tool for basic epidemiological surveillance, in an interactive and user-friendly manner which includes time trends, epidemic curves, key epidemiological parameters such as growth rate, doubling time, and effective reproduction number have been estimated. This demonstrates the application of data science methods and epidemiological techniques in public health decision-making while addressing the gap of timely and reliable decision aiding tools.

Keywords: public health data science, covid-19 dashboard, outbreak monitoring, decision support system

INTRODUCTION

As of 15th May 2021, over 160 million confirmed coronavirus infections with over three million deaths across 192 countries were reported worldwide (Dong et al., 2020; World Health Organization Coronavirus (COVID-19) Dashboard, 2021). According to the WHO COVID-19 situation update report on 11th May 2021, India had over 22 million confirmed COVID-19 cases (3 million active cases) with close to 250,000 deaths (Ministry of Health and Family Welfare (MoHFW), India, 2021; World Health Organization & others, 2021). The government’s decision of a nationwide lockdown during the initial phase of the epidemic and its sequential extension resulted in a significant reduction in the total number of COVID-19 cases in India. The effect of lockdown is also reflected by the decrease in the key epidemiological parameters of the COVID-19 outbreak in India (Chatterjee et al., 2020; Das, 2020; Mitra et al., 2020). However, this decrease was variable across different states and districts, which might call for a more cautious approach in the post-lockdown era (Basu et al., 2020). The variation across different geographical and administrative regions also highlights the need for a more tailored approach based on individual clusters and the epidemic phase rather than taking a blanket approach.

The rapid spread of the COVID-19 pandemic has demanded collective action against coronavirus disease on an unprecedented scale (Holmes et al., 2020; Lin et al., 2020; Ohannessian et al., 2020; Wong et al., 2020; World Health Organization & others, 2020b; Zhang et al., 2020). Governments, organizations, institutions, and individuals came up with a vast array of innovations and technological advances in the field of infectious disease epidemiology and vaccine research.
Dashboards quickly became a popular tool to visualize and monitor the coronavirus disease spread and aid in decision-making and implementation of containment measures by tracking the critical epidemiological parameters and studying the transmission dynamics in real-time. A Google trend analysis shows that the keyword “COVID dashboard” quickly rose to peak popularity by the end of March 2020, with many such dashboards with varying degrees of granularity and interactivity developed for various purposes being available online.

1.1. Dashboards for public health decision making

From the general public to policymakers, government agencies, and even corporate to research firms, many actively seek authentic information on COVID-19’s impact on human lives—to stay updated and avoid misinformation-induced panic. Dashboards are tools that help in aggregating data from different sources in real-time and helps in decision making. They are tools to induce transparency in decision-making and explain the policy decision (Head, 2020). Another purpose of dashboards in COVID-19 has been to generate awareness about the case trends, tracking and monitoring the epidemics while guiding in corrective action in a timely fashion.

The applications and use of dashboards in the COVID-19 have been very diverse. These range from monitoring and mitigating preventive measures like social distancing and wearing masks to monitoring clinical trials. In the USA, dashboards were used to offer interactive visualization about the infection rates across different geospatial regions and the use of morgues in these areas. The authors used this tool for both aiding and increasing situational awareness as well as for capacity-building. It also helped the policy decision-makers and program managers to be better prepared for the epidemic and better utilize the available resources to the maximum benefit (Kaul et al., 2020). Dashboards also have been used in monitoring hospital infections and bed occupancy rates in the COVID-19 context as well as aiding in the monitoring of multiple drug and intervention trials (Thorlund et al., 2020). In the Democratic Republic of Congo, a dashboard was created based on the variables collected from street passers about the perceived utility of preventive measures, actual practices, and adherence to mask. This was found to be an effective visual stimulation for daily monitoring (Wimba et al., 2020). The team behind a US dashboard (WATCHERS) argues the need to report trends at the municipality level in order to have a better understanding of the ground reality, which was lacking in the Centre for Disease Control and Prevention reports (Wissel et al., 2020).

1.2. Indian context

There have been several dashboards developed by the Indian government and various state governments (MyGov, 2021; World Health Organization Coronavirus (COVID-19) Dashboard, 2021). A few dashboards for India are developed by the academic institutes (Harvard T.H. Chan School of Public Health, 2020; IIT Delhi, 2021) and by and volunteers (Coronavirus in India, 2021; Covidtracking.In, 2021). Table 1 shows a summary of some of the dashboards relating to COVID-19 in India. Apart from these, there are many other Github repositories, Tableau visualizations, and ArcGis pages that provide many insights on the transmission and impact of the COVID-19 epidemic. Crowdsourced initiatives like WhatsApp working groups and Telegram Folding groups that volunteer to maintain the tracking websites also play a crucial role. One such initiative is a tracking website (covid19india.org) curates count data published in state bulletins and official handles and provides an API for public use of the data. Many research papers, blog posts, visualizations and dashboards use these APIs for fetching the data. This is an excellent example of the benefits of information and communication technology for public benefit. Also, there have been instances where state governments realized the importance of dashboards for monitoring and tracking the
COVID-19 epidemic is an illustration for the use of information technology in health governance (ETGovernment, 2020).

Though many dashboards have been developed with varying levels of granularity for COVID-19, most of the dashboards fail to provide the crucial insights necessary to understand the transmission phenomenon. Barring a few, the majority of the dashboards are descriptive and do not provide additional information beyond case counts and deaths. Some dashboards which provided projections were far from the observed cases. One of the significant limitations of many such dashboards was the lack of domain knowledge. Thus, none of these dashboards have integrated the epidemiological aspects with social-geographical and macro-environmental aspects and have not seen the phenomenon with background susceptibility. Decision-making in public health could be viewed as a complex network of actors, agencies, and technologies with dynamic relationships. Lots of factors influence the decision-making in public health and these can be viewed at different levels (individual level i.e., patient, caregiver, clinician, program manager, decision-maker, policymaker, politician etc.; population-level i.e., sociodemographic variations, geospatial differences, etc.; infrastructure level i.e., health system capacity, health information infrastructure, digitalization of healthcare etc.; policy level i.e., health information use policy, public trust, vision, implementation etc.). This process is very complex and based on many interactions and relationships. Having good quality health information and robust health information systems could enhance the decision-making process. The current COVID-19 pandemic makes the case stronger for the urgent need for a more efficient epidemic tracking mechanism that can provide insights at the district level while also being scalable and reproducible.

OBJECTIVE

In this manuscript, we attempt to demonstrate the application of data analytics, data visualization, and epidemiology to develop an intuitive and interactive dashboard for real-time analytics and monitoring the COVID-19 outbreak in India based on crowdsourced data.

MATERIALS AND METHODS

3.1. Data Source

In India, confirmed cases of COVID-19 and deaths are reported to the Ministry of Health and Family Welfare (MoHFW), Government of India, through the national reporting network. The health authorities of the state simultaneously publish daily bulletins of the same. The crowdsourced database and website maintained at https://covid19india.org curates these bulletins and publishes this data into an application programming interface (API) available for public use. The API includes district-level, state-level, and national-level datasets. The downloadable dataset is updated regularly and contains the latest available public data on COVID-19 in India. The source of the data relating to district level population density was Census 2011, conducted by the Government of India. A compilation of these figures is available from the Wikipedia page, which was scraped using rvest package for scraping hypertext markup language (HTML) and eXtensible markup language (XML) tables. Additional data sources include the Google Mobility Trends data (Google, 2021).

3.2. Variables used in the study

The variables used in the study are the daily caseload, including the confirmed cases, recovered, and deceased. These variables are provided by the API at https://covid19india.org. The population projections for 2020 for each state which were required to estimate indicators such as cases per million, deaths per million, and other relevant indicators such as for testing and vaccinations, were taken from the website of the Unique Identification Authority of India (UIDAI), which is the statutory body established under the Aadhaar Act, 2016 by the Govt of India (Government of India, 2021). Variables on COVID-19 vaccinations are sourced from the Open API provided by the
COWIN portal, which is the official centralized portal for COVID-19 vaccinations in India. Additional variables reflecting the population dynamics, such as the mobility trends at the district level, were taken from the Google COVID-19 Community Mobility Report (Aktay et al., 2020; Google, 2021), while variables providing details on contact tracing, testing, and hospitalizations for the state of Kerala were obtained from the Department of Health Services, Kerala website. These data are provided as part of the daily situation report in the form of a PDF (portable document format) which is then scraped for data using packages such as rvest (Wickham & Wickham, 2016).

3.3. Comparison of Epidemiological Parameters of the First and Second Wave

The epidemiological parameters that were estimated were growth rate, doubling time, and effective reproduction number. A detailed description of the methods on the estimation is provided elsewhere (Mitra et al., 2020). The end of the first wave and the start of the second wave has been defined as the day with the least number of cases after the peak of the first wave. The peak of the first wave was estimated to be 19th September 2020 (95% CI 18th September – 21st September). The valley was estimated to be 13th February 2021. The growth rate and doubling time to the peak of the first wave were compared with the growth rate and doubling time to the peak of the second wave.

3.4. Projections and Validation

For the purpose of the projections of the daily incident cases, we have made some empirical decisions based on some considerations. Taking into consideration the second wave of COVID-19 in India, we thought the best time to freeze the dataset would be 1st May 2021. This was done to include the most recent data but also to avoid any technical or erroneous entries in the recent past, which are usually rectified in a few days. We also decided the number of days for the projection of future incidence to be 15 as any projection beyond two weeks would mean a wide confidence interval and high error rate. Also, as the model is based on the regression of log incidence over time, it would be subject to overestimation as time progresses. We also decided on a 14-day moving average of the daily incident cases for modeling the future projections. For the epidemic simulation, we assumed that the branching process of the probability mass function follows a Poisson distribution.

Based on the considerations provided above, we then divided the dataset into two based on the date, 15th April 2021. The cases before 15th April 2021 were used to estimate the effective reproduction number by the time-dependent method developed by Wallinga and Teunis and improved by Cauchemez and colleagues (Cauchemez et al., 2006; Wallinga & Teunis, 2004). The effective reproduction number of 15th April 2021 was then extracted and provided as a hyperparameter for the epidemic simulation along with the distribution of the serial interval. As already described, we projected for each state the daily incident cases for the next 15 days and plotted against the observed 14-day moving average to check for the robustness of the effective reproduction number and the validity of the projections.

3.5. Implementation

The dashboard was developed using R, version 4.0.4, a free and open-source statistical software, and the RStudio, version 1.4.1106, an IDE interface. Key packages used for the dashboard development were the tidyverse packages, flexdashboard, and shiny. Graphing libraries like ggplot2 and plotly were used to create interactive and 3D data visualizations. Epidemiological analysis was done using the packages, incidence, projections, R0, and EpiEstim. Packages rvest and fuzzyjoin were used to scrape sociodemographic information from the web and enable data linkage. The packages furrr and future were used to optimize the code execution.

We used the package incidence to model the incidence and estimate growth rate and doubling time and package R0 to estimate the time-varying reproduction number (Rt) for different districts. The growth rate and doubling time were estimated by fitting an exponential model to the incidence data.
in the form of $\log(y) = r*t + b$; where $y$ is the incidence, $t$ is the time (in days), and $r$ is the growth rate while $b$ is the intercept or origin. The doubling time is then estimated by dividing the natural logarithm of two with the growth rate of the epidemic i.e., doubling time $(d) = \log (2) / r$. The package *projections* was used to simulate the epidemic outbreaks and project their respective trajectories based on the state-specific transmission parameters. Regression of log-incidence overtime was used to model the cumulative incidence. Then we simulated 1000 probable epidemic outbreak trajectories and plotted the future daily cumulative incidence predictions based on the estimated time-dependent effective reproduction number. The time-dependent reproduction numbers were estimated using the method proposed by Wallinga & Teunis (Wallinga & Teunis, 2004). We substituted the generation time with the serial interval, which was chosen as a gamma distribution as it accommodates the underlying changing number of events. The mean and standard deviation for the serial interval approximations was 4.4 days and three days, respectively. The shape (number of events in a time-step) and scale (the reciprocal of event rate) of the distribution were 2.15 and 2.04, respectively.

### 3.6. Salient Features of the Dashboard

The components of the dashboard include the daily and cumulative estimates at the national, state, and district levels. These are both the incidence as well as mortality estimates such as deaths per million and case fatality rate, which was defined as the ratio between the number of deaths and the number of diagnosed cases. Other epidemiological parameters such as growth rate, doubling and halving time, as well as other indicators. The dashboard also incorporates other databases such as the sociodemographic information from the Census 2011 population estimates. Test positivity rate, tests per million are also estimated and presented in an intuitive fashion. This dashboard is intended to be used by public health stakeholders. A summary of the intended users and the mode of use has been provided in Table 2.

#### Interactivity

The dashboard encourages the user to interact with the data and visualizations and offers a more immersive experience. The dashboard allows the user to select the state of interest and then specify the district that he/she would like to view. The dropdown menu allows for automatic updating based on the state selected. The scale of the axis i.e., linear or logarithmic, can also be specified by the user based on a check box beside the plot. This feature also allows the user to gain better insights into the transmission phenomenon. The three-dimensional graphs also add to the overall interactivity of the dashboard, allowing the user to zoom, pan, and rotate the 3D visualization. The *plotly* library also allows for the districts which are added as traces on the plot to be turned off or on without rendering the whole plot anew, thereby greatly enhancing the user experience.

#### Data Visualization

Data visualization such as epidemic curves, animated plots, time series plots, and 3D graphs have been used to visualize the data. Some of the relationships that were linear on 2D scatterplots show varied non-linear relationship across different geographical regions in the 3D graphs. Also, animated plots using the *gganimate* package allow for the static plots to come to life while increasing their interpretability.

### RESULTS

The full results of the study could be found as a standalone dashboard in the supplementary appendix. The shape of the epidemic curves not only suggests a classic case of a propagated epidemic but also points to the onset of the second wave of COVID-19 infections in India. Figure 1 shows the epidemic curve (daily and cumulative) for India, which clearly suggest the start of the second wave of COVID-
19 infections in India, which is reflected in all the three plots, i.e., a spike in the daily new cases, the increase in cumulative cases and an increase in the Rt has also been noted.

Figure 1: (a) The epidemic curve of daily new COVID-19 cases in India, (b) Cumulative incidence of COVID-19 in India

1.1. Epidemiological Parameters of the First and Second Wave

Almost all the states in India are experiencing a second wave of COVID-19 infections, as seen in the epidemic curve. The epidemic trajectories suggest a variation in the onset of the second wave among the states. Table 3 summarizes the key epidemiological parameters (growth rate, doubling time, peak of the first wave, and end of the first wave). It was found that the growth rate of the first wave (estimated until the peak of the first wave) is lower than that of the second wave. This was found to be true for almost all the states and union territories of India. Also, the doubling time that was estimated for the second wave was found to be lower than that of the first wave.

1.2. Estimation of the time-dependent reproduction number (Rt)

The estimated time-dependent reproduction number (Rt) for India was above the threshold of one (Figure 2.a). Figure 2.b and 2.c illustrate the three-dimensional visualization of the time-dependent reproduction number across different states and districts of Maharashtra, respectively. The findings of the analysis suggest that the R(t) is well above the threshold of one in many states and requires closer monitoring. This also suggests that the second wave of COVID-19 infections in India is still in the exponential phase of the epidemic.
1.3. Projection of future daily incidence for the next 15 days

The below figure (Figure 3) plots the projections of the future daily incidence (red-line) based on previous data (red-bars) against the observed daily incidence (blue-bars). It was found that the log-incidence overtime model performs well in predicting the future daily cases of COVID-19 in India. It was also found that since the estimation of projected cases (15th April 2021), there has been about 5% reduction in the $R(t)$, which can be seen in the second panel of the below presented plot. Similar results were found in many of the states of India, especially where the second wave has started early. However, the model did not seem to perform well in states with fewer numbers of cases (daily incidence < 50 cases), especially in the north-eastern states.
Figure 3: Projections of future daily incidence from 15th April 2021 to 30th April 2021. The projections are represented as a thick red line, while the observed cases are represented as blue columns on the x-axis. The light red columns on the x-axis represent the previous cases based on which the projections are estimated.

DISCUSSION

The current study demonstrates the applications of data science and epidemiologic techniques in tracking and monitoring COVID-19 outbreaks at the district level in India. The dashboard allows the use of scientific methodology and open-source technology to infer from the epidemiologic indicators in an intuitive manner. It not only allows timely information critical for decision making but also provides an interactive interface for the user. Some of the key inferences that can be made from the dashboard tracking COVID-19 epidemic in India are discussed below.

First, the incidence plots suggest the onset of the second wave of COVID-19 infections in India. The growth rate and doubling time have seen a steep increase when looking at the national context. Maharashtra saw a similar trend of increase in the number of cases as well as the key epidemiological parameters in the recent weeks. However, this second wave phenomenon has not yet been observed in all of the states. Also, within Maharashtra, there is a geographical variation across districts in terms of the current magnitude of the epidemic trajectory. This points to the fact that the phenomenon of COVID-19 transmission in India is not homogenous and needs to be looked at in greater detail.

Second, the epidemic trajectory and rate of increase in epidemiological parameters like time-dependent reproduction number, growth rate, and doubling time during the first wave of the COVID-19 epidemic seen last year point to the “flattening of the curve” as suggested by many. In contrast, the rate of increase in the epidemiological parameters at the beginning of the second wave points to the intensity of infections, as seen clearly in the visualization part. Though it may suggest a grim future in terms of the impact of the second wave of COVID-19, this rate of increase may also be
reflective of the responsive health system in terms of testing capacity and active case finding. The relationship between case incidence with population density across different districts also is interesting to note. Also, the association between the incidence and mortality estimates reveals that the relationship is not uniformly linear across the country. Different districts, based on their individual attributes, including sociodemographic variables, have an influence on this relationship.

Third, during the first wave, the capacity for testing and availability of tests have been low as compared to the present. The scaling of testing has been possible through the efforts of both governmental agencies and industry professionals. The regulations on price capping have ensured the affordability of COVID-19 testing in India. This has enabled in the improvement of data quality in the present time as compared to the first wave. The scaling of testing is inferred from the visualizations in the dashboard, but we can also see the relationship between the test positivity rate and the number of tests positives. This could mean that as we are increasing testing, the test positivity rate also has increased. Though the raw data required to make this inference is only available for the state of Kerala, this demonstrates the need to look at testing capacity and test positivity as a key performance indicator for the COVID-19 response. As data quality is fundamental to make meaningful decisions relating to public health, it is also important to acknowledge that health information is not immune from the political influences and strategic aspirations of the government.

The projections of the future incidence seem to provide robust estimates of daily incidence over a 15-day time period. The model performs well in estimating the future incidence in most states. The model overestimated the projections in states which saw an early second wave (E.g., Maharashtra, Uttar Pradesh, Chhattisgarh, Delhi). This could also be due to the relative reduction in R(t) owing to the precautionary measures / public health interventions in these states. The model also performs well in all the southern states, such as Andhra Pradesh, Karnataka, Kerala, Tamil Nadu, Telangana, and Puducherry. The model failed to provide robust estimates for the northeastern states as well as some union territories such as Andaman and Nicobar Islands, Ladakh, and Lakshadweep. This may be due to the fact that there was a lack of adequate data and the daily incident cases were less than 50 per day. The model thus has many limitations as it does not take into account many important factors such as health system parameters, testing information, as well as vaccinations.

All of the aspects discussed above are dynamic in nature, i.e., as knowledge on COVID-19 is being updated every day there is an important need to review the situation on a frequent basis. Conventional methods in epidemiology and complex mathematical modeling approaches require high-quality data with little uncertainty, which might be difficult to come by in a low resource setting like India. The collective action of the community in providing support by curating the official information into an information exchange platform for public use is indeed a very welcoming and appreciative initiative. The collective action of various health departments, academic and research institutions, volunteers from the technology industry, and the general public made immense strides in advancing how health information is communicated.

The current dashboard has a lot of benefits over many existing dashboards available for India that have been discussed in the previous sections, and it also has a few limitations. We acknowledge the controversy of whether the data source is credible or not as a complex issue. Though there is a risk of undercounting new cases or deaths, our main data source has been used by many researchers for modeling COVID-19 in India. We also acknowledge that the application in its current form does not take into account the geospatial, genomic, climatic, or factors relating to population dynamics and variation across the district. We hope to incorporate these variables in the subsequent versions of the dashboard. Some of the districts had to be excluded from the analysis due to some empirical constraints. Moreover, the analyses are not free from the biases linked to the source of information provided at https://covid19india.org. Hence, our estimates might not be an accurate representation of the on-ground reality.
THE ROAD AHEAD

Apart from using the study findings in teaching and academic discussion at various academic and research forums, the authors also intend to use it in the training of district-level program managers. The parent institute of the authors, Sree Chitra Tirunal Institute for Health Sciences and Technology which is under the Department of Science and Technology, has been identified by the Government of India as the Regional Center of Excellence (RoCE) for training in the management of COVID-19 epidemic in India. As part of the training of the district-level program managers of Kerala, the findings of the study would be shared as an interactive dashboard for aiding in decision making. The feedback received would provide insights into user experience and help in the subsequent versions of the dashboard. This could in turn promote data use culture and evidence-informed decision making. We also shared some of the findings of our study with the general public in the form of blog posts to invite citizen participation and public discussion.

CONCLUSION

This dashboard also demonstrates many possible implications to the district, state, and national level program managers and public health decision-makers. It is a proof of concept that fills a significant gap by presenting a set of tools that are useful for updated analysis and visualization of the COVID-19 epidemiological indicators for India at the district level. It also allows for timely inferences to be made that are region and context-specific in nature rather than having a blanket approach for the whole country.
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Table 2: Summary of the intended users of the data analysis

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<th>Intended Purpose</th>
<th>Mode</th>
<th>Updates</th>
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<tr>
<td>1 District-level program managers</td>
<td>Evidence informed decision making; feedback on future improvements</td>
<td>Interactive Dashboard</td>
<td>Real-time</td>
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<tr>
<td>2 Decision makers</td>
<td>Evidence informed decision making</td>
<td>Dashboard</td>
<td>Periodic</td>
</tr>
<tr>
<td>3 Academia and researchers</td>
<td>discussion on methods; peer-review; academic discourse</td>
<td>Dashboard + Methodology</td>
<td>Real-time</td>
</tr>
<tr>
<td>4 General public</td>
<td>Citizen involvement, public discourse, media and information professionals</td>
<td>Website / Blog</td>
<td>Periodic</td>
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Table 3: The epidemiological indicators of the first wave and second wave across different states of India

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<th>Start of Second Wave</th>
<th>Growth Rate</th>
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<td>Second Wave</td>
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<td>0.047</td>
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Guest, J. L., del Rio, C., & Sanchez, T. (2020). The three steps needed to end the COVID-19 pandemic: Bold public health leadership, rapid innovations, and courageous political will. JMIR Public Health and Surveillance, 6(2), e19043.


A SYSTEMATIC APPROACH TO CLEANING ROUTINE HEALTH SURVEILLANCE DATASETS: AN ILLUSTRATION USING NATIONAL VECTOR-BORNE DISEASE CONTROL PROGRAMME DATA OF PUNJAB, INDIA

Gurpreet Singh, Sree Chitra Tirunal Institute for Medical Sciences and Technology, India, drgurpreet.md.afmc@gmail.com
Biju Soman, Sree Chitra Tirunal Institute for Medical Sciences and Technology, India, bijusoman@sctimst.ac.in
Arun Mitra, Sree Chitra Tirunal Institute for Medical Sciences and Technology, India, arunmitra2003@gmail.com

Abstract. Advances in ICT4D and data science facilitate systematic, reproducible, and scalable data cleaning for strengthening routine health information systems. A logic model for data cleaning was used and it included an algorithm for screening, diagnosis, and editing datasets in a rule-based, interactive, and semi-automated manner. Apriori computational workflows and operational definitions were prepared. Model performance was illustrated using the dengue line-list of the National Vector Borne Disease Control Programme, Punjab, India from 01 January 2015 to 31 December 2019. Cleaning and imputation for an estimated date were successful for 96.1% and 98.9% records for the year 2015 and 2016 respectively, and for all cases in the year 2017, 2018, and 2019. Information for age and sex was cleaned and extracted for more than 98.4% and 99.4% records. The logic model application resulted in the development of an analysis-ready dataset that can be used to understand spatiotemporal epidemiology and facilitate data-based public health decision making.

Keywords. Routine data, Data Science, Data cleaning, Reproducible algorithm, open-source software.

1. INTRODUCTION

Routine Health Information Systems (RHIS) includes data that is collected at regular intervals from multiple health facilities including community-level public health centers, public and private hospitals, and other healthcare institutions (MEASURE Evaluation, 2021). These datasets provide information on health status, health services, and resources available for improving the health of populations. The strengthening of RHIS has emerged as a global as well as national agenda in numerous countries for data-driven decision-making. The processes involved in RHIS strengthening are thus looked at from a broader perspective beyond the data collection and entry processes. Harrison et al. suggest five pillars that form the basis of the simplified theory of change in strengthening routine health surveillance data for decision making: governance, people, tools, processes, and evidence (Harrison et al., 2020). The framework provided by World Health Organization to strengthen health systems includes health information as one among the identified attributes of a health system (World Health Organization, 2007). Also, the current existing initiatives such as the “Performance of Routine Information System Management” (PRISM) framework suggested by the Measure evaluation study group addresses many of the current challenges for improving data quality through the data life cycle. Some of the aspects involved in the data life cycle as suggested in the PRISM framework for evaluation of routine health information systems include behavioral challenges, environmental challenges, organizational challenges, and technological challenges (MEASURE Evaluation, 2021).
Good quality data is paramount to the success of health information systems. Generally, data is considered high-quality if it is “fit for [its] intended uses in operations, decision making and planning while representing the real-world constructs it” (Fadahunsi et al., 2019). Data quality of routine health information systems has been a subject of extensive research over the years. Availability of good quality data at timely intervals is critical to data-based public health decision-making (AbouZahr & Boerma, 2005). In addition to social, economic, political, and local contextual factors, multiple factors have been identified at each stage of the data life cycle which affect data quality. The quality of data collected is largely influenced by the level of work engagement, training, and perceived-self efficacy of the individual collecting data. Health system-related factors such as multiple communication channels, increasing variables for data entry, limited health infrastructure, and frequent changes in reporting formats are known challenges to good quality data (Aiga et al., 2008; Glèlè Ahanhanzo et al., 2014).

Advances in Information and Digital Technologies and data science approaches have potential in cleaning and extraction of information from routine large datasets. Routine health information datasets are prepared primarily for administrative and programmatic use. As a result, the data quality standards laid for monitoring data elements are thus bound to be defined differently when compared to those required for research-level datasets. This brings forward the need for data cleaning measures on raw routine datasets before use for research purposes. Inability to identify data anomalies efficiently leads to loss of information, high missing values, and inaccurate outcomes (Maïga et al., 2019; Van den Broeck et al., 2005). A systematic approach to data cleaning is recommended along with transparent documentation, however, there is a dearth of studies that explicitly disclose the steps followed and anomalies detected and corrected during data cleaning (Maina et al., 2017; Wilhelm et al., 2019). Further, it is essential to understand data cleaning as a systematic process rather than a one-time activity. The importance of data cleaning in the data lifecycle is crucial as the resultant data’s quality would not only determine the robustness and generalizability but also allow for data linkage and sensible extrapolation of the study findings (Gesicho et al., 2020; Phan et al., 2020; Randall et al., 2013; Van den Broeck et al., 2005). Adopting a systematic approach to data cleaning would enable the researcher to find anomalies more efficiently and allow for reproducibility and transparency of the data lifecycle (Huebner et al., 2016).

The implications of open-source algorithms using technological advances on the future public health landscape are enormous. The volume of the data that flows through a health system is enormous and ever-increasing. Studies have documented that the data volume in the digital universe is doubling every two years (Oracle India, 2021). Further, data integrity and data consistency have been raised by many in context to the routine health information system (Smeets et al., 2011). Though a lot of light has been shed on data quality assurance and data quality control, these principles are yet to be translated into practice, especially in low-and-middle-income country settings including India. Evidence-informed data-based real-time decision-making by health program managers and data users require efficient data cleaning processes to extract information and knowledge from data. Manually, this process is not standardized, time and resource-intensive, and is often faced with manual omissions and commissions. The development of reproducible algorithms will enable efficient data cleaning on one hand and will provide solutions to numerous challenges which country is facing in terms of estimating the real-time burden of diseases, capacity building, rapid public health decision making, and thus enhanced prevention and control of diseases.

The use of open-source and reproducible algorithms will enable the generation of semi-automated mechanisms for data cleaning and provide transparency to the cleaning process followed. As it is important to study attributes related to the decision-makers such as data use culture, personal believes, and power relations in the organization to strengthen information systems, at the same time, it is prudent to look at the technological challenges when dealing with routine health information systems in the 21st century. The data science approach is useful in achieving this humongous task efficiently and scientifically. This is especially relevant as much of the data collected through the routine health information system currently is in the digital format. The data science approach also incorporates accountability and transparency which are now being realized as
key issues when it comes to the use of health information. Reproducible algorithms can be used for revealing patterns of disease and transform health-related data for public health decision-making.

National Vector Borne Disease Control Programme (NVBDCP) is the nodal program for the prevention and control of vector-borne diseases in India (NVBDCP, 2021). Routine surveillance of vector-borne diseases is being carried out and data is generated from multiple health facilities. Dengue is a notifiable disease in the state of Punjab, India, and line listing of lab-confirmed cases are prepared for detailed epidemiological investigations, administrative requirements, and as decision support for the institution of preventive and control measures. Use of these routine health surveillance datasets to understand spatiotemporal patterns of dengue and linking with routine data from non-health sectors to understand determinants (climatic, environmental, socio-demography, health systems, etc.) will enable an in-depth understanding of dengue situation and development of disease forecasting models. This will strengthen existing surveillance mechanisms, and thus improve the health of the populations. However, for cross-linking of datasets, and the conduct of data analytics for knowledge generation, it is essential to clean the datasets in a manner that analysis-ready datasets are prepared from raw data without losing information. Thus, the present study was conducted to develop a rule-based reproducible and scalable logic model for cleaning routine health surveillance data in India using NVBDCP, Punjab program data as an illustrative example.

2. MATERIAL AND METHODS

2.1. Data source. Routine health care surveillance data provided by National Vector Borne Disease Control Programme, Directorate of Health Services, Government of Punjab, India. The datasets are composed of line listing data of lab-confirmed Dengue cases in the state from 01 January 2015 to 31 December 2019.

2.2. Study variables. The variables extracted from the routine data line list included information on the age of the patient, gender, place of occurrence, type of test performed, testing facility, and dates of testing, reporting, outpatient consultation, admission, and discharge.

2.3. Framework. The present study was conducted using the framework provided by Broeck et al. for data cleaning as a process (Van den Broeck et al., 2005). According to the framework, a data cleaning process is integral to all the components of a study process viz. study designing, data collection, data transformation, data extraction, data transfers, data exploration, and data analysis. The data cleaning process is a logical sequence of screening, diagnosing, and editing. The datasets are screened for anomalies and diagnosed to determine whether the anomaly is a true normal value, true extreme, an error, or undiagnosed with available data. This is followed by editing the data values by correction, deletion, or leaving as unchanged.

2.4. Study design. The data science approach was used for screening, diagnosis, and editing of raw datasets within the broad framework stated above. A reproducible algorithm was prepared which included a query code for screening, check code for diagnosis, and correction code for editing of data. Apriori definitions for valid data values expected range, data type, outliers, and data entry anomalies were created. The raw datasets were then systematically screened using the prepared algorithm for validity, presence of additional information, inconsistencies, strange patterns, and misplaced data in the line list. Once identified, the observed value, expected value, and neighborhood values were compared to confirm the presence of data issues that can be cleaned using the algorithm. All the data anomalies which were diagnosed to be due to apriori definitions were cleaned and data was extracted using an automated algorithm. The data anomalies wherein strange patterns were identified but had implicit valid values, a manual correction was carried out. In case of failure to obtain any valid value, the respective data cell was considered to be missing.

2.5. Logic model. A schematic representation of the logic model used for the data cleaning process is represented in Figure 1. The model imports the dataset and applies a rule-based, interactive algorithm to develop tidy data. The algorithm developed enquires about multiple possible anomalies in the dataset which can be cleaned in a semi-automated manner to extract information, and thus avoid loss of information for the respective variables. Each inquiry was based on the
Detection of string patterns in each reported case followed by an automated correction code on confirmation. The algorithm had subsets of inquiries for each variable and was run on all the cells in a phased manner for the data cleaning process. Data values were standardized by importing as text variables and creating a tidy string variable as the first step of the data cleaning process.

2.6. Operational definitions and computational workflows.
2.6.1. Data cleaning process for date variables. Date information can be analyzed when the date variable is present in a standard date format (e.g. ISO format). The date values were categorized into two types viz “excel-numeric” and “as-typed”. Excel-numeric dates are values defined as values with five characters, all digits, and no separator between digits. As-typed format values varied from a minimum length of 4 (e.g.: “2918” can represent for 02 September 2018) and had variations resulting from the field data entry personnel preferences (e.g.: “04 Jan 2020”, “04-01-2020”, “04/1/20”, etc.). All the date values were read as string/text/character variables and standardized by removing all punctuations, separators, and whitespace. Each data value was then screened for the format of the date variable. In the case of the “excel-numeric” format, the date value was extracted by calculating the number of days since 01 January 1990. In the case of the “as typed” format, the value was screened for anomalies and data editing was carried out using the algorithm. All date values were transformed to the “ddmmmyy” format for data extraction. Further, for missing data, data imputation by addition of mean days to testing from date of admission/OPD and subtracting mean days from discharge was carried out to estimate the date of testing.

2.6.2. Data cleaning process to extract age-related information. Age in analyzable format was defined as a numeric variable between 0 to 120 years. The expected column containing age details was imported as a text/ string/ character variable. All cells were screened for the presence of digit and character values. The values with the presence of non-digit characters were screened for the presence of valid digit values and data editing was carried out based on the findings. The alternate
columns (e.g. sex details) which are likely to contain misplaced values for missing data cells in the age column were screened in a phased manner for enhancing the data extraction process.

2.6.3. **Data cleaning process to extract sex details.** The sex variable was defined as a factor variable with three levels viz. Male, Female, and Transgenders. All the cells were screened for the presence of non-case-sensitive keywords including “Male”, “Female”, “M” without “F”, “F”, “Child”, “Transgender”, and “TG”. Data values containing digit characters were cleaned by deletion of digits and standardizing character values to lower case, removal of punctuations, and whitespaces. To obtain data on missing values, other columns were screened in a phased manner using keywords.

2.6.4. **Data cleaning process to extract location details.** The address variable was defined as a string/ text variable containing information related to the district, sub-district/ block, city, village, and town details. To extract location details, the addresses were standardized before bulk geocoding. Bulk geocoding was done using google API client services. The location details were extracted from the raw address using a reference list of blocks, cities, towns, and villages adapted from Census 2011 datasets. Information related to the patient/ caretaker was found to be present in raw address datasets, especially for the children during exploratory data analysis. The same was removed from the raw addresses through regular expressions-based text mining approaches.

2.6.5. **Data anonymization.** All the identifiers such as name and contact details were removed from the dataset. R package. Epitrix was used to generate anonymized data using the “scrypt” algorithm.

2.7. **Software.** All the data cleaning algorithms were prepared and executed in R software (R Core Team, 2020) using tidyverse, stringr, lubridate, ggmaps, and epitrix packages.

2.8. **Ethics statement.** The present study is part of a larger research project culminating in the Ph.D. program of the first author. Institutional Ethics Committee (IEC/IEC-1653; IEC Reg. No. ECR/189/Inst/KL/2013/RR-16) clearance obtained vide letter SCT/IEC/IEC-1653/DECEMBER-2020 dated 19/12/2020. Permission for use of program data has been obtained from the Directorate of Health Services, Government of Punjab, India.

3. **RESULTS**

The algorithm was executed for line listing data of 64,688 lab-confirmed dengue cases reported from the state during the study period. Logic algorithm for date extraction with screening results, automated cleaning process using the algorithm, and manual corrections are represented in Table 1. A total of 2,04,985 cells expected to contain date values were screened. The excel-numeric format was found in 42,902 cell values. Among 1,31,931 values identified by the screening algorithm, 1,31,569 (99.72%) were cleaned using the apriori cleaning codes (automated) after confirmation of screening results, and 362 (0.27%) values required manual correction.

<table>
<thead>
<tr>
<th>Logic algorithm</th>
<th>Rationale</th>
<th>Automated data cleaning process</th>
<th>Screening results</th>
<th>Automated</th>
<th>Manual correction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total values screened</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td>To covert string variable to date, same pattern should be present across the cells for correct parsing. In this pipeline, all the different date formats are converted to ddmmyyyy format for standardization of pattern and thus correct parsing of dates.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of non-digit characters</td>
<td>Identify date specification using month values such as Jan, Feb, etc-</td>
<td>Remove all other non-digit characters.</td>
<td></td>
<td>41747</td>
<td>41747 0</td>
</tr>
<tr>
<td>Five-digit character values not starting with excel numeric date digit format and last two digits in yy format</td>
<td>All five-digit dmmmyy/ddmmyy format values will end in yy format</td>
<td>Replace last two digits with yyyy year format.</td>
<td>5627</td>
<td>5627</td>
<td>0</td>
</tr>
<tr>
<td>Five-digit character values numerically outside the range of excel format dates and last two digits in yy format</td>
<td>Remaining five digit character values in as-typed format will be outside the range of number of days since 1899-12-30 to start and end days of the specified year.</td>
<td>Replace the last two digits with yyyy year format.</td>
<td>202</td>
<td>202</td>
<td>0</td>
</tr>
<tr>
<td>Five-digit character values numerically outside the range of excel format dates and not ending in yy format</td>
<td>Erroneous data values</td>
<td>Deletion.</td>
<td>257</td>
<td>228</td>
<td>29</td>
</tr>
<tr>
<td>Five-digit character values numerically within the range of excel format dates</td>
<td>Five-digit character values in excel format will be within the range of number of days since 1899-12-30 for the specified year</td>
<td>Excel format date extraction for five-digit values.</td>
<td>42902</td>
<td>4290</td>
<td>0</td>
</tr>
<tr>
<td>Any value with length more than eight characters.</td>
<td>Maximum length of dates in ddmmyyyy format is eight</td>
<td>Deletion.</td>
<td>565</td>
<td>512</td>
<td>53</td>
</tr>
</tbody>
</table>

**Eight-digit character values**

| Values not ending with yyyy format of the specified year | All eight-digit character dates should end with yyyy year format | Replace the last four digits with yyyy year format. | 168 | 119 | 49 |
| Month location holding a value greater than 12. | All eight-digit character dates should be ddmmyyyyy format for parsing dates | Convert to ddmmyyyy format from mmddyyyy format. | 81 | 74 | 7 |

**Seven-digit character values**

<p>| Values ending digit as 1. | Mention of NS-1 positive along with dates in the raw data introduces error | Remove 1 from the last position. | 443 | 438 | 5 |
| Values not ending in yyyy format. | All seven-digit dates ending in yyyy format | Replace last four digits by 2019. | 157 | 72 | 85 |
| Values starting with 311, 211, or 111, and ending in the yyyy year format | Dates in seven-digit character have similar pattern on occurrence in month of January and November | If the date is in December or November, no changes are required. Else, replace the value with ddmmyyyy format. | 931 | 931 | 0 |
| Values with first two digits equal to 1st, 2nd, and 3rd of every month till September and 10th, 20th and 30th have | | If the dates are 1st, 2nd or 3rd, (ddmmyyy) no changes required. Else | 1181 | 1160 | 21 |</p>
<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
<th>Conversion Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 and ending in yyyy format.</td>
<td>same pattern in seven digit character format.</td>
<td>(ddmmyyyy) Insert a zero in the third location to create ddmmyyyy format.</td>
</tr>
<tr>
<td>Values starting with zero.</td>
<td>Any seven-digit characters value starting cannot start with zero for parsing dates.</td>
<td>If the value is in ddmmyyyy format, insert a zero at the third place.</td>
</tr>
<tr>
<td>Values ending in yyyy year format and numerically second and third location value is less than or equal to 12.</td>
<td>In seven-digit character values, from January to September, till 9th of every month (9122019), dates are written in dmmmyyyy format. Then, from 11th to 31st of every month, dates are written in ddmmyyyy format.</td>
<td>Insert a zero at first position to convert the value into ddmmyyyy format.</td>
</tr>
<tr>
<td>Remaining seven-digit character values</td>
<td>-</td>
<td>For values in ddmmyyy format, insert a zero at third location to convert it into ddmmyyyy format.</td>
</tr>
<tr>
<td>Six-digit character values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Values starting with dmyyyy format.</td>
<td>Six-digit dates can be parsed and converted to date format when it is in ddmmyy format. In case of dmyyyy format or yyyydm format there will be error to parse.</td>
<td>Convert yyyymd into ddmmyyyy format.</td>
</tr>
<tr>
<td>Values which do not have last two digits as yy format.</td>
<td>All six-digit character values for a specified year should end in yy format</td>
<td>Replace last two digits with yy format.</td>
</tr>
<tr>
<td>Values which are ending in yy format, month location value is less than or equal to 12, and the date location value is less than or equal to 31</td>
<td>Six-digit character values in ddmmyy format should be converted into ddmmyyyyy format for similar pattern across dates for easy parsing at a later stage</td>
<td>Replace last two digits with yyyy format.</td>
</tr>
<tr>
<td>Four-digit character values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Values with yyyy format</td>
<td>Four-digit character values should be in dmyy format</td>
<td>Convert to ddmmyyyy format or manual correction</td>
</tr>
<tr>
<td>Values not ending with yy format</td>
<td>Values with ddmm format</td>
<td>Convert to ddmmyyyy format or manual correction</td>
</tr>
</tbody>
</table>
Table 1 Logic model characteristics and performance for date extraction.

Data extraction details for date, age, and sex variables from the dataset using the logic model are represented in Figure 2. The algorithm was able to clean and compute the estimated date of testing for 96.1% and 98.9% of observations for the year 2015 and 2016 respectively, and for all cases in the year 2017, 2018, and 2019. Age details were extracted maximum for the year 2017 and 2019 (99.4%) and minimum for the year 2015 (98.4%). Information on the sex of the patient was available for more than 99 percent across the study period, and location details were available for all the reported cases during the study period.

Figure 2 Data extraction summary for age, gender, and estimated date of testing.
4. DISCUSSION

The present study documents a systematic and reproducible logic model for data cleaning of routine health surveillance datasets in India. Though the systematic approach for data cleaning has been documented earlier on routine health information datasets (Gesicho et al., 2020; Maina et al., 2017; Phan et al., 2020), this study is novel in its application and illustration on routine program level dataset in India. Also, the present study was based on a data science approach that is increasingly being used for data analysis in epidemiology, but its utility in the development of reproducible and scalable data cleaning models has limited documentation. A recently published systematic review looking at the strategies applied in research articles to counter the issues of RHIS data quality across low- and middle-income countries suggest that majority of the studies that used RHIS data neither described the extent of the quality issues nor the steps they took to overcome them (Hung et al., 2020). The logic model developed in this study is expected to provide a practical strategy to clean routine health information program datasets in India resulting in strengthening of data quality for information and knowledge generation in the decision-making process as well as for research purposes.

The algorithm developed screened the data for date variables in a logical systematic approach. Among multiple variables present in the datasets, the timeline of disease occurrence is of utmost importance when analysis for disease patterns and model development is considered. Time series analysis is the most common analytical method followed by geostatistical analysis in routine data analytic studies (Hung et al., 2020). However, the dates are entered in varied formats in routine health information systems. This may be attributed to the use of basic data entry platforms such as Microsoft excel in the system. Though it suffices the “intended use” as defined for good quality data for day-to-day performance within the existing system, digital transformation of health care surveillance can be achieved by incorporating advancements in data handling and management technologies. Engagement of both data producers and users, identification of information needs, capacity building for data use at multiple levels, strengthening of data use and demand infrastructure are recommended measures for enhancement of data use context in health care systems (Nutley & Reynolds, 2013).

The present study used a rule-based semi-automated logic algorithm for data cleaning. Data cleaning approaches commonly used are broadly classified as logic-based and quantitative approaches. The use of Machine Learning and Artificial Intelligence based automated data cleaning workflows are largely based on the metadata of datasets. The semi-automated approach was chosen in the present context as it allows the user to understand the data along with the cleaning process in an iterative manner. The routine data currently in the country can be considered as digitalized as compared to the process of digital transformation wherein open data standards and metadata are inherent in database management systems. Initiatives for such database systems are required to enable the adoption of automated data cleaning workflows.

The presence of missing data values for the selected variables was found to be lower in the present study. This is in contrast to reported data missingness percentages in previous studies using routine datasets. This may be attributed to the type of variables selected and their perceived importance in the primary data use process. The line listing datasets prepared in the NVBDCP program include details on a limited number of variables that are considered essential for decision-making in the program. Further, the data values for a specified variable which seemed missing were found to be more commonly misplaced in the dataset. As a result, if alternate columns which are likely to hold information are not processed, the rate of missing data will be higher.

The research dissemination and uptake in health services require a collaborative approach between decision-makers and researchers to optimally utilize the advancements in information and digital technologies in health care. Data availability of program data for research purposes is required. Studies have proved that with increasing use of routine health data in decision making as well as for
research purposes creates a self-perpetuating milieu in the data environment leading to improved data quality and strengthening of health systems.

Study limitations. Understanding the reasons behind the data anomalies present in the routine datasets is a critical factor to guide interventions to improve data quality. However, its understanding was beyond the scope of the present study. The algorithm developed in the present study was based on a single disease dataset from the national vector-borne disease control program. Its application in other diseases and program datasets may require additional screening mechanisms on one hand and may not require some screening steps on the other. Future studies on the application of the algorithm for external generalizability will establish the robustness of the algorithm for larger use. Similarly, limited variables required for the present project were explored in the present study, however, being scalable, algorithms for additional variables as required by health program managers and for research purposes can be incorporated into the model.

The strength of the present study includes the use of a reproducible and scalable logic algorithm for data preprocessing of routine health surveillance data. This will enable the researchers to start looking at available routine datasets. The resulting dataset can be used to understand the Spatio-temporal epidemiology of diseases. Good quality data can be used to develop forecasting models which can complement existing surveillance mechanisms and reduce disease-related burden in the populations. The scalability of algorithms prepared in open-source software provides enormous potential for application to routine datasets for other diseases and for geographical regions with similar challenges globally. However, the conceptualization of development in ICT4D involves careful understanding of the research context within the broader goals for sustainable development. The institutionalization mechanisms for outcomes of ICT4D research will require ingrained perspectives related to the dimensions and theories of change for development (Zheng et al., 2018).

5. CONCLUSION

Data quality of routine health information systems can be strengthened using systematic, reproducible algorithms for data cleaning in open-source software. The algorithm in the present study was semi-automated and based on routine health surveillance data in India. It resulted in the development of a research-level dataset that can be analyzed and interlinked with data from non-health sectors, thus illuminating one of the key contributions of data science to public health systems. Being scalable, the implication of this information and digital technology in health systems and digital epidemiology is enormous. The logic model can be expanded for additional variables according to the health system and research needs in the future.

REFERENCES AND CITATIONS


MEDICAL GRAPHS IN PATIENT INFORMATION SYSTEMS IN PRIMARY CARE

Theda Hvalen Thodesen, University of Oslo
Uy Tran, University of Oslo
Jens Kaasbøll, University of Oslo, jensj@ifi.uio.no
Chipo Kanjo, University of Malawi, chipo.kanjo@gmail.com
Tiwonge Manda, University of Malawi, tiomanda@gmail.com

Abstract: Graphs are very effective tools in visualizing information and are used in many fields including the medical field. In most developing countries primary care, graphs are used to monitor child growth. These measures are therefore often displayed using line graphs, basing it on three indicators (stunting, underweight and wasting) based on the WHO 2006 Child Growth Standard. Most literature on information visualization of electronic health record data focuses on aggregate data visualization tools. This research therefore, was set out to provide such an overview of requirements for computerized graphs for individual patient data, implemented in a way that all kinds of medical graphs showing the development of medical measures over time can be displayed. This research was interpretive, using a user-centric approach for data collection where interviews and web search was used to ensure that the graphs developed are fit the user requirements. This followed prototype development using one of the three free, open source software libraries for Android that were evaluated. The prototype was then used to refine the user requirements. The health workers interpreted the graphs developed flawlessly.

Keywords: Medical graphs, Visualization, Patient information systems

1 INTRODUCTION

Graphs are very effective tools in visualizing information and have been used in many fields including the medical field. Visualization allows data to be presented in a quick way whilst lifting out the most important facts. In the health sector for example, health workers need to view how different medical measurements develop over time. In most developing countries primary care, graphs are used to monitor child growth. These measures are therefore often displayed using line graphs, basing it on three indicators (stunting, underweight and wasting) based on the WHO 2006 Child Growth Standard (WHO, 2010). Child linear growth failure is known as stunting and often indicates malnutrition in children (Rutstein, 2000). Many health workers in primary care plot measures into graphs by hand, a process that takes a lot of time. Further, once the manually plotted graphs are well used, it makes the graph difficult to read and use as a tool.

This research was carried out in order to design graphing functionality in the DHIS2 Android Capture App (DHIS2, 2020) for community health workers or clinical work in primary care. The DHIS2 software is used in more than 100 low- and middle-income countries for health management information, disease surveillance and individual patient tracking. Utilization of DHIS2 software in these countries has enabled bulky patient registers to be replaced by mobile phones and laptops. Prior to this study, The DHIS2 Capture App for Android had no graph-feature.

Most literature on information visualization of electronic health record data focuses on aggregate data visualization tools (West et al., 2015). There is hardly literature that gives an overview of
medical graphs for individual patient data for primary care. This research therefore, was set out to provide such an overview of requirements for computerised graphs for individual patient data, implemented in a way that all kinds of medical graphs showing the development of medical measures over time can be displayed.

Free, open source software packages for drawing graphs in Android were used. This research evaluated the software libraries based on the requirements. Further, the suitability for medical graphs was evaluated through implementing and testing digital graphs amongst community health workers to gauge the usability and usefulness of the graphs.

2 METHODOLOGY

This research was interpretive, using a user-centric approach for data collection. Interpretive methodology positions the sense-making practices of human actors at the center of scientific explanation as they encompass an experience-near orientation that sees human action as meaningful and historically contingent (Bevir and Kedar, 2008). Having solicited the initial requirements for the graphs a prototype was developed and subsequent data was collected using the prototype for refined requirements. That way, the respondents would suggest ways of improving the graph after testing the prototype.

The data was collected in two stages, first data collection was done during the month of November 2019 for two weeks. The second data collection, based on the prototype was done during the month of March 2020.

The main research sites were two primary health centres in Malawi, where some of the authors had a research project on patient information systems (Cunningham et al., 2018). Reproductive health was the dominant activity in the clinics, and treating malaria, TB, diarrorea, HIV/AIDS and other endemic diseases constituted other larger areas of work. The clinics had no medical doctors, but 1-2 nurses/midwives, some clinical workers with 1-2 years of health education, and the majority of staff were community health workers (CHW) with a few months of education.

2.1 Finding the variety of graph types

To ensure that appropriate visuals are used to represent the medical data, internet search and interviews with health personnel were carried out to find appropriate variety of graph types.

The interviews followed the snowball strategy. Initially, two clinic managers at the two health facilities were asked about the uses of graphs; the two managers guided the researchers to other personnel using graphs in their daily patient work. Additionally, guidelines and manuals present in the clinics were collected. Much as the primary source for data collection was Malawi, the main researcher, who resides in Norway collected some data from a medical doctor in Norway with experience as a GP.

Using the internet, the web was searched with the terms “graph” or “chart” and the medical areas that were mentioned in the interviews. General phrases like “medical” and “care” were also used.” The WHO web-site was also searched with the terms “graph” or “chart.”

The variety of graph properties found was summarized in a requirement specification document.

2.2 Evaluation of graphing software libraries

Internet search and visit to known software repositories were carried out to find graphing software libraries. The software library was to be used on Android devices in the free, open source software DHIS2. Software that was to be accessible from the programming language Java was selected. The software was tested and assessed according to the requirements. Also, documentation of the software and recommendations from other software developers were included in the evaluation criteria.
2.3 Testing and refining the graphs in the patient information system
The evaluations aimed at finding possible ways of improving the software rather than measuring efficiency or effectiveness. Variation in data was therefore more important than consistency. Growth monitoring graphs were selected as the type to be tested, due to its widespread use by the majority of primary health care workers. In total, 29 health informants in two health centres tested the app.

The tests took place at convenient places in or outside of the clinic. Interruptions took place when patients or colleagues needed contact with the health workers. Attempts at measuring time for completing tasks were abandoned due to the unpredictable test situation.

Previous research in rural African communities has shown the preference amongst informants to work together in small groups (Winschiers-Theophilus & Bidwell, 2013), thus we allowed for 1-5 health workers to join around the person holding the tablet. While this setting reduces experimental control, the conversations taking place between the health workers constitute a rich data source.

The cheapest hardware will often be purchased in governmental institutions. To keep the test close to reality, the cheapest devices we also selected for the test, and Huawei was the cheapest brand at the point of purchase. Two tablets were chosen, one 10” tablet and one 5” P10 Lite smartphone to determine whether screen size mattered. The app was installed in both devices.

In the field, the app was first presented to the health workers and they were shown how to add new children and register the measures of the child from a visit. Then charts containing the measures registered were demonstrated. The devices were then handed over to the health workers for them to try using.

Data was collected in two areas.
- The functionality of the graph, its presentation and user interaction.
- Health workers’ understanding of the graphs.

Data was collected through observing how they interacted with the app and how they communicated with each other to navigate in the app and enter data. Lastly, they were interviewed and discussed with them about their opinions and what to change or add.

3 RESULTS

3.1 Graph types
Graphs for monitoring of child growth, weight gain during pregnancy, weight of TB patients, lymphocytes and viral load for HIV, glucose and insulin levels for diabetes, four different measures during deliveries, were observed in the clinics and found through internet searches. In addition, several graphs displaying number of cases, including immunization coverage, were observed in the health centres. Since these graphs concern aggregate, and not data on an individual over time, these aggregate data graphs are outside the scope of this study.

Three graphs span the range of requirements for graph functionality. Graphs for child growth and deliveries were used in the clinics visited. The HIV graph was of the textbook-type. It is likely that similar graphs are found in some primary care clinics.

3.1.1 Child growth
Child growth graphs all have the general form illustrated in Figure 1 below. The age on the x-axis could be 0-2, 0-5 or 5-19 years. WHO has tables of normal values and +1, +2, +3, -1, -2 and -3 standard deviations. The health personnel is to take action if the graph crosses a line.

The WHO tables have values for each day during the age 1-5 and for each month 5-19 years, hence the time scale has a finer granulation for younger children.
In addition to weight-for-age, there are also graphs for height-for-age and weight-for-height and different standard values for girls and boys and for premature babies. To calculate the SD for a child, the software has to store the approximately 20000 values per graph and interpolate between the data points.

Some of the preprinted charts used have colour coding between the SD-lines, e.g., red outside of SD 2, yellow between SD1 and SD 2, and green in the middle.

Weight gain during pregnancy had two alert lines above and below the predicted gain (National Research Council, 2010, p. 273). This corresponds to the child growth graph with only the ± 1 SD lines. Heart rate during pregnancy was also recorded, but not in graphs. However, it could have been displayed in the same type of graph as weight gain.

The graph for monitoring the weight of TB patients only concerns weight gain or loss. Thus it is a much simpler version of the child growth graph.

### 3.1.2 HIV graph

The HIV graph has two series as shown in Figure 2, each presented in separate Y-axes. The lymphocyte Y-axis is linear, while the viral load axis is logarithmic. Its x-axis is more fine-grained to the left than to the right. This shift from high to low granulation along the x-axis is similar to the standard values for growth graphs.

![Weight-for-age GIRLS](image-url)
The diabetes graph also had two lines, each with its own y-axis scale. Since these scales both were linear, the HIV graph requires more functionality in the software.

3.1.3 Delivery graph

The delivery graph observed in the clinics had four values per time point at the x-axis; foetal heart rate, cervix opening, descent, and contractions. These values were marked in four different graphs above each other without repairing the x-axis, as shown in Figure 3 below.
The cervix graph has two straight alert and action lines to notify the midwife if the graph crosses the lines.

3.1.4 Required functionality

In summary, the requirements for graph functionality were:

1. Any number of series.
2. Linear and logarithmic scale.
3. Double y-axis in one plot.
4. Several charts above each other without repeating the x-axis.
5. Flexible resolution on the x-axis.
7. Colour between lines.

3.2 Code libraries for graphs

We found three open-source, Java libraries for drawing graphs, all licensed under the Apache License 2.0 (Apache Software Foundation, 2004).

**MPAndroidChart** supports several different types of charts like line, bar, pie, bubble, radar, etc. (Jahoda, 2019). It is one of the most discussed online library and is, as far as we could see, the one most people recommend in the different developer forums. It was also recommended by the DHIS2 Android Developers in Spain. It is well documented and easy to work with. From the documentation,
it seemed to meet requirements 1-3 and 5-6. The only thing the documentation did not clarify was whether it would support coloring between two lines in the chart.

- **AndroidPlot** supports several types of charts, both static and dynamic (Fellows, 2019). It also seems to support the same functionality as MPAndroidChart, and is easy to customize. However it is less documented than MPAndroidChart.

- **AChartEngine.** This library (Dromereschi, 2016) has functionality for many chart types, but it does not seem to have been updated for four years.

None of the libraries met requirement 4. To plot several graphs above each other with only one x-axis would require extending the libraries, something which our project did not have the resources to do.

We decided to use the chart library MPAndroidChart, because this was the library that had the best documentation and was easiest to find information and tips on developer forums like StackOverflow and Quora. Another factor in our choice was the recommendation from the DHIS2 Android developer team. Through experimenting, we also found ways to colour the background between two lines in this library, therefore it could meet requirements 1-3 and 5-7.

### 3.3 Coding DHIS2 Android

DHIS2 Android app handles data on individual patients and is configurable to any information needs in primary care. It is connected to a server where data can be shared and also aggregated to produce periodic reports. The app is optimised for slow and intermittent internet connection. It can be used offline, it synchronises data when online, and the data transfer is minimised.

To keep data traffic at a minimum, the graph extension was designed to download the standard data when connected to wifi and only when changes in the standard data was made.

The extension was coded in Java with the Android Studio using the DHIS2 Android Software Development Kit ([DHIS2 Android SDK](https://www.dhis2.org/), 2020)

When bringing the graph into the user interface, several design decisions had to be made. The group could be shown besides a data input field. This option would make the chart very small, hence difficult to read on a small screen on a phone or tablet. Also, the graphs in the paper documents used by the health workers had a small page on their own, hence they were accustomed to having the graph on a separate sheet. It was therefore decided to make a graph tab in the app, which could display the graphs of the relevant health programme, see Figure 4 below. This screenshot is from a child Outpatient Therapeutic Program, where the user has entered data for weight and height and thereafter pressed the Charts tab. The Weight for Age comes up, and the user can also choose the two other available graphs for this programme; Height for Age or Weight for Height.
This project was limited to developing and testing the Android app. To obtain a production system, the configuration functionality of the system has to be extended with the ability to couple specific data fields with the standard value data sets. This extension of the configuration software was outside the scope of the research project, hence the app extension is a prototype.

3.4 User experience

We started off by showing the health workers, mainly CHWs, how the app worked:

- How to create a new child
- How to add a new event/visit
- The tab with the different graphs height-for-age, weight-for-age and weight-for-height.

After demonstrating how it worked, we asked the CHWs to create a new child and add a few visits. They found the schemes for Outpatient Therapeutic Program children and started to add a child, some CHWs reading from the schema and others adding data in the app. When the child was added and some visits were registered, they found the tab for graphs.

3.4.1 Colour coding

The health workers were given the app with the colours in the figure above. They remarked that the health passports they were used to fill have two colors only green (2 to -2) and yellow (3 to -3), and that the app should be changed accordingly. Since the colouring might differ in other countries, the colours should be configurable in the software.
When they tested the weight for height graph, we encountered a problem. Since the children are visiting every week when enrolled in the Outpatient Therapeutic Program, the plots in the graph are almost on the same spot on the x-axis. It is limited how much weight they gain or lose in 7 days and the height is always the same in this program, as they use the height from admission for all the next visits. They use a table to find the z-score for weight-for-height, instead of a graph. The colors in the table are the same as the colors we used in the weight-for-height, therefore they did not want us to change the colors in this graph.

The health workers were most impressed by the ability to see the z-score relative to the standard deviation ranges, saying

"With this we do not have to use the tables to calculate the z-score"

### 3.4.2 Zooming

They used their fingers trying to zoom in on the graph on the 5” phone screen. "Are you trying to zoom?", we asked. "Yes, is it possible?". We told him it was disabled, because the zooming function collided with the function for swiping between the tabs. It was also hard to move around when the graph was zoomed in. Their comment was that "If zooming was possible, that would be good", this would also result in more space between the plots in the graphs where this was a problem.

The need for zooming was less urgent on the tablet due to the larger screen size.

### 3.4.3 Data storage

The health workers reported that on many occasions mothers lose their child’s health passport; where all the data for a child was registered. Some were aware of the server capability offered through a platform like DHIS2, from where the data can be retrieved even when the data entry device is lost:

"Phone might get lost, but the data is not lost, compared to health passport."

### 3.4.4 Calculating therapeutic doses

The health workers wanted to see other data values in addition to the growth graph, and the MUAC measure was central. We therefore included the option for the app to display four data fields above the chart, see Figure 5 below. The values in the four data fields change according to the data point pressed in the chart.

The number of rations of Ready-to-Use-Therapeutic Food is determined by the weight of a child, and the health workers would need to look up in a table in order to get that number. The DHIS2 Android app can be configured without coding to calculate such values; the RUTF is shown in the figure below.

The health workers believed that using the mobile phone would be quicker than having to look up RUTF recommendations in a table.
We asked the health worker to plot a child from the Outpatient Therapeutic Program and he could check if the Capture app recommended the same program. The first child he added was admitted to the same nutrition program that the app recommended, the measured MUAC suggested the child should be in the Outpatient Therapeutic Program. "This is very good!". When asked if they thought the messages would be helpful or distracting, they responded that it was "Helpful" and "Not just helpful, they would be very helpful".

3.4.5 Satisfaction

When asked how it was to read the charts and how the app was working, he answered "It is easy to use and see what to do. It tells the direct growth of the child." On the question if there is something that should be different, he thinks for a minute, but says it is ok and nothing should be different. We asked if we should remove the weigh-for-height graph, as the plots were difficult to distinguish; "No, keep it. It should be there".

When asked what they think after seeing the app for the first time, they responded that: "It is easy to use" and "Other than fixing the colors, it looks good".

3.5 Interpreting graphs and SD-scores

3.5.1 Reading growth graphs

Displaying graphs, SD-scores and other calculated values were regarded as improvements by the health workers. Hence, we also wanted to know their ability to relate to the graphs and the numbers in their work.

A simple, first test was showing a health worker four charts of different children and asking him what they would do when this child came to the clinic. We decided to test the weight-for-age graph, since it is always updated in the child’s health passport.

The four charts displayed the following:

1. An average child with stable growth. The response was: "This child is normal, we do nothing".
2. Average child with decreasing weight: "This child is normal, but losing weight. We would consult and give guidance to the mother".

Figure 5 - Illustration of other data values
3. Child decreasing weight, into the yellow color: "We would admit this child to the Supplementary Feeding Program (SFP) and consult the mother about 6 food groups".

4. Child growth below the yellow field: "This child we would admit to Outpatient Therapeutic Program (OTP) and consult the mother"

These were all adequate interpretations according to their guidelines. After trying out with a few more health workers, the responses were consistently the same, hence the health workers seem to interpret the graph adequately.

3.5.2 Looking up in tables

In OTP, the weight-for-length indicator requires the health workers to look up the z-scores in Table 1 and set symbols to denote the inequality. A girl with length 45 cm and weighing 2kg can both be written as $<-2z$ or $>-3z$ using the weight-for-length reference table below.

Table 1

<table>
<thead>
<tr>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3 Z</td>
<td>-2 Z</td>
</tr>
<tr>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
<td>1.9</td>
<td>2.1</td>
</tr>
<tr>
<td>2.0</td>
<td>2.2</td>
</tr>
<tr>
<td>2.1</td>
<td>2.3</td>
</tr>
<tr>
<td>2.2</td>
<td>2.3</td>
</tr>
</tbody>
</table>

According to older and experienced CHWs, most new health workers very often make mistakes when doing this.

When looking at the follow-up schemes for the children admitted to the Outpatient Therapeutic Program, we could see there were some inconsistencies in the calculations of the SD-score. In the figures below, the child (left) has a height of 69 cm, and at 3 visits the weight has been 7.1 kg. In these 3 visits the z-score (WHZ-score in the figure) has been calculated to $> -2$, $< -2$, and $= -2$. Also in another form, for the child at right, the same weight and height has given rise to z-scores both $> -2$ and $< -2$.

When questioning them about z-scores, it was clear that some of them found it hard to find the correct z-score, because they changed their opinion and gave different answers.
Z-scores in the app are viewed when clicking on the plots in the graph. It will show the x-axis and y-axis values of the plot, as well as the z-score. As shown in the form in Figure 6, the health workers are using the greater than and less than symbols when entering the z-score. Our calculation of the z-score displays decimal numbers. This gives a more precise score, but the health workers are not used to z-scores with decimals. When they compared the calculated score from the app and what they found in their reference table, they said "- 1.2 - that is almost correct." Their reference table showed -1. One health worker said, however, "The information is more clear with accurate numbers".

4 DISCUSSION

4.1 Tables

The health workers interpreted the graphs flawlessly, but when having to look up in Table 1, errors were frequent. In general, the error probability rate for reading a number in a table wrongly is around 1%, and this error rate could increase to 10% when working under moderate stress (Smith, 2017). These general findings apply when a person looks up a figure in a specified row and column. The health workers started with the row which corresponded with the baby’s length, thereafter compared the figures in the row with the weight and finally looked up the column heading to find the z-score, hence a more complicated operation than looking up a number in a specific cell. Further, they had to know which column to select when the weight was between two figures in the table. For instance, a 47cm long girl who weighs 2.5kg lies between the figures in the green (2.6) and the yellow (2.4) column. The figures in the column mark the lower bounds of this column, hence the girl is in the yellow zone. Since the table does not indicate whether the figures are lower bounds, middle values or upper bounds of the column, the health workers might fail at making the correct inference for this reason.

The z-scores are marked with < or > symbols in the forms. Amongst middle school students, 30% did not manage to use these symbols correctly for positive numbers (Duru & Koklu, 2011). Also, pre-service teachers have been observed to interpret a comparative symbol (= < >) as a command to perform an arithmetic operation (Ilany & Hassidov, 2018), thus completely misunderstanding the type of symbol. We would therefore expect that people pick the wrong symbol at times.

Ranking negative numbers is another challenge. In a study of children in Sweden learning negative numbers (Kilhamn, 2011, p. 219), one of the high achieving, 12 year old students was given the task to calculate -6-2. His first response was minus 4, with the explanation

“ … you have minus 6, and then you take away 2 from that. Then you kind of think that it will be, smaller number, yes?”

He corrected himself to -4, but his initial response assumed -4 < -6. Ordering of negative numbers also came up with large variations in a similar study in Turkey, where the students were given special attention (Altiparmak & Özdoğan, 2010). Hence, a person at any age could make the mistake of mixing up the relationship between the numbers and that of their absolute values.

Health workers filling the forms in figure xxx are thus faced with three challenges; reading the table, using the < and > signs properly, and ordering negative numbers. If there is a 20% chance of failing at each of these three challenges, the result will be random.

The health workers in Malawi had completed high school, and had a few months and up to 2 years of college education. Average percentage of correctly answered items on a statistical numeracy scale for health for people with some college education was 64.5% in the US and 79.2% in Germany. With only high school, the scores were around 10% lower. A study of numeracy amongst patients with university education in the US showed that 40% could not convert a percentage into a proportion of 1000, and 80% failed on the opposite operation (Lipkus et al., 2001).
Based on the three challenges to overcome in the filling of the tables and the frequent math mistakes that educated people do, it is reasonable to assume that many primary care health workers will end up with random use of < and >.

### 4.2 Graphs

In a test of nurses’ comprehension of graphs and tables in the US, they performed in the following order; bar graph 88%, table 81%, line graph 77% and spider graph 41% correct responses (Dowding et al., 2018).

In the general population in Germany and the US, the % of correct responses in Table xxx were given to line graph reading tasks (Galesic & Garcia-Retamero, 2011).

<table>
<thead>
<tr>
<th>Question no</th>
<th>Task</th>
<th>Overall correct response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Reading off a point on a line chart</td>
<td>83.3%</td>
</tr>
<tr>
<td>6</td>
<td>Comparing slopes of a line at 2 intervals</td>
<td>71.9%</td>
</tr>
<tr>
<td>7</td>
<td>Projecting future trend from a line chart</td>
<td>80.5%</td>
</tr>
<tr>
<td>12</td>
<td>Differentiating slope and height of a line</td>
<td>81.8%</td>
</tr>
</tbody>
</table>

Hence, around ⅕ of all readings are wrong.

The fluency which the health workers demonstrated with the graphs versus tables contrasts the general findings on graph literacy. There may be several reasons for this.

First, the health worker only needs to see which colour in the area of the data point. Second, no less-than or greater-than comparisons are needed. Third, the health workers do not need to order negative numbers, they just need to see that the data point is below the green level, meaning underweight instead of overweight. Hence, the most difficult operation on paper is to draw the data point and the line. In the app, the drawing is automated, hence this challenge, which could correspond in correctness rate with question 5 in the table is removed.

Another reason for the health workers’ ease of dealing with the graphs compared to the general population can be that they are used to one type of line graphs for growth monitoring. Being fluent with this particular graph does not imply a general graph literacy, since specific competencies gained do not easily transfer to the general area.

The graph libraries were used to extend the DHIS2 Android Tracker app, which can store data locally and synchronise with a server when online. To limit data transfer in resource limited places with poor connectivity, standard values were stored on the device and only changed when standard data was changed and when connected to wifi. To make the graph clearly visible, graphs were displayed on a separate tab, where also four essential data fields were displayed.

The 29 health workers appreciated the graph showing the colour codes, such that they did not have to look up in the table. They also wanted to be able to zoom in on the graph, and have the app calculating doses, raising alerts and suggesting treatment programmes.

They interpreted the graphs with ease and chose the appropriate treatment for the children. While people in general make many mistakes when interpreting graphs, the health workers were very familiar with the growth graphs. Also, the colour coding eased the interpretation, such that there was no need for dealing with negative numbers and < and > symbols; the latter would normally cause many mistakes.
While decision support systems have demonstrated mixed results (Bright et al., 2012; Krick et al., 2019), there were cases where the health workers had to consider several conditions simultaneously. The criteria for admission and discharge for Supplementary Feeding Program and Outpatient Therapeutic Program were: a child must have a SD-score between -3 and -2, a MUAC between 11.5 and 12.5 or just been discharged from OTP, while the criteria for Outpatient Therapeutic Program is MUAC less than 11.5, SD-score less than -3 or Oedema +/++ and no other medical complications. The app could be extended without coding to perform such tests and to provide a recommendation. Future research will include such extensions.

5 CONCLUSION

We found no prior overview on the types of graphs used for individual patient data in primary care. Through web-search and interviews with health workers, several graphs were found, including graphs for monitoring growth, weight during pregnancy and during TB treatment, HIV, TB, diabetes and deliveries. The following requirements for graphing emerged from these cases:

1. Any number of series.
2. Linear and logarithmic scale.
3. Double y-axis in one plot.
4. Several charts above each other without repeating the x-axis.
5. Flexible resolution on the x-axis.
7. Colour between lines.

Three free, open source software libraries for Android were evaluated according to their ability to fulfil the seven requirements. None of the libraries fulfilled requirement 4. The MPAndroidChart (Jahoda, 2019) was chosen because it coped with all the other requirements, had the best documentation and was recommended by other developers.

REFERENCES

ESTABLISHING DATA WAREHOUSE TO IMPROVE STANDARDIZE HEALTH CARE DELIVERY: A PROTOCOL DEVELOPMENT IN JAKARTA CITY

Verry Adrian, Jakarta Department of Health, dr.verry@gmail.com
Intan Rachmita Sari, Jakarta Department of Health, intanrachmita@gmail.com
Hardya Gustada Hikmahrachim, Jakarta Department of Health, hardyagustada@yahoo.com

Abstract: Jakarta is a metropolitan city and among the most dense city in Indonesia. Jakarta has 12 major indicators of standardize health care delivery (Standard Pelayanan Minimum or SPM) derivates from Ministry of Health consists of services related to maternal and neonatal health, school-aged population, working-age population, elderly population, some specific conditions (hypertension, diabetes, tuberculosis, HIV), and also mental health. We planned to construct a data warehouse to provide a single integrated data center. In the first phase (2021), we improve the system by giving responsibility to the health Sub Department of Health of Administrative City for direct data input into a data warehouse. This period also let an introduction and adaptation to new data collection schemes by using a single entry for the first time. The basic platform use for this system is District Health Information System 2 (DHIS-2), an open-source platform that has been used worldwide, including Ministry of Health Republic of Indonesia. The major advantage of this data warehouse is the simplicity and convenience to collect a wide data from a different source and presenting it faster than using the conventional system. Less data contradiction was also found between health programs with intersecting data. During this transition phase, a double-work is made as data should be input to both the DHIS-2 system by Jakarta and the National Ministry of Health system, but an integration process is ongoing, and hopefully that in 2022 single data entry can be established.

Key words: Data warehouse, DHIS-2, Jakarta

Introduction

Jakarta is a metropolitan city and also acts as the capital city of the Republic of Indonesia. The population of Jakarta City in 2020 is around 10.5 million occupying an area of 699.5 km square. Various efforts have been made to improve the health status in Jakarta. Following the instruction from The Central Government, there were twelve major indicators of standardize health care delivery, named Standard Pelayanan Minimum (SPM). SPM consists of services related to maternal and neonatal health, school-aged population, working-age population, elderly population, some specific conditions (hypertension, diabetes, tuberculosis, HIV), and also mental health. SPM are government affairs that must be pursued.

Since the beginning of the regulation on SPM, there have been several problems related to recording and reporting of SPM data. Before the SPM Data Warehouse was created, data reporting was done manually from district health office to provincial health office via excel sent via email or google spread sheet, as well as the verification and validation processes were also done manually. This prolonged the data collection process, and made it difficult for manager program to recapitulate data. Including the data visualization process which also complicates the program, so that manager of program must spend more effort to analyze existing SPM data.
Furthermore, there are several data elements for each indicator that must be verified by two different programs, such as data on immunization for children under five in the indicator for children who receive health services. So far, the immunization program and the child health program in the health office have always reported basic immunization data for toddlers with different data values, so that outsiders always question the quality of the data in the end. With the SPM Data Warehouse, we can adjust the authority of each existing data element, so that there is no longer the publication of different data values with the same data element.

Accurate and actual data should be gathered to support health program implementation. On the other hand, data collection in a low-resource situation is another challenge in Jakarta. It is impossible to draw health problems, and further allocate health resources, if no reliable data available. Quality data will help the government to formulate objective and accurate policies to shoot at existing problems.

In the middle of 2020, we start to digitize health data. We planned to construct a data warehouse to provide a single integrated data center. The initial purpose is to optimize data collection for SPM-related programs and further use in all health-related data. Jakarta might be the pioneer in applying big data to public health in a practice at province level in Indonesia. The development of this data warehouse is under monitoring of Ministry of Health and in collaboration with the University of Oslo. This paper was written to share some strategies and experience in preparing concepts of data warehouse, thus might give insights to other cities in developing countries.

Goal

The goal in building public health data warehouse in Jakarta city are:

1. Speed up the process of reporting and collecting SPM data
2. Make it easy for data visualization and analysis so that presenting comprehensive health data as a basis for health policy making in DKI Jakarta
3. Integration and synchronization of existing health data in DKI Jakarta

Profile of Jakarta City

In designing public health data collection, demographic assessment is an important step. Jakarta is a province – known as a special capital region – consist of five administrative cities (central, north, south, east, and west Jakarta) and an administrative regency (Seribu Island), but popularly known as Jakarta City. It is the smallest province but the densest population in Indonesia, approximately 16.262 per square kilometer. In 2019, its gross domestic product (GDP) in total is $660 million or $55 per capita. Its Human Development Index (HDI) is 0.807, classified as very high (2019).
A lot of things need to be done to improve Jakarta health status. In 2019, both maternal and neonatal mortality rates are still high (55.4 per 100,000 livebirth and 5.48 per 1000 livebirth, respectively). Services for noncommunicable diseases, such as hypertension, diabetes, and mental health also need improvement. Besides, currently, Jakarta is still in the fight for COVID-19 pandemics.

**The current system for data collection**

The major sources of health data in Jakarta are health program data and healthcare services data. The majority of data flow is in a conventional scheme by using e-mail or online documents which can be accessed by limited persons. Data were recapitulated and visualized manually by the data manager. Several programs that are involved in one data element may report different aggregate data. The integration of data is the responsibility of the Data and Information Section of Jakarta Department of Health. Following an urgency to develop a system for data utilization, at 2020 Jakarta designing a framework for public health data integration as seen in Figure 2.
The focus on the first phase of development is on the box “Integrating Public Health Data and Electronic Data Interchange” from the current data source and then develop an integrated data repository. Data visualization in different forms such as dashboard, report, specific query, events, and alert are an innovation to improve health program evaluation and monitoring for stakeholders. This framework is the main goal for the next 5 years.

**Conceptual Framework**

In establishing a system for building a data warehouse for data collection, a conceptual framework is the main foundation. We modified a framework from Public Health Surveillance and Action (McNabb et al, 2002) as seen below.

![Diagram](image)

**Figure 3. Data warehouse development framework. Adapted from McNabb, et al (2002)**

Based on the framework, the input for the data warehouse (blue dash line box) is the responsibility of Puskesmas, covering district and sub-district areas. Data warehouse system provides the ability to register, report, detect and confirm data with direct analysis dan feedback. In this section, the data source should be of a high-quality. On the support activity section (green dash line box), Sub Department of Health of Administrative City (sudinkes) acts to ensure that the process is always in line with the framework by doing tight supervision and close communication. Training and resource-provision might be conducted in collaboration with Jakarta Department of Health (dinkes).

Data collected in a data warehouse are utilized for rapid health program monitoring and finally the main outcome: giving response to both acute situation (such as epidemic) or a planned response. In the first years of this data warehouse development, we are focusing to utilize for a planned response, according to 12 indicators of SPM.
Figure 4. Data collection and management in Jakarta. A) current situation, B) Design for Phase 1, C) Design for Phase 2. Note: Jakarta Health Office = Jakarta Department of Health; Jakarta Health Suboffice = Sub Department of Health of Administrative City (abbreviated to optimize scheme understanding)
Data collection concept

Current health data collection is using a conventional gradual system from the smallest administrative area into a larger one. It starts from the level of Kelurahan (subdistrict), Kecamatan (district), Kotamadya (Administrative City), and at the province level (Jakarta City) as seen in Figure 3. Pusat Kesehatan Masyarakat (puskesmas) is a community health center that responsible both for health service delivery and health data collection in subdistrict and district area. Data then will be pooled at the administrative city level by Sub Department of Health of Administrative City to be validated. Those aggregate data are then sent to Jakarta Department of Health (Health department) to be analyzed further. The principal objective of this gradual system is to ensure data validity, but in recent years it has been considered to lengthen the data collection system. Otherwise, its validity is still problematic due to manual data recapitulation using paper-based reports or using offline and online Microsoft Excel in some districts.

In the first phase (2021), we planned to improve the system by giving responsibility to the Sub Department of Health of Administrative City for direct data input into a data warehouse. This period also let an introduction and adapted new data collection schemes by using a single entry for the first time. The single entry defines as only one source for specific data of which increases its reliability. Although it might be questionable as no triangulation was made, yet giving responsibility should increase the validity of the data reported. For example that malnutrition data might come from the nutrition section program, child health section program, and on many occasions both data are not in accordance.

The next phase (2022-2023) is a more open data phase that the responsibility for data input is given to sub-district and district health office. Data are then simultaneously validated and verified by the Sub Department of Health of Administrative City and Jakarta Department of Health but did not delay the data flow.

Software and system

The basic platform use for this system is District Health Information System 2 (DHIS-2), an open-source platform that has been used worldwide. The main purpose of using this software is data presented in the form of routine statistic data and aggregate data. DHIS-2 also had been previously used in Ministry of Health Indonesia so that any issue such as data security and integration between national and provincial government can be minimized.

Data input is according to organization units. It defines as a person in charge (PIC) for each subdistrict and district that has access to the main website. They should regularly do data imputation to the predetermined schedule. Besides data input, PIC did not have any access to other data.

Workshop

Workshops for trainees consist of two different targets: 1) data manager (Jakarta Department of Health and Sub Department of Health of Administrative City) and 2) data enumerator (health program person in charge). The first workshop begins with building metadata and deciding a list of users. Metadata is a definition and code for each element and variable in the DHIS-2 system. Workshop participants are program data managers so that given access to change metadata in the future, including data input, verification, validation, and also analysis. The second workshop aimed to train about data visualization and presentation. Participants were also trained to assess the quality of data.

As an evaluation, around half of participants could not tune in to the workshop materials, due to 1) online workshop (for some participants), 2) unfamiliarity to technology, and 3) difficulty to...
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understand technical materials due to some not user-friendly dashboard according to participants.

Data quality was assessed using the principle of 4C: current, correct, consistent, and complete. Current defined as actual data by routinely update health program data. In this new system, the Sub Department of Health of Administrative City had to be more concentrated on monitoring data imputation, thus following the principle of consistent. Correct defines to ensure minimal error during data input using system validation for each variable (deciding which nominal or decimal data type, and range set for each variable). The main purpose is to reduce human error during data imputation. Data were then verified and any deviated data should be justified. Complete means that each form should be filled completely before being submitted. Evaluation

An in-depth interview is conducted with data enumerators, data monitoring (sudinkes), and program evaluator (dinkes). The major advantage of this data warehouse is the simplicity and convenience to collect a wide data from a different source and presenting it faster than using the conventional system. Less data contradiction was also found between health programs with intersecting data. We could provide a single data on an indicator that was approved by all organizational units. As long as data were collected regularly, the Jakarta Department of Health might update all relevant public health data for public consumption, as never before.

Another advantage of using DHIS-2 is that no data lost during network disconnection due to the offline data saving ability of the system. Data then be synchronized when the network available. This is crucial as internet connection in the city of developing countries, such as Jakarta, might be problematic. This would also reduce the risk of re-inputation due to connection loss, a situation that often happened.

During this transition phase, a double-work is made as data should be input to both the DHIS-2 system by Jakarta and the National Ministry of Health system, but an integration process is ongoing, and hopefully that in 202 single data entry can be established.

Discussion

Sustainability

The key of successful data management system is to maintain its sustainability. In previous experience at West Africa countries, a collaboration with international investigators and also school of medicine and public health are an important point of leverage to facilitate long-term retention. Those collaboration might transform the quality of health data into a healthcare services delivery improvement in host-country according to Heidelberg-Nouna institutional collaboration past experience. An intense training in bioinformatics also offer an advantage to maintain sustainability of data collection as this might be an obstacle found in our development of Jakarta data management system. Another key of sustainability are an agreement on system vision and goals followed by innovative tools to measure this activity. The goals should be delivers in clarity and concordance, thus boost the implementation of data collection system.

Other Countries

By implementing data collection management system, West Africa had been able to control malaria through improving quality of data for healthcare services. Those systems bring benefits by reducing data error rate, encourage more specific data based on regional, and help health professionals to combat disease, specifically Malaria at that study.

Problems found in previous study are quite similar to our programs. There is a risk of hesitancy to
complete transition to computer-based system and a parallel use of paper-based report system. Stakeholders engagement also crucial but sometimes problematic in real situation application.\textsuperscript{6} Sometimes, attractiveness to participant are related inversely to the utilization in public health. Public health policy remain the preferred alternatives to improve data collection and maximize health benefits.\textsuperscript{8} A report from India stated that developing data management system face some challenges: maintaining record-keeping system, standardizing the data collected, assuring data completeness and availability, and do routine backup on this data to prevent misuse public health data.\textsuperscript{9}

A strong system of data collection might place public health as a strategic area in political point of view. A case study in Canada reported four main threat to health care sustainability: downgrading the status of public health within governments and health authorities, eroding the independence of medical officer on matters of public health concerns, limiting public health scope by combining it with primary and community care, and decreasing funding for public health. Thus, besides a system, the availability of funding, human resources, and structural requirement is crucial for public health system, especially on data management.\textsuperscript{10}

Acknowledgment

We would like to thank Mr. Ras Vagel and the team from the University of Oslo for assistance during this system development and made all the works follow the timeline. We also thank to Ministry of Health and Head of Jakarta Department of Health for the support during the development of this data warehouse system. This collaboration will continues until the system is fully developed.

Future direction

There were also room for improvement in the development of this data warehouse:

1. Adapting to input data using computer-based system
2. Adapting to input data routinely according to predetermined schedule
3. Providing person in charge (PIC) to help enumerators when facing problems during data input
REFERENCES

APPLICATION OF EXECUTIVE INFORMATION SYSTEM FOR COVID-19 REPORTING SYSTEM AND MANAGEMENT: AN EXAMPLE FROM DKI JAKARTA, INDONESIA

Verry Adrian, Jakarta Department of Health, dr.verry@gmail.com
Intan Rachmita Sari, Jakarta Department of Health, intanrachmita@gmail.com
Hardya Gustada Hikmahrachim, Jakarta Department of Health, hardyagustada@yahoo.com

Abstract: SARS CoV-2 infection and transmission are problematic in developing countries such as Indonesia. Due to the lack of an information system, provinces must be able to innovate in developing information systems related to surveillance of SARS CoV-2 infection. Jakarta Department of Health built a data management system called Executive Information System (EIS) of COVID-19 Reporting. EIS aimed to provide actual data so that current epidemiological analysis is accurate. The main idea of EIS is to provide valid and actual information to stakeholders, which can then be presented in the form of a dashboard. EIS is utilized to push data flow and management for rapid surveillance purposes. This could be the first time in Indonesia that a system reports near-actual data of nearly half a million people daily using an integrated system through a transparent system. The main data presented is important to monitor and evaluate COVID-19 transmission is the cumulative case and daily case number. Data in EIS also can offer data geographically so that a more detailed analysis could be done. EIS's data and the dashboard help the government in pandemic control by presenting actual data on bed occupancy and availability across hospitals, especially isolation wards. Stakeholders, academic institutions should utilize EIS data and other elements to help Indonesia fight COVID-19.

Keywords: COVID-19, Information System, Data Reporting, Public Health, Jakarta

1. INTRODUCTION

The first coronavirus disease (COVID) 19 case in Indonesia was reported in March 2020, specifically in Depok, a city near Jakarta. Since that, massive infection and local transmission are unstoppable in Indonesia. In the middle of March 2021, around 1.5 million people were infected by SARS CoV-2 virus in Indonesia, with currently 122,000 active cases and a 2.7% mortality rate. The highest cases were found in Jakarta. Yet, Indonesia had not overcome COVID-19.

Due to the lack of an information system, provinces are pushed to do any innovation related to SARS CoV-2 infection surveillance. Daily data reported are mandatory for every province, consist of new cases, recovered cases, and death cases. Those data were then collected to be summarized as a daily national report.

To provide valid and reliable data, Jakarta Department of Health had been developing a data management system called Executive Information System (EIS) of COVID-19 Reporting. EIS aimed to provide actual data so that current epidemiological analysis is accurate. Any decision for pandemic control should be based on high-quality data. This paper aimed to present the design and outcomes of EIS utilization in Jakarta. This system had been build at the beginning of 2018. The main idea of EIS is to provide valid and actual information to stakeholders in the form of a dashboard.
This idea is growing as demand increases during the pandemic, especially when COVID-19 case reporting emerged.

During the COVID-19 pandemic in Jakarta, EIS is utilized to push data flow and management for rapid surveillance purposes. As seen in Figure 1, Jakarta’s data sources are public health services, hospitals, and laboratories. Both patient data and the result of PCR data are reported by those healthcare facilities by using an online database, excel, csv, and other tools. Data were then processed into EIS so that further steps can be integrated. Document management primarily uses line unit and line unit folder and is brought to automated data feed on sharing. Epidemiologic analysis and presentation (information products) of EIS in Jakarta are daily COVID updates (will be explained later), GIS dashboard and maps, weekly external SitMap and Epi Analysis, and also pandemic dashboard.

This data would then be utilized by epidemiologists and public health analysts for pandemic-related policy, writing of scientific reports, and knowledge sharing via social media. Using this system, actual data were presented and accessible for all elements in Jakarta. Due to a large amount of data incoming across the province, the EIS system optimizes data verification by collaboration with the civil registration department to prevent data duplication, mostly using a single civil registration number (Nomor Induk Kependudukan or NIK) (Fig 2). Although it still needs improvement, this scheme prevents potential data duplication during COVID-19 case reporting. The significant difference of data collection and analysis before and after the establishment of EIS is presented in Table 1.
Table 1. Difference in data collection to data analysis before and after the establishment of EIS

<table>
<thead>
<tr>
<th>Aspects</th>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection</td>
<td>Written in paper-based form, then recapitulated manually.</td>
<td>Direct input into system and automatic data summary by system.</td>
</tr>
<tr>
<td>Reporting</td>
<td>Manually recapitulated data sent into stakeholders in higher level for data input into system.</td>
<td>Data connected via API, directly visualized in dashboard.</td>
</tr>
<tr>
<td>Time consumption</td>
<td>Needs longer time due to manual processing from data input to data analysis.</td>
<td>Less time needed for data analysis due to interconnected system.</td>
</tr>
<tr>
<td>Data quality</td>
<td>Moderate quality data due to incomplete data, duplication, and human error during data collection process.</td>
<td>Better data quality due to mandatory variable input in EIS system. Not possible for data duplication due to similar data will be automatically merged. Accumulative calculation is done by system to prevent human error during data calculation.</td>
</tr>
<tr>
<td>Data analysis</td>
<td>More difficult step for data analysis and data visualization due to manual process.</td>
<td>Automatic data analysis and visualization in the form of table, graph, or any presentation that been set before.</td>
</tr>
<tr>
<td>Data sharing</td>
<td>More difficult due to manual sending data to every stakeholder.</td>
<td>Data is accessible both for stakeholders and public as presented in the dashboard.</td>
</tr>
</tbody>
</table>

2. **DATA PRESENTATION AND VISUALIZATION**

This EIS COVID-19 Reporting system's main objective is to provide data for Jakarta Provincial Government and then assisted by the Department of Communication, Informatics, and Statistics; data will be reprocessed and visualized in the form of a dashboard for use by stakeholders, academic institutions, and public consumption. Data should be regularly updated and give a lot of useful information. This is probably the first time in Indonesia that a system could report near-actual data
of nearly half a million people daily using an integrated system through a transparent system. EIS is the back end of this system information, while the front end is presented on Jakarta COVID-19 website. Current dashboard that presented at corona.jakarta.go.id:

Figure 2. Daily Summary of Cumulative COVID-19 Cases in Indonesia (left) and Jakarta (right). Kasus terkonfirmasi = confirmed cases; kasus positif = positive cases; kasus aktif = active cases; sembuh = recovered; meninggal = death; dirawat = hospitalized; isolasi mandiri = self-isolation; tanpa gejala = asymptomatic; bergejala = symptomatic; belum diketahui = unknown.

The main data presented that is important to monitor and evaluate COVID-19 transmission is cumulative case and daily case number. Using EIS, Jakarta could present a more specific data compared to national data by reporting self-isolation case, asymptomatic cases, and symptomatic cases. Those proportion is important to estimate how severe this disease are among people of Jakarta.

Figure 3. Detailed information about suspect (suspek), probable, travelers (pelaku perjalanan), close contact (kontak erat), and discarded cases (cumulative). Selesai isolasi = finished self-isolation; isolasi di rumah = self-isolation at home; isolasi di RS = isolation at hospital; meninggal = death.
Data above present a stratification analysis about COVID-19 in Jakarta, especially about suspected cases, probable cases, travellers cases, close-contact cases, and discarded cases. This information is crucial as Indonesia yet do not have an optimal testing number and strategies and near half of them are conducted in Jakarta. Cumulative number of self-isolation compared to hospital admission can be an information to be used for policy making about Jakarta capacity to fight for this pandemic.

Figure 4. Daily New (Penambahan Kasus Harian) COVID-19 Case and Mortality Report. Meninggal harian = death case daily; positif harian = new positive case daily; sembuh harian = recovered case daily

Another important role of EIS is that it can visualize an actual report of daily new cases and its trend (Fig 5). This graphic has been adapted based on other international health organization report such as US CDC and UK NHS. Accumulative cases could also be accesses freely as it also presented at COVID-19 website after being processed in EID (Fig 6).

Figure 5. Cumulative (Akumulasi) Data on COVID-19 Active (Masih perawatan), Death (meninggal), Self-Isolation (isolasi mandiri), and Recoved Cases (Sembuh)

As seen in Fig 7, EIS also can report the daily positivity rate of COVID-19 diagnostic test in Jakarta. The trend of specimen tested and positivity rate helps epidemiologist in deciding for the further strategies. Any strategies related to pandemic control would not be explained in detail in this paper.
Figure 6. Positivity Rate and Other Related Data on COVID-19 Testing in Jakarta. Tanggal = date; jumlah orang di test = people tested; orang positif harian = daily new positive cases; orang negative harian = daily negative cases; kasus baru harian = new active cases daily; total specimen di test = number of specimen tested; positivity rate specimen harian = daily positivity rate.
Data in EIS also can present data geographically so that a more detailed analysis could be done. Data reported as cumulative (Fig 8) or daily new cases (Fig 9). New cases reported in detailed information such as age, gender, and hospitalization status.
Information at EIS dashboard that can be accessed by public are:

1. National COVID confirm cases - cumulative (active, recovered, and death cases)
2. Jakarta COVID confirm cases - cumulative:
   i. Hospitalized
   ii. Recovered
   iii. Death
   iv. Self-isolation
   v. Asymptomatic
   vi. Symptomatic
   vii. Unknown symptom status
3. Mapping of suspected, close-contact, and positive cases in Jakarta
4. Crosstabulation data on gender and age group
5. Daily new suspected, close-contact, and positive cases
6. Comparison between national and Jakarta new cases trend data
7. Daily mortality rate with COVID-19 protocol or without protocol
8. Positivitiy rate of daily COVID-19 diagnostic workup
9. Data on law violation by companies
10. Data on Jakarta air quality and traffic information
11. Network graph of COVID-19
Data on bed availability and referral system

An innovation delivered by EIS is that this system help government in pandemic control by presenting actual data on bed occupancy and availability across hospitals, especially isolation wards. EIS integrate both government-owned and private-owned hospitals in Jakarta. This transpiration on data had been proven to prevent delay in referral and further improve survival of critical COVID-19 patients that needs ICU, PICU, or NICU (Fig 10).

Data presented on EIS including isolation ward, ICU with and without negative pressure, pediatric ICU, neonatal ICU, operating theater with negative pressure, and hemodialysis facilities for COVID-19. Data were directly inputted by hospitals into the system and being updated hourly. More detail data also presented (Fig 11) specifically for each hospital. This might be one of the first system to present almost actual data on bed occupancy in Indonesia.

<table>
<thead>
<tr>
<th>ICU Tekanan Negatif</th>
<th>ICU Tanpa Tekanan Negatif</th>
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<tbody>
<tr>
<td>Dengan Ventilator</td>
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</tr>
<tr>
<td>Tanpa Ventilator</td>
<td>77</td>
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<tr>
<td>Dengan Ventilator</td>
<td>40</td>
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<td>Tanpa Ventilator</td>
<td>32</td>
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<th>PICU/NICU/Perina Khusus Covid-19</th>
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<tbody>
<tr>
<td>Isolasi Tekanan Negatif</td>
<td>PICU Covid-19</td>
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<tr>
<td>Isolasi Tanpa Tekanan Negatif</td>
<td>NICU Covid-19</td>
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<tr>
<td>Tanpa Ventilator</td>
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<tr>
<td>Dengan Ventilator</td>
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<tr>
<td>Tanpa Ventilator</td>
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</table>

Figure 9. Bed Availability and Occupancy Data Presented in Executive Information System Jakarta. ICU tekanan negatif = negative pressure ICU; ICU tanpa tekanan negatif = without negative pressure ICU; Kamar isolasi = isolation room; OK Khusus COVID-19 = operating theater for COVID-19 cases; HD Khusus COVID-19 = hemodialysis facilities for COVID-19 cases; tersedia = availability in number; sisa kapasitas = capacity in percentage; dengan ventilator = with ventilator; tanpa ventilator = without ventilator.
3. DISCUSSION

EIS brings Jakarta into a city with more developed data system on public health. This breakthrough should become an example for other cities of provinces in Indonesia and a further collaboration is always welcome. Some developing countries also have an information system to support policy making during COVID-19 pandemic. The key to fight pandemic is how to present data in transparency.\textsuperscript{1, 2}

Data reporting are a major issue in developing countries. India reported that only 10 out of 29 states that provide visual representation of COVID-19 cases trends, while most of states did not report data stratification in age, gender, district nor comorbidities.\textsuperscript{3} Previous studies had reported that gender and age played an important role in COVID-19 data reporting due to its impact on severity and mortality.\textsuperscript{4, 5}

An objective indicator on how data reporting quality can be assessed using COVID-19 Data Reporting Score (CDRS) as developed by Stanford or other scoring systems, in which related to health development index.\textsuperscript{3} This disparity would be common among developing countries, especially with geographical challenges like Jakarta, so that an intersectoral collaboration is necessary.

IT infrastructure and system also the major source of problem during system reporting. EIS might be easily implemented in Jakarta due to prior IT readiness, but a contrast finding could be met in other Indonesian cities. It needs a policy commitment to build an efficient IT system in a short time during this pandemic era.\textsuperscript{6}

Some other concern that might impair data collection are about privacy. Some patients, both in developing and developed countries, are not giving permission of his civil ID number to be registered in national system as a COVID-19 cases. This phenomenon is strongly related to local social and spiritual belief, or a feeling of ashamed to be infected by SARS CoV-2. Thus, during EIS development, data privacy should be handled carefully to prevent further ethical issues.\textsuperscript{7}

Future direction

The large amount of data, known as big data, should be optimized by academicians to publish scientific paper in both national and international level. Data utilization is not limited to health sectors, but social and economic institution can also bring this to a scientific evidence in order to help government for policy making.
EIS should also be integrated to central government system, such as New All Record Kemenkes, Peduli Lindungi application for contact tracing, self-isolation monitoring apps, and other new mobile-based apps. This collaboration can boost the quality of information extracted from the present data and open for any innovation in the future.

REFERENCES AND CITATIONS
DATA JUSTICE IN DIGITAL SOCIAL WELFARE: A STUDY OF THE RYTHU BHAROSA SCHEME

Silvia Masiero, University of Oslo, silvima@ifi.uio.no
Chakradhar Buddha, LibTech India, samalochana@gmail.com

Abstract: While digital social protection systems have been claimed to bring efficacy in user identification and entitlement assignation, their data justice implications have been questioned. In particular, the delivery of subsidies based on biometric identification has been found to magnify exclusions, imply informational asymmetries, and reproduce policy structures that negatively affect recipients. In this paper, we use a data justice lens to study Rythu Bharosa, a social welfare scheme targeting farmers in the Andhra Pradesh state of India. While coverage of the scheme in terms of number of recipients is reportedly high, our fieldwork revealed three forms of data justice to be monitored for intended recipients. A first form is design-related, as mismatches of recipients with their registered biometric credentials and bank account details are associated to denial of subsidies. A second form is informational, as users who do not receive subsidies are often not informed of the reason why it is so, or of the grievance redressal processes available to them. To these dimensions our data add a structural one, centred on the conditionality of subsidy to approval by landowners, which forces tenant farmers to request a type of landowner consent that reproduces existing patterns of class and caste subordination. Identifying such data justice issues, the paper adds to problematisations of digital social welfare systems, contributing a structural dimension to studies of data justice in digital social protection.

Keywords: Data justice, social welfare, social protection, India, Rythu Bharosa

1. INTRODUCTION

Over the last decade, a substantial literature has related digital identification of users to efficacy and justice in social protection systems (cf. Gelb & Clark, 2013; World Bank, 2016; Gelb & Metz, 2018). Taylor (2017) defines data justice as “fairness in the way people are made visible, represented and treated as a result of their production of digital data”. Visualisation, representation and treatment of people through digital data production acquire greater relevance in contexts of vulnerability, such as informal labour (Krishna, 2021), labour in the gig economy (Heeks et al., 2020), forced migration and displacement (Cheesman, 2020; Martin & Taylor, 2021). Overlap of data injustices with pre-existing forms of vulnerability has been highlighted as a pressing concern on the data justice agenda (Heeks & Renken, 2018; Dencik et al., 2019; Heeks & Shekhar, 2019).

Yet, concern has emerged on the extent to which digital and, especially, biometric identification can concur to data justice in social protection systems. From the legal perspective, subordination of essential rights to enrolment in biometric databases (Srinivasan et al., 2018) makes enrolment a condition for rights that are, on paper, universal. From the informational point of view, uncertainty remains on the treatment of user data, leading research to question the extent to which coercive enrolment results in transparent data handling (Cerna Aragon, 2021). As a result, research finds a space of enquiry in the extent to which digital identification can provide welfare to impoverished people, and on the justice concerns with such a process.
We engage the problem with a study of Rythu Bharosa, a social welfare scheme announced in 2019 to provide cash subsidies to farmers in the Indian state of Andhra Pradesh. We use a data justice lens to ask, how does digital social protection meet the needs of vulnerable beneficiaries? Drawing on narratives collected from users entitled to Rythu Bharosa in early 2020, our analysis identifies two dimensions of data injustice (design-related and informational) in line with Masiero and Das (2019), but builds on data in finding a structural dimension, mirroring the concept of structural data justice in Heeks and Shekhar (2019), that reflects the perpetuation of subordination of tenant farmers to landowners in the digital scheme.

As a result, the paper contributes a structural dimension to studies of data justice in digital social protection. Heeks and Shekhar (2019: 994) define structural data justice as “the degree to which the interests and power in wider society support fair outcomes in other forms of data justice”. Conceptualising structural data justice in digital social protection allows visualising perpetuation of exploitative class and caste relations in datafied schemes and the way technology participates in these, illuminating its implications for vulnerable users.

The paper is structured as follows. We first summarise the literature on data justice in social protection schemes, highlighting the orthodoxy of digital identity for development and the main critiques to it. We then introduce Rythu Bharosa and its digital architecture, illuminating the data justice lens through which we study it. In the analysis, we outline three forms of data justice in digital social protection: two, design-related and informational, are derived from Masiero and Das (2019), while a third, structural, stems from our data on Rythu Bharosa. The discussion positions our contribution in data justice research, highlighting its implications for digital social protection.

2. LITERATURE AND CONCEPTUAL BACKGROUND

A focus on visualisation, representation and treatment of people through data defines data justice (Taylor, 2017). The intersection of data injustices with pre-existing forms of social and economic vulnerability is highlighted on data justice research agendas (Heeks & Renken, 2018; Dencik et al., 2019; Heeks & Shekhar, 2019), inspiring a focus of data justice on social protection schemes.

Social protection is defined as “public and private initiatives that provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of the marginalised; with the overall objective of reducing the economic and social vulnerability of poor, vulnerable and marginalised groups” (Devereux & Sabates-Wheeler, 2004). Among extant domains of data justice research, social protection offers a space where data-based architectures promise better functioning of existing programmes (Masiero & Shakti, 2020). Such a promise suggests that, by matching people’s biometric credentials with their entitlements, more accurate delivery of programmes can be achieved. Digital identification and delivery of entitlements combat both inclusion and exclusion errors, ensuring that leakage is tackled and that those entitled are able to receive their benefits (cf. Gelb & Metz, 2018).

Masiero and Bailur (2021) propose a further taxonomy of the theoretical link of digital identity and development, finding three channels along which such a taxonomy is articulated. First, a link between digital identity and the provision of improved public services is theorised. The core idea is that better identification of users, through the improvement of targeting, leads to exclusion of non-entitled users from benefits, with a positive effect on reduction of leakage and diversion from social protection schemes (Gelb & Clark, 2013; World Bank, 2016; Gelb & Metz, 2018). Made explicit in the global agenda on digital identity for development, the assumption of digital identity leading to better service provision finds, however, only limited empirical confirmation (Bhatia et al., 2021; Carswell & De Neve, 2021; Chaudhuri, 2021; Martin & Taylor, 2021).
A second channel through which digital identity is supposed to foster development pertains to ability to improve assistance to systemically excluded minorities. This point applies to refugees and internally displaced people, for whom it is suggested that a digital identification system can guarantee registration even in conditions of statelessness. The promise, as summarised by the World Bank (2016), is that of recognition of identity where one is not easily established. From a theoretical perspective, the inclusion of minorities transcends the promise of better services, as it seeks to guarantee solutions that combat the roots of exclusion (Bhatia et al., 2021).

Thirdly, improvement of humanitarian assistance is a further promise held by digital identity. The humanitarian sector is becoming based on recognition of beneficiaries that is digitally grounded, conceived and operated (Donovan, 2015). The digitisation of the humanitarian sector informs a new focus of digital identity in aid (Weitzberg et al., 2021), as abilities to recognise entitled subjects produce systems that can assign assistance to the needful.

Articulated along the lines of improved public services, inclusion of minorities and better delivery of humanitarianism, the link of digital identity and development is widely recognised by advocates of digital provision of social protection. The same link is, however, problematised in all its three components from data justice and social protection research (Masiero & Bailur, 2021). Below we engage the main problematisations of each component of the link in point.

First, the link between digital identity and improved public services is questioned especially by studies of user experience of digital social protection. Exclusions from biometrically-mediated services are proved, in the case of large food security schemes such as India’s Public Distribution System, both in quantitative (Muralidharan et al., 2020) and qualitative terms (Hundal et al., 2020; Chaudhuri, 2021). Experiences of digital access to the state lead to subordination of fundamental rights to biometric recognition, leading to trading of personal data for services (Srinivasan et al., 2018). Studies of digital social protection during COVID-19 illustrate the exclusions of social protection users in times of global emergency (Cerna Aragon, 2021; López, 2021): exclusions are harder to measure for groups, such as migrants and displaced populations, which may not be seen and counted in mainstream statistics (de Souza, 2020; Milan & Tréré, 2020).

Second, the link of digital identity to inclusion of minorities is problematised as well. In a study of informal workers in India, Krishna (2021) finds a systematic discrepancy between promotion of digital identity as an enhancer of protection and the reality of workers, subject to surveillance rather than assistance. Studies of refugees being registered through digital identity schemes find similar forms of surveillance: in the refugee stories from Jordan, Lebanon and Uganda collected by Schoemaker et al. (2021), digital identity results in a blurred boundary between assistance and policing. In the cases of Uganda and Bangladesh studied by Martin and Taylor (2021), systematic differences are found in regulatory practices: while Uganda has enacted a virtuous cycle of assistance, narratives from Bangladesh still reveal how digital technology acts as an enhancer of discriminatory practices towards refugee populations.

Completing these narratives, studies of digital identity in aid reveal the coexistence of logics of recognition and surveillance (Weitzberg et al., 2021). Cheesman (2020) studies the ambivalence of decentralised technologies of self-sovereign identity, noting the limits to the thesis that views these as “emancipatory” architectures for refugees. In his study of biometric registration in one of the largest refugee camps of Kenya, Iazzolino (2021) finds a duality of assistance and repression in biometric systems for refugees, for whom profiling has direct effects on the ability of the state to monitor and police their movements. As observed in Donovan (2015), this duality is implicit in digital monitoring, resulting in exacerbated effects for populations at risk during displacement (Iazzolino, 2021). Problematising the ability of digital technologies to offer better assistance to refugees, digital identity arises again as questionable in its ability to strengthen social protection.
It is against this backdrop that we set to study how digital social protection meets the needs of vulnerable beneficiaries. From the voices of users of Rythu Bharosa, a subsidy scheme designed for vulnerable farmers in the southern Indian state of Andhra Pradesh, we set to explore whether, and how, digital social protection schemes can fill existing exclusions and ensure data justice to beneficiaries. From Rythu Bharosa recipient narratives we derive more problematisations of the link between digital identity and development.

3. METHODOLOGY

Case selection for this paper was based on considerations of timeliness and conformity of the Rythu Bharosa scheme with the research object, digital social protection, on which our question is centred. Time wise, the implementation of Rythu Bharosa from October 2019 made it possible to gather first-hand information on the scheme and have one of the authors establish access to recipients, with whom group discussions were conducted in the aftermath of the rollout. Access was established under the aegis of an Indian collective of engineers, social workers and social scientists, inspired by the Right to Information Movement (Sharma, 2013) and working to promote democratic engagement in rural public service delivery.

Group discussions with users entitled to Rythu Bharosa revolved on three core themes. A first theme was centred on access to the scheme: questions on this topic regarded the ability, or lack thereof, of users to receive their entitlements. In the cases where users had their entitlements denied, questions invited narratives on the reasons offered by officials at bank and village levels on such an outcome, and on redressal mechanisms sought by users. A second theme was centred on the conditions surrounding entitlement, and invited users to expand on the conditions to apply for Rythu Bharosa and their enforcement through the digital system. Finally, a third set of questions pertained to information received on the scheme, asking how such information was conveyed through the digital system and its ability to enable the performance of applications.

<table>
<thead>
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<th>Date</th>
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<th>No.</th>
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<td>Tenant farmers</td>
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</tr>
<tr>
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<td>03.01.2020</td>
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<tr>
<td>--------------</td>
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<tr>
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<tr>
<td></td>
<td>Women tenant farmers</td>
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<td></td>
<td>Tenant farmers</td>
<td>4</td>
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<td>06.01.2020</td>
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</tr>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Table 1: Summary of Interviews

Field data were progressively integrated with statistics on the Rythu Bharosa scheme, as well as press releases and state government documentation on the programme. While limited to the immediate aftermath of implementation, group discussions with entitled beneficiaries have been key to illuminating user appraisal of a large digital social protection programme, as well as its affordances and challenges for farmers across gender and caste.

4. CASE BACKGROUND

After a landslide victory in the State Assembly elections of 2019, the newly elected government of the Indian state of Andhra Pradesh announced a set of social welfare schemes termed Navarathnaulu (meaning “nine gems”). Navarathnaulu is a set of nine social welfare schemes introduced with the objective of bringing positive change in the lives of underprivileged and vulnerable groups. Navarathnaulu follows an integrated approach including schemes on agriculture, health, education and housing among other sectors.

The Rythu Bharosa scheme, one of the nine schemes within Navarathnaulu, aims to support small and marginal farmers in the state of Andhra Pradesh. The state government implemented the scheme from October 15th, 2019, for augmenting the income of landowner farmer families and to the Scheduled Caste, Scheduled Tribe, Backward Caste and Minority Landless Tenant farmer families by providing financial assistance across the state. The scheme consists in the provision of a cash subsidy to landowner farmers, in order to meet investments (especially high during the crop season) and thereby mitigate their financial struggles.

As part of the scheme, farmers identified as entitled receive 13,500/- Indian rupees per year. Out of these, the Central Government transfers 6,000/- across 3 equal installments in the name of PM Kisan, a central government scheme aimed to extend income support to all landholding farmers’ families in the country having cultivable land. PM Kisan is a Government of India scheme that guarantees

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Rs 6,000 per year to small and marginal farmers as minimum income support. The state government completes this transferring 7,500/- in two installments. Eligibility criteria vary slightly across users: all the farmers who received land entitlements under the Record of Forest Rights (ROFR), a scheme that defends the rights of forest cultivating communities, and tenant farmers are ineligible for the PM Kisan scheme, in these cases the state government pays the whole 13,500/- entirely from its budget.

Rythu Bharosa ensures delivery of subsidy to entitled users by a management information system (MIS) that matches user identity with records of their entitlement. User identity is recorded with Aadhaar, the database that records biometric credentials of Indian residents and assigns them a 12-digit number. The Rythu Bharosa information system matches Aadhaar credentials with the status assigned to users, also linking to each record the bank account where the subsidy money is to be deposited. Based on a system of digital identification of users, the scheme offers a paradigmatic case of the object, digital social protection, that our research aims to investigate.

5. FINDINGS

At the time of writing, about 51 lakh (5.1 million) farmers are getting their benefits from Rythu Bharosa. This coverage rate testifies to the wide reach of the programme, and to its ability to deal with issues suffered by farmers subjected to income limitations.

Farmer narratives, however, revealed multiple dimensions questioning principles of data justice in the programme. Such dimensions have informational, design-related and structural aspects.

5.1. Informational data justice

Masiero and Das (2019) refer to informational data justice as a situation in which users of social protection are properly informed on how their data are treated, and of the decisions made on the basis of such data. Narratives collected from recipients entitled to receive Rythu Bharosa have, however, revealed several issues with this dimension of data justice.

- **Awareness of entitlements.** Group discussions with beneficiaries reveal that the assignment of entitlements under Rythu Bharosa is not always clear, and is in many cases opaque. To determine entitlement, an existing list - available to the State Government from extant farmer databases - has been augmented with the request to village volunteers to identify eligible farmers in given areas. Village volunteers are the street level bureaucrats whose job is to help people in getting their entitlements. They collect requisite documents from people and deposit them in village secretariats which are administrative offices at panchayat level. The digital trial of the beneficiaries start from there. Yet, at the moment of claiming Rythu Bharosa subsidies, several farmers found themselves excluded from such a list. Some farmers suggest this may be due to errors in the praja sadhikara survey, which took place in 2016 and was supposed to capture the socio-economic status of all households in the state.

- **Mismatches with existing Aadhaar seedings.** Way back in 2014 the state government seeded all the land accounts in the state with Aadhar and the local officials were given unreasonably short time to complete the process. To avoid being pointed out for not meeting deadlines they seeded land accounts with whichever Aadhar numbers they came across. Shortly before the rollout of Rythu Bharosa, the local government was required to do verification and correction of field

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mapping of all Aadhaar numbers of beneficiaries in 15 days. This was found, some farmers suggest, a challenging task given the density of households to cover. In fact, several farmers report erroneous Aadhaar seedings, resulting in entitlements being deposited in bank accounts that do not belong to them. A redressal issue is also reported, since discussions with farmers highlight their inability to verify online the Aadhaar number that their land account number is seeded with. As stated by a farmer in one of the village areas, information is “hidden behind the logins”: in the way the MIS is planned out, even the officers responsible for it find it difficult to investigate missing subsidies.

- **Unclear reasons for rejection.** When farmers apply for Rythu Bharosa, rejection can happen at two stages. The system distinguishes between *bank rejection* and *village rejection*: in the former case, subsidies are rejected at the level of the bank, due to data mismatches or absence of data for the individual in point. In the latter case, subsidies are rejected at the village level, where local databases have either not been accurately seeded with user data, or not seeded at all or rejected due to ineligibility. Such information is however not available to the user, who is therefore left with uncertainty on the reason why their subsidy has been rejected.

- **Lack of effective grievance redressal mechanisms for farmers.** Our fieldwork did not show evidence of any form of effective grievance redressal for the farmers that, while entitled to Rythu Bharosa, still received rejections either at the bank or at the village level. The system is predicated on the idea that grievance redressal is needed in order to assist beneficiaries for whom entitlement is not converted into reality. At the same time, our fieldwork gave no evidence of any attempt of the state to engage in grievance redressal, which is especially problematic in the context of repeated rejections of effectively entitled beneficiaries.

All these points suggest issues of informational justice, since treatment of user data and decisions made on their basis are often unclear. Mismatches between Aadhaar records, landholder and bank accounts are difficult for both users and officers to investigate, making it difficult for users to obtain the information needed on their cases.

### 5.2. Design-related data justice

Masiero and Das (2019) conceive design-related data justice as a situation in which the design of social protection schemes is in line with the needs that users experience. This concept follows the idea of design-reality gaps as in Heeks (2002), where ICT4D project failure may result from gaps between the way in which the technology is designed and the reality perceived by recipients. In our fieldwork, several questions of design-related data justice have emerged.

- **System design preventing change of wrong records.** In case of wrong digital records, users who have been denied subsidies can request a change. Many farmers and lower level officials complained that changes made in the digital land records website, hasn’t got reflected in the Rythu Bharosa website thereby denying entitlements to a large number of farmers. But there have been cases where the clerk has printed out the old record, and justified that by stating “this was set in this way” – preventing changes from being done. Viewed from user voices, the MIS seems exceptionally difficult when it comes to make changes to existing records, changes that may be determinant for someone’s ability to effectively receive the subsidy.

- **Complexity of system update procedures.** Related to the above, farmers who want to update their records have to approach the village volunteer or village revenue officer, asking for updates to be done. Again, if updates are not done in time, entitled users can be excluded from the system.
In the case of tribal users, knowing whether the money has arrived or not means multiple trips to the bank: it can occur that they travel all the way to the bank to find that the money is not there.

- **Uncertainty of records.** The system is built in such a way that the user should know how much has been paid, but a common thread across our group discussions is that transparency is not a characteristic of the system. Respondents from a tribal village that we visited in January 2020 define this as “the most opaque scheme” they have dealt with, as the whole process of assigmentation of entitlements is perceived to be hidden to the user. Even when going to the village volunteer, the system is designed in such a way that the volunteer is not enabled to have the information needed to help. Tribal areas have the additional problem that forest lands are not registered in the land record system, resulting in information on such lands not being available in the public domain. The system, users told us, is like a lottery: even those who do get subsidies often do not know why they got it.

To sum up, several design-reality gaps exist between the design of Rythu Bharosa and the lives of recipients. These revolve around system design preventing the change of wrong records, the complexity of system update procedures and uncertainty of the records entered in the system.

### 5.3 Structural data justice

Our analysis finds an additional form of injustice, which pertains to the MIS reflecting structural, long-term relations of class and caste in landowning. Instances of such a type of data injustice are presented here, observing how technology intersects with existing power relations.

- **Perpetuation of class relations.** Tenant farmers need a signature from landowners to obtain subsidy from the Rythu Bharosa scheme, a signature without which the application for the subsidy is incomplete. Village volunteers ensure that families get state benefits, but in the absence of the landowners’ signature, it is not possible to give such an assurance.

In practice, tenant farmers find themselves in the situation that the landowner can just decide not to sign the agreement entitling them to Rythu Bharosa, which perpetuates extant forms of tenant farmer subordination. As explained by one of the village volunteers, the idea that the state government promoted through Rythu Bharosa is to invite landowners to pursue some form of legal agreement with tenant farmers, but limited evidence of agreements taking place has emerged from our discussions with users. In one of the group discussions, we became aware of landowner farmers applying for the subsidy on a certain land, without informing their tenants who hence became not entitled to the same.

- **Perpetuation of caste relations.** The role of caste in landowning relations has been evidenced in our field data. In an interview with Dalit women in one of the villages, a specific caste has emerged as the landowning caste in the area, with farmers reporting having tilled the same land from the same landowner for over twenty years. But even then, they were given no agreement to receive Rythu Bharosa entitlement. Some of them did not do so as they were not informed of the requirement for landowner signature, which is however embedded in the MIS.

In discussions with the same tenant farmers, it has emerged that in some cases, tenants are reluctant to ask a signature from their landowners even if they are aware of the requirement. Two women farmers in the group said that, as they had worked in the land for their landowners for over twenty years, they felt that requesting a signature for access to Rythu Bharosa could
upset the trust relation built with landowners. As powerfully summarised by one of them: “we have been trusted all these years, how would we put that in peril?”

As a result, the Rythu Bharosa MIS feeds into a history of power relations between farmers and landowners. Rythu Bharosa is a subsidy of the state to help needful farmers, but if that subsidy is (a) conditional to approval by landowners, (b) sent to the wrong account, or (c) accompanied by no information on rejection reasons, data justice issues of informational, design-related and structural nature are likely to persist.

6. DISCUSSION

Faced with the orthodoxy of digital identity for development and its critiques, in this paper we set to investigate how digital social protection meets the needs of vulnerable beneficiaries. Our study revealed that Rythu Bharosa is a well-planned scheme to help vulnerable farmers, which however reveals several aspects of data justice to monitor. These belong to the design-related and informational domain, theorised in Masiero and Das (2019), and to the domain of structural data justice as theorised in Heeks and Shekhar (2019). We suggest that data injustices of the structural type reinforce adverse power relations, such as the dependency of farmers on landowners, that hamper the economic empowerment that social protection is supposed to enable.

The paper contributes a taxonomy of forms of data justice in digital social protection, which enriches existing ones (Masiero & Das, 2019) and adds a structural dimension to them. As noted in Masiero and Bailur (2021), the orthodoxy of digital identity as a route to development is questioned on theoretical and empirical grounds, which makes it important to assess the extent to which it comes alive in existing social protection programmes. Schemes like Rythu Bharosa are paradigmatic of the state’s commitment to vulnerable residents, and their provisions embody the strengths of social protection as defined by Devereux and Sabates-Wheeler (2004). Focusing on the MIS that operates the scheme, our study affords understanding the dimensions of data justice that need monitoring.

The study reveals dimensions of design-related and informational justice, that Masiero and Das (2019) highlight in digital social protection. From a design-related perspective, the system makes it difficult to perform operations, such as amending user records and connecting them to bank accounts, that are needed for subsidies to be credited. From an informational perspective, the programme emerges as especially opaque: users, it emerges, are extremely uncertain on the reasons behind acceptance or rejection of their subsidy application. Chaudhuri (2021) points at this specific dimension: an “opaque” state, that does not reveal the reasons for key decisions on social protection, is extremely problematic for its residents.

To these dimensions, the study adds that of structural data justice. Such a dimension impinges on power relations as in Heeks and Shekhar (2019) but reflects such relations in the lived reality of users of digital social protection. Echoing studies of colonial relations embedded in biometric systems (Weitzberg, 2020), our study shows that the Rythu Bharosa MIS embodies extant relations of subordination between tenant and landowner farmers, whose signature is requested when tenants wish to apply for the subsidy. Doing so, the system transposes into data the power relations of the real world, hampering the economic empowerment that the system could ensure.

Structural data justice is especially important in the current context of digital social protection. With our fieldwork conducted ahead of the declaration of COVID-19 as a pandemic, our study meets a world in which digital social protection is adapting to new needs (Masiero, 2020; Milan et al., 2021). Across countries, the COVID-19 pandemic has made effective social protection systems a priority, posing new data justice concerns that overlap with the previous ones (Taylor et al., 2020; Martin, 2021). In a world where social protection has received a new, suddenly enhanced importance, it has
become crucial to find ways for social protection to tackle structural power imbalances, acting on cases in which such imbalances are digitally reinforced.

Finally, a limitation of the study relates to the temporal window of late 2019-early 2020 in which primary data are concentrated. While the ongoing pandemic has largely changed the way fieldwork is conducted, we find value in our data due to their ability to voice user perspectives, putting them in the context of a digital social protection scheme with a wide coverage. The pandemic has maximised the importance of strong social protection, making our results especially important in a context of continued global emergency (Milan et al., 2021). As the consequences of COVID-19 on vulnerable groups pernate, we hope that this study enables the recognition of core dimensions of data justice in digital social protection.

7. REFERENCES


POLICY–PRACTICE CONTRADICTION: CASE OF CLOUD COMPUTING ADOPTION IN THE MALAWI HEALTH SECTOR

Deborah Amos Phiri, University of Malawi, deboraphiri4@gmail.com  
Chipo Kanjo, University of Malawi, chipo.kanjo@gmail.com

Abstract: This paper examines the dynamics of policy implementation and how policy contradicts reality on the ground when it comes to practice. The paper finds that despite having well-laid out policy; the actual practice is contrary. Taking data storage policy within the Ministry of Health in Malawi as a case study, the paper highlights that the contextual realities of where Ministry of Health (MoH) data is stored depends on a number of Technology-Organizational-Environmental (TOE) factors. In the wake of cloud computing; some of these factors act as causative factors for data to be stored in the cloud; contradicting the data storage policy.

Keywords: Policy, Practice, Cloud Computing, Contradiction

1. INTRODUCTION

A policy provides an overarching framework that is to be enforced by practice. Anderson (2003) defines policy as “a relatively stable, purposive course of action followed by an actor or set of actors in dealing with a problem or matter of concern” (Anderson, 2003; pp.2). This definition distinguishes a policy from a decision, which is essentially a specific choice among alternatives; instead, it interprets policy as something that unfolds over time. The world is full of policies, and they occur at various levels of interaction; personal, organizational, and public. Practice on the other hand is repetition of an activity to improve skill. Policy needs to be translated into activities that constitute practice for it to be effective. However, it is not always the case that what has been articulated in a policy is put into practice. The challenges of policy implementation and success lie in the heterogeneity of the players (Walsham, 2010); as different players may have different agenda. In this paper, we examine the Ministry of Health (MoH) data storage policy which stipulates that all patient-related data should be stored within the borders of Malawi.

The policy comes at a time when most organizations are turning to cloud computing for storage. Cloud computing is a model for enabling universal, convenient, on-demand network access to a shared pool of configurable computing resources such as networks, servers, storage, applications, and services (Mell & Grance, 2011). In the recent decade Malawi health sector has shifted from traditional ways of manual collection, storing and managing health data to digital technologies due to the growing demand for good quality health information and also as a result of performance-based resource allocation by donors. This shift has brought about the need to come up with effective ways of storing, sharing and access to the data that should also keep up with the growing demands of the data. Evidence has shown that cloud computing use in the healthcare offers many benefits such as storage of large amounts of data (it is scalable and elastic for increasing or decreasing), offering remote data access and allowing sharing between authorized units (Manya, Nielson, & Pundo, 2016).
The Malawi National Health Information Systems Policy (2015) states that any health-related data whether physical or electronic shall be stored only within the borders of Malawi except for the purpose of continuation of care, on the other hand there is evidence of cloud computing utilization in the health sector. This paper describes and analyses the policy-practice contradictions when it comes to implementation. Contradiction here is defined as the dynamic interplay between unified opposites that are actively incompatible (Baxter & Montgomery, 1998) and contrary to each other.

Malawi health sector was chosen as the context of study because the resources necessary for information management in the health sector such as skilled human resource, finance, technical and physical infrastructure (Smith, 2018), laws and policies have not evolved in parallel to cope with increased demand for data management (MoH, Malawi National Health Information System Policy, 2015) a condition that may force the country to adopt cloud computing technology.

2 LITERATURE REVIEW

1.1 Why Policy

A Policy is important because no public activity can be attempted without the stipulation of clear objective and a proper policy (Marume, 2016). As such, public policies emerge in response to policy demands, or those claims for action or inaction on some public issue made by other actors (Anderson, 2003). Other than the definition of policy provided in the introduction section above, Dodd and Boyd (2000) had defined policy as a plan of action agreed to by a group of people with the power to carry it out and enforce it. In their definition, two terms are of interest: having the power to carry it and enforcing the policy. Policy plays an important role in influencing the degree which research findings may influence health services, however, while there may be extensive research on the effectiveness of health-care interventions, there is often less evidence on their cost-effectiveness, implementation, cultural appropriateness and effects on health inequalities, all of which are important considerations for policy-making.

1.2 Factors affecting Policy Implementation

A number of factors affect policy implementation, Kunyenje (2019) found that excessive influences of the external actors led to the resulting National ICT policy not being owned and consequently not implemented. Social challenges such as shortage of infrastructure (MoH, Malawi National Health Information System Policy, 2015) also affect policy implementation.

1.3 Cloud Computing in the Health Sector

Cloud computing is increasingly becoming important in the generation, storage and transmission of information worldwide and has made a tremendous impact on the information technology industry over the past years (Manya, Nielson, & Pundo, 2016). The health sector is one of the fields that is gradually gaining acceptance of cloud computing technology as an effective means of improving healthcare delivery across the globe (Mgozi & Weeks, 2015). The effectiveness of health care services relies on the availability of information systems that convey timely, accurate and readily available information to health practitioners, policy makers, researchers and the general public (Yi et al., 2008) as cited in (Msiska, 2018).

Institutions do not need to invest on hardware, complex technical capacity and maintenance because these concerns are already taken care of by the cloud computing providers thus resulting in a more efficient and improved health care management (Munene & Macharia, 2015). Cloud computing essentially stores all of its applications and databases in the data centers which are mostly stationed in different locations. Initiatives in eHealth should be seen as an investment in the health sector to
secure benefits that exceed costs over time by adopting appropriate architecture coupled with comprehensive and rigorous interoperability standards to ensure sustainable HIS (Mgozi & Weeks, 2015). It should also be known that despite the cloud computing benefits there are also some concerns mostly to do with data ownership, privacy and security of the data due to the location of the servers by many institutions (Rieger, Gewald, & Schumacher, 2013; Sahay, Sundararaman, & Braa, 2017).

1.3.1 Key Benefits of Cloud Computing

There are different ways in which cloud computing may benefit the health sector and make health industry more advanced and efficient. These include: *pay-as-you-grow* where public cloud providers like Amazon allow companies to avoid large up-front infrastructure investment. This model is a relevant approach in health institutions in developing countries where financial resources for investment in hardware are scarce and the human capacity to maintain local servers is often lacking and they cannot afford to spend large sums of money at the beginning of their business journey (Manya, Nielson, & Pundo, 2016). A second benefit is *initial cost saving*, this eliminates upfront cost, offering economic savings and financial benefits of decreasing the cost of entry by reducing the initial and operational costs for start-up of new IT projects (Abubakar, Bass, & Allison, 2014; Alharbi, Atkins, & Stanier, 2017). *Simplicity* is another key benefit where there is relief of not having to buy and configure new equipment. This allows institutions and their IT staff to get right to their core business as the cloud solution makes it possible to get the application started immediately, and it costs a fraction of what it would cost to implement an on-site solution (Velte, Velte, & Elsenpeter, 2010). Finally, there is *accessibility of information*; Cloud computing enables remote access to information and applications irrespective of the location and accessible via the internet using a secure authentication (Council, 2017). Literature shows that cloud in health opens up a new horizon facilitating availability of information irrespective of the location of the patient and the clinicians which enables improved clinical outcomes and physicians make right decisions when critical information such as blood types, X-Ray and test results are viewed at the right time (Priyanga.P, 2015; Almubarak, 2017).

1.3.2 Challenges of Cloud Computing

As with any other technology cloud computing has its own challenges that play a major role in the decision-making process for institutions. It should be well known that challenges of cloud computing differ between different context. *Data security* being the most challenging barrier to cloud computing in that some institutions fear its adoption due to the sensitivity of their data. Security is linked with the concepts of integrity, confidentiality, authenticity and availability which should be carefully examined (Anand, 2018). This is the most dominant factor influencing the adoption of cloud computing particularly in health institutions because the data requires a more secure environment for storage and retrieval of information (Lian, Yen, & Wang, 2014).

However, there are two schools of thought, one as articulated above, argue that given the sensitive nature of the health information, there may be some reservations because everyone wants to be assured that their private and confidential data is safe. A second school of thought argue that there is no guarantee that data is better protected internally compared to the cloud; in a sense that there is a possibility that data could be even safer in the cloud because cloud providers may pose higher level of data security expertise compared to in-house expertise (Kuo, 2011; Gorelik, 2013; Abubakar, Bass, & Allison, 2014). *Lack of awareness* of what cloud computing concepts are and what benefits and risks exists when institutions adopt is another challenge especially in developing countries, and this may weaken its adoption (Muhammed, Zaharaddeen, Rumana, & Turaki, 2015). The lack of exposure and prior experience makes it impossible for top management IT personnel to
be fully aware of what it entails to adopt cloud computing technology (Dahiru, Bass, & Allison, 2014; Abubakar, Bass, & Allison, 2014; El-Gazzar, Hustad, & Olsen, 2016). Another challenge is vendor lock-in, a situation where customers are dependent (i.e. locked-in) on a single cloud provider technology implementation and cannot easily move to a different vendor without substantial costs, legal constraints, or technical incompatibilities (Opara-Martins, Sahandi, & Feng, 2016). Applications that are developed on a platform of one cloud provider cannot be easily migrated to the other provider as they may be running different versions of the same open-source system and may have their own ways of doing things. Each cloud provider for SaaS solutions creates its own application programming interfaces (APIs) to the application (Petcu & Crăciun, 2011). Since there are no uniform cloud management software standards across different providers available, once an institution invests time and resources to establish operations on one cloud platform, it can be difficult to switch (Gorelik, 2013).

1.4 Applications of Cloud Computing in Health

Literature indicates that some countries are already using cloud computing services in health. A South African non-governmental organization, combines the cloud with database technology and mobile services to fight HIV/AIDS transmission from mother to children. They digitize patient records and shares them with counsellors across its networks of over 700 sites in Africa. The records contain information on treatment plans, and advanced reporting tools, which allow quick response (Kshetri, 2011). In Kenya, cloud computing is used to host a web-based national data warehouse. This uses an international cloud hosting company physically located in London for implementation of the DHIS2 system. The study showed that with that development the immediate benefit was availability of data, which made it possible for stakeholders at all levels of the government to access the data online avoiding bureaucracy of seeking permission from the decentralized government units. This, in the long run also enabled the integration of national data thus reducing fragmentation of parallel systems (Manya, Nielson, & Pundo, 2016). Furthermore, a study showed that in Australia, cloud computing is used in telemedicine, combined with multiple concepts such as e-appointment, e-consulting, and e-prescription to enable patients to use the internet for maintaining remote connection with their physicians and discussing their health-related problems (Moghaddasi & Tabrizi, 2017). The resulting system allowed the physician to easily access the patient’s medical history, files, test results, etc (ibid.).

1.5 Factors Influencing Cloud Computing Adoption

There are several factors that may influence institutions to adopt cloud computing despite the known characteristics and benefits that the technology offers. Cloud computing is not a one size fits all hence institutions need to assess their current and future IT systems needs very well and understand its concepts before making any decision to adopt the technology or not. Cloud computing adoption in the health institutions requires strategic planning and insight to gain full advantages and trade-offs of this new model (El-Gazzar, Hustad, & Olsen, 2016). These factors have been grouped in terms of technological, organizational, and environmental as stipulated in the TOE theoretical model.

1.5.1 Technological Factors

The technological context includes all of the technologies that are relevant to the firm, both technologies that are already in use at the firm as well as those that are available in the marketplace but not currently in use (Baker, 2011). Technological factors comprise of relative advantage, complexity, and compatibility.
1.5.2 Organizational Factors

The organizational context includes attributes such as size, quality of human resources, and complexity of the firm’s managerial structure (Low, Chen, & Wu, 2011). Top management support and behaviors are critical for creating a conducive environment for providing adequate resources for the adoption of new technologies as cited in (Low, Chen, & Wu, 2011). Top management must be willing to allocate valuable organizational resources (Willcocks & Sykes, 2000). In addition, top management must have sufficient information for cloud services which it requires and align with the vision of their institution if they are to use a specific cloud service (Abdollahzadehgan, Hussin, Gohary, & Amini, 2013).

1.5.3 Environmental Factors

Environmental factors refer to a firm’s industry, competitors and government policy or intention (Low, Chen, & Wu, 2011). The environmental factors that have been used in this study are government policy and vendor scarcity. Government Policy refers to policy relating to the geographic location of where the data is stored. Data protection is a general concern for most countries wishing to adopt cloud computing technology. A study conducted in South Africa showed that the legislative policy framework is a critical enabling factor to resolve key concerns inhibiting the adoption of cloud computing in the health sector (Mgozi & Weeks, 2015). Whereas the German banking sector revealed that government regulations are a major factor influencing the cloud-computing decision as they are highly interdependent with other factors like security and compliance requirements, the data and provider location (Rieger, Gewald, & Schumacher, 2013). Furthermore, a study conducted in Saudi Arabia revealed that national regulation about the implementation of cloud computing can play an important role in supporting or slowing the adoption (Alharbi, Atkins, & Stanier, 2017). Vendor Scarcity is another environmental factor which is the availability of credible and experienced cloud service providers. A study conducted in China revealed that institutions may be constrained in their vendor selection if the service they need is not available (Li, Zhao, & Yu, 2014). In German, a study showed that the image of the cloud service provider plays a role as it builds trust, especially for handling sensitive data (Rieger, Gewald, & Schumacher, 2013) and the cloud provider’s reputation plays an important role in meeting business needs as stipulated in the service level agreement (Sadoughi, Ali, & Erfannia, 2019).

1.6 Policy Diffusion

Policy diffusion is a process where policy innovations spread from one government to another (Shipan and Volden 2008). Policy-makers learn from other governments experiences: particularly where an adopted policy is deemed successful elsewhere. The second mechanism, economic competition, can lead to the diffusion of policies with economic spillovers across jurisdictions. Policy-makers consider the economic effects of adoption (or lack thereof). Particularly where there are positive spillovers, governments are more likely to adopt the policy of others (Shipan and Volden 2008). Another mechanism is imitation/emulation which means ‘copying the actions of another in order to look like the other’ (Shipan and Volden 2008: 842). The last mechanism is coercion, this is different from the other three which are voluntary. For instance, countries can coerce one another through trade practices or economic sanctions, either directly or through international organizations (Shipan and Volden 2008).

1.7 Conceptual framework

This study adopts concepts from two theories: i) the TOE theoretical framework (Baker 2011) to illuminate the factors’ that influence cloud computing adoption as detailed in section 2.5. The theory focuses on Technological, Organizational and Environmental issues of which policy is one of the
specific environmental factors. ii) As a way of understanding how the data storage policy came into being, *policy diffusion* is used to complement the TOE theoretical framework, focusing on the mechanism of imitation/emulation.

2 METHODOLOGY

This paper is part of findings of a qualitative study which was chosen with the aim of gaining an in-depth understanding of cloud computing adoption in the context of health institutions. The research was carried out in different health institutions in Malawi which helped in answering different factors influencing cloud computing adoption, the perceived benefits and potential barriers to the adoption of cloud computing at the level of the institution in the health sector. The factors assisted in examining the policy practice contradiction that exists.

Data was gathered from fourteen (14) health institutions targeting middle and top managers who were purposively selected as respondents with experience and expertise in health information systems management and knowledge of cloud computing technology.

Whilst the broader study was guided by the Technology Organizational and Environment (TOE) theoretical framework, this paper complements TOE theoretical framework with Policy diffusion (imitation) concept to be able to understand the genesis of the data storage policy.

2.1 Data Collection

The respondents for the study were from fourteen (14) selected health institutions in Malawi that are currently managing different data systems either for program monitoring, studies or clinical trials. The study used purposive sampling technique to choose key respondents, which is the deliberate choice of an informant due to the qualities the informant possesses (Tongco, 2007). The respondents interviewed were mostly middle or top manager representatives as these were perceived to be the most knowledgeable or experts in the research area and perceived to provide relevant information pertaining to the study. The initial sample size for the study was nineteen (19) health institutions out of 31 health institutions registered to be actively using different IT solutions. Nineteen (19) institutions were purposively selected and invitation for interviews were sent via email and followed up by phone, fourteen (14) responded and accepted to take part in the interview. All the interviews were done virtually due to covid-19 which made it impractical to arrange for face-to-face interviews or follow-up.

2.2 Approaches to Theory

This study was an interpretive approach and was guided by a Technology Organizational and Environment (TOE) theoretical framework. The data collected was guided by the main themes that are used in the framework namely *technology* which the researcher looked in terms of relative advantage, complexity and compatibility, *organization* which the researcher looked in terms of top management support, technology readiness particularly IT infrastructure as well as the quality of human resources and lastly *environment* in terms of government policies and vendor scarcity.

<table>
<thead>
<tr>
<th>No.</th>
<th>Institution</th>
<th>Position</th>
<th>Communication Mode</th>
<th>Found Via</th>
</tr>
</thead>
<tbody>
<tr>
<td>01</td>
<td>R1</td>
<td>Health Informatics Manager</td>
<td>Skype</td>
<td>LinkedIn</td>
</tr>
<tr>
<td>02</td>
<td>R2</td>
<td>IT Manager</td>
<td>Skype</td>
<td>LinkedIn</td>
</tr>
<tr>
<td>03</td>
<td>R3</td>
<td>IT Officer</td>
<td>WhatsApp Call</td>
<td>Other Colleagues</td>
</tr>
</tbody>
</table>

Table 1 – Respondents’ communication mode
2.3 Data Analysis

The first five (5) recorded interviews were manually transcribed and the remaining ones were transcribed using Express Scribe software version 9.09 upon the researcher being introduced to it, which proved to be faster than the manual transcription. Data analysis was done based on the main themes that were used in the theoretical framework.

3 FINDINGS AND ANALYSIS

The study found that cloud computing was already in use in most of the institutions interviewed. Eleven (11) institutions out of the fourteen (14) interviewed were already using cloud services in their institutions and one (1) once used but was no longer using and the other two (2) were not using any cloud services. Table two shows the different cloud services used by the institutions interviewed.

Table 2: Cloud Usage in Institutions

<table>
<thead>
<tr>
<th>Institution</th>
<th>Core Competence</th>
<th>Type of Institution</th>
<th>Using Cloud</th>
<th>Type of Service</th>
<th>Cloud Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>R1</td>
<td>● Health SystemStrengthening</td>
<td>International</td>
<td>Yes</td>
<td>SaaS, IaaS</td>
<td>● Data hosting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>● Online collaboration</td>
</tr>
<tr>
<td>R2</td>
<td>● Primary Health Care</td>
<td>International</td>
<td>Yes</td>
<td>SaaS, PaaS</td>
<td>● Data hosting</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>● Build applications</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>● Online collaboration</td>
</tr>
<tr>
<td>R3</td>
<td>● Health Systems Strengthening</td>
<td>National</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
</tbody>
</table>
The study shows that some factors influencing cloud computing adoption are context specific to developing countries and a lot of investment must be done as well as create awareness campaigns to enlighten institutions on the risks and benefits associated with the technology to clear out any misconception that institutions may have.

### 3.1 Is the Malawi Health Sector Technological Ready?

Most respondents mentioned that for their IT human resources there is readiness. However, lack of basic IT and network infrastructure was their main hinderance in the adoption of cloud because that is a prerequisite for cloud computing. Poor ICT infrastructure and poor connectivity were also mentioned as technological factors affecting cloud computing adoption.

<table>
<thead>
<tr>
<th>R4</th>
<th>• HIS Innovation</th>
<th>International</th>
<th>Yes</th>
<th>PaaS</th>
<th>• Hosting applications</th>
</tr>
</thead>
<tbody>
<tr>
<td>R5</td>
<td>• Healthcare and systems delivery</td>
<td>International</td>
<td>Yes</td>
<td>SaaS, IaaS</td>
<td>• Data storage • Online collaboration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R6</td>
<td>• HIS Innovation</td>
<td>National</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>R7</td>
<td>• Healthcare service delivery</td>
<td>National</td>
<td>Yes</td>
<td>PaaS</td>
<td>• Data collection</td>
</tr>
<tr>
<td>R8</td>
<td>• Clinical Research</td>
<td>International</td>
<td>Yes</td>
<td>SaaS, IaaS</td>
<td>• Data backup • Online collaboration</td>
</tr>
<tr>
<td>R9</td>
<td>• Epidemiological Research</td>
<td>International</td>
<td>Yes</td>
<td>PaaS, IaaS</td>
<td>• Data collection • Data hosting • Build applications</td>
</tr>
<tr>
<td>R10</td>
<td>• Capacity building and Research • HIS Innovation</td>
<td>National</td>
<td>Yes</td>
<td>SaaS, IaaS</td>
<td>• Data hosting • Online collaboration</td>
</tr>
<tr>
<td>R11</td>
<td>• Health Systems Innovation</td>
<td>International</td>
<td>Yes</td>
<td>SaaS, PaaS</td>
<td>• Data management • Build applications</td>
</tr>
<tr>
<td>R12</td>
<td>• Healthcare service delivery</td>
<td>National</td>
<td>No</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>R13</td>
<td>• HIS Strengthening</td>
<td>National</td>
<td>Yes</td>
<td>IaaS</td>
<td>• Data hosting</td>
</tr>
<tr>
<td>R14</td>
<td>• HIS Strengthening • HIS Innovations</td>
<td>International</td>
<td>Yes</td>
<td>PaaS</td>
<td>• Hosting applications</td>
</tr>
</tbody>
</table>

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The most common barrier which I have noticed in these health centers is usually connectivity, so most of the health centers are located in the remotest part of this country where you cannot even make a phone call, connectivity is quite a challenge” R2.

3.2 Vendor Scarcity

The availability of credible vendors was another factor that this study found to significantly influence the level of adoption of cloud computing. Respondents stated that there is scarcity of cloud vendors within Malawi, a thing that leads them to use other cloud vendors outside Malawi. Some respondents mentioned that having a reliable cloud provider especially within the country would increase trust and enable all those with doubts about the technology to physically go and ask. At the time of write-up only one cloud provider was identified in Malawi. In addition, because the credibility and history of the new entrants in the cloud service market is not yet known, it may have a negative impact on the level of confidence that institutions may have.

“We will wait and see what others will experience with this new vendor, we cannot give them all our data or give them business when we do not know their history, we do not want to be part of the experiment, we would rather be with those that are already known” R5.

3.3 Government Policy

Government policies related to IT in this study showed that it is a significant factor that may inhibit the adoption of cloud computing. The location of where the data is replicated for disaster recovery preparedness is something that may break the regulations put forward by the Malawi government on the geographical boundary of the data. The results in this study are consistent with the findings from studies conducted in the German banks and Bangladesh education sector that showed that government regulations heavily influence the cloud computing decision in that the location where data is being stored and where the cloud provider resides is a major factor influencing cloud computing decision-making (Rieger, Gewald, & Schumacher, 2013; Rahman & Rahman, 2019). Furthermore, the respondents were asked on their perception on the current government policies and if they are at par with current HIS innovations. The respondents had mixed views; others expressed that the policies are at par with current HIS innovations but only lack enforcement but 36% of the respondents felt that they need to be updated because ICT has evolved. A similar study conducted in Malawi on cloud computing adoption in Higher Education Institutions (HEI) also concurs with the findings of this study that policies and regulations put forward by the government may affect the environment for the adoption of cloud computing in institutions (Makoza, 2016).

Potential Benefits for Cloud Computing Adoption

The respondents (50%) expressed that cloud computing can offer cost saving in institutions by transitioning from capital expenditure to operational expenditure in form of monthly or annual fees. Storage capacity that comes with the cloud technologies was another benefit cited by 37% of the respondents. This was viewed from the volumes and variety of data that most institutions are storing for different programmes. One (1) respondent expressed the storage capacity to be one of the gains for cloud technologies in this regard: “The potential benefits that we can have is the storage capacity because I know at the [...] we have limited capacity of hosting large data, so we can gain on that” R3. It was also mentioned that cloud can act as a means of backing up data in case of unforeseen circumstances such as loss of data by the institutions.

Broad network access where data or applications are accessed anytime from anywhere from any device with internet access was another benefit that respondents mentioned. Institutions that have offices outside of Malawi or those within Malawi but operating in different regions or districts shared this benefit. Another benefit cited was system availability. System availability for cloud
infrastructure can be referred to the time that the data center is accessible or delivers the intended IT service.

3.4 Potential Barriers of Cloud Computing Adoption

The barriers to cloud computing have been summarized as indicated in Table 2.

Table 3 - Barriers to Cloud Computing

<table>
<thead>
<tr>
<th>Barriers of Cloud Computing</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Connectivity</td>
<td>Eight (8) respondents expressed concern on how poor the connectivity is for Malawi to support a technology like cloud computing.</td>
</tr>
<tr>
<td>Data Security</td>
<td>Six (6) respondents highlighted that the nature of data that most institutions have and the fear of privacy and confidentiality breach when they move it to a cloud storage is a barrier.</td>
</tr>
<tr>
<td>Running Costs</td>
<td>Six (6) respondents expressed a concern on the running cost of cloud such as high internet charges to be the barrier for cloud adoption</td>
</tr>
<tr>
<td>Lack of Awareness</td>
<td>Four (4) respondents mentioned that lack of awareness of cloud computing weakens the adoption.</td>
</tr>
<tr>
<td>Perception</td>
<td>Three (3) respondents mentioned that the perception that people have that they will lose control of their data and that it is not safe if moved to cloud is more likely to hinder its adoption</td>
</tr>
<tr>
<td>Government Policies</td>
<td>Two (2) respondents mentioned that the government policies are not accommodating to support cloud technologies</td>
</tr>
<tr>
<td>Legislations</td>
<td>One (1) respondent expressed that the legal differences in place by different regions hosting cloud technologies may be a barrier for cloud computing</td>
</tr>
</tbody>
</table>

4 DISCUSSION AND CONCLUSION

4.1 Technological Readiness

Most respondents mentioned that for their IT human resources there is readiness. However, lack of basic IT and network infrastructure was their main hinderance in the adoption of cloud. This is consistent with findings from study conducted in Portugal on the determinants of cloud computing adoption (Oliveira, Thomas, & Espadanal, 2014) which stated that technology readiness is a significant factor and that institutions must ensure that the technology infrastructure as well as IT specialists are adequate for the integration of cloud-based solutions in their institutions. However, this study also highlighted some context-specific factors such as poor ICT infrastructure and poor connectivity which emphasize findings in most studies related to developing countries (Muhammed, Zaharaddeen, Rumana, & Turaki, 2015; Skafi, Yunis, & Zekri, 2020).

4.2 Vendor Scarcity

The availability of credible vendors was found to significantly influence the level of adoption of cloud computing. Respondents stated that the scarcity of cloud vendors especially within Malawi may lead institutions to engage external vendors thus resulting into non-compliance with what the policy stipulates. A study conducted in China (Li, Zhao, & Yu, 2014) also found that institutions may be constrained in their vendor selection if the service they need is not available with existing vendor because of lack of competition in the emerging market, which may compromise the quality of services provided. A study conducted in a Jordanian Hospital articulates that vendor scarcity plays a vital role, given that the presence of sufficient, reputable, and competent vendors will encourage
institutions to adopt cloud services and create trust with the providers and the technology itself (Harfoushi, Akhorshaideh, Aqqad, & Janini, 2016). Here we have a situation where we have only one cloud provider as indicated in the findings whose history or reputation is not yet established which may have an impact on the choice of provider by clients. The global cloud service providers have more and secure data centers and are more careful when providing cloud computing services making sure they do it in an appropriate manner (El-Gazzar R. F., 2014).

4.3 Policy, Practice and Pragmatism

The Malawi government has a policy that stipulates that any patient-related data generated locally must be housed within the geographical boundaries of Malawi. The findings of this study, however, show that seventy six percent (76%) of the institutions interviewed were already using the cloud services. One (1) of the respondents further stated that they use cloud storage because it was a prerequisite put forward by the donor funding their project but further expressed that the data they store for such projects is not sensitive. Two (2) respondents mentioned that they use cloud computing for easy data sharing and collaboration with other staff outside Malawi. In addition, from secondary data collection it was noted that 70% of implementing partner institutions host their data off-premise outside Malawi. This is a clear indication that what the policy stipulates and reality on the ground is contrary, at the time of data collection there was no indication of any a single enforcing policy decision into implementation concerning cross-border data transfers. Dodd and Boyd (2000) had defined policy mentioning two terms of interest in their definition: i) having the power to carry it and ii) enforcing the policy. Where donor puts forward conditions where to store data, then the power to carry out is lost. Additionally, the findings clearly indicate that over 70% are already using the cloud, a thing that makes enforcement difficult to implement.

The practicality of having policy enforcement match practice on the ground would be to have a central data repository locally being managed by the available local cloud provider. In addition, there must be a supporting updated national policy to establish a quality and secure cloud hosting environment in these local data centers. Having a central repository would also ensure that data remains in the country even when some international projects phase out.

However, with the performance-based funding allocation put forward by most donors, cloud technology may be one way that institutions looking for solutions that will enable them to monitor their data in a timely manner from anywhere.

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Factors enhancing e-government service gaps

Gilbert Mahlangu, Cape Peninsula University of Technology and Midlands State University, mahlago97@gmail.com
Ephias Ruhode, Cape Peninsula University of Technology, RuhodeE@cput.ac.za

Abstract: Globally, the discourse of e-government has gathered momentum in public service delivery. No country has been left untouched in the implementation of e-government. Several government departments and agencies are now using information and communication technology (ICTs) to deliver government services and information to citizens, other government departments, and businesses. However, most of the government departments have not provided all of their services electronically or at least the most important ones. Thus, this creates a phenomenon of e-government service gaps. The objective of this study was to investigate the contextual factors enhancing e-government service gaps in a developing country. To achieve this aim, the TOE framework was employed together with a qualitative case study to guide data collection and analysis. The data was collected through semi-structured interviews from government employees who are involved in the implementation of e-government services in Zimbabwe as well as from citizens and businesses. Eleven (11) factors were identified and grouped under the TOE framework. This research contributes significantly to the implementation and utilisation of e-government services in Zimbabwe. The study also contributes to providing a strong theoretical understanding of the factors that enhance e-government service gaps explored in the research model.

Keywords: E-government, e-government service, e-government factors, service gaps, implementation, Zimbabwe, developing country

1. INTRODUCTION
E-government is the praxis of transforming government services from traditional to electronic means using modern information communication technologies (ICTs) to provide easy access to government services for all users such as citizens, businesses, and government agencies (Hanum et al., 2020). Globally, the discourse of e-government has gathered momentum in the public service delivery (Alabdallat, 2020; Almutairi et al., 2020; Jacob et al., 2019; Lee & Porumbescu, 2019; Lindgren et al., 2019; Mukamurenzi, 2019; Sánchez-Torres & Miles, 2017; Twizeyimana & Andersson, 2019). Accordingly, Alabdallat (2020) revealed that no country has been left untouched in the implementation of e-government. Several government departments and agencies are now using ICTs to deliver government services and information to citizens, other government departments, and businesses. However, Alabdallat (2020, p. 5) noted that “most of the government departments have not provided all of their services electronically or at least the most important ones. This issue seems to be confined to the developing countries, especially among countries with very low incomes”. Thus, this creates a phenomenon of e-government service gaps.

There is a range of definitions of this term, but in this study, e-government service gaps refer to the extent to which e-government services are not fulfilled to the intended users (government employees, businesses and citizens) of the e-government system (Herdiyanti et al., 2018) either because the system is constrained to deliver the required services or some of the expected services are not being provided. Thus, e-government service gaps represent two major fine points: the constraints on the system to deliver e-services and the service deficiencies from the government.
E-government service gaps in developing countries have not yet been bridged (Sterrenberg & Keating, 2016). Despite the significant amounts of public investment committed to enhancing e-government over the past two decades, the use of this service is still limited (Pérez-Morote et al., 2020). Citizens are still required to visit respective government departments and agencies to get basic information, complete and submit forms (Madariaga et al., 2019) or get other services that possibly can be offered electronically (Alraja, 2016; Khamis & Weide, 2017). Predominantly, public service delivery in developing countries is still characterised by inefficient, rigid and manual systems (Singh & Travica, 2018; Yang, 2017).

This study aimed to explore the opinions of government employees, businesses and citizens to understand the contextual factors enhancing e-government service gaps in a developing country from multiple perspectives. To accomplish the objective of the study, the primary research question was formulated as follows: What are the contextual factors enhancing e-government service gaps in a developing country resulting in low usage?

2. LITERATURE REVIEW
2.1. The concept of e-government
Ideally, e-government is expected to decrease travelling costs, reduce waiting time for the service, reduce operational time, decrease corruption and cost in service delivery, increase transactional capabilities and convenience and improve accessibility (Alabdallat, 2020; Dewa & Zlotnikova, 2014; Kalu & Masri, 2019; Nabafu & Maiga, 2012). The emphasis on e-government implementation is put on how to transform both internal and external relationships of governments to reduce complex and over-stretched bureaucratic system (Alassim & Alfayad, 2017; Almutairi et al., 2020; Janowski, 2015; Mees et al., 2019). The emergence of e-government was a response to make government departments and agencies more efficient and open in public service delivery by utilising ICTs to provide services electronically (Sharma, Bao & Peng, 2014). Thus, the resulting transformation makes the government more efficient and transparent in delivering public services. For these reasons, the concept of e-government is treasured for being evolutionary, transformational, efficient, and transparent.

2.2. E-government service delivery models
Accordingly, the transformation drive in public service is facilitated by the following e-government delivery models: Government-to-Government (G2G); Government-to-Employees (G2E); Government-to-Business (G2B); and Government-to-Citizens (G2C) (Ahmad et al., 2019; Ramdan et al., 2014; Voutinioti, 2014). On the first hand, G2G represents the backbone platform for e-government adoption, implementation and utilisation in the entire country (Voutinioti, 2014). On the other hand, G2E represents an internal relationship between the government and its employees (Ramdan et al., 2014). G2B service delivery model denotes an online platform that enables government and business organisations to do business electronically (Ahmad et al., 2019). Lastly, G2C ensures that the citizens interact and transact with the government far and wide (Ramdan et al., 2014).

2.3. E-government in developing countries: The African context
Studies have confirmed that most of the government services in developing countries particularly in Africa are still unavailable online (Humphrey et al., 2016; Rabaa et al., 2018; Sarrayrih & Sriram, 2015; Singh & Travica, 2018; Twizeyimana et al., 2018). African region lags in e-government development compared to the rest of the world. Basic e-government services are still not easy to find in African countries; only limited services are offered online (Agboh, 2017; Mukamurenzi, 2019; Owusu-Ansah, 2014; Twizeyimana et al., 2018; Verkijika & De Wet, 2018). Most government services are still provided manually. Probably, this is the reason why developing countries have the lowest e-government service development intensity. Thus, this suggests that there
2.4. E-government services in Zimbabwe: The research context
Like many other developing countries, Zimbabwe is implementing e-government projects as part of the public sector reforms to improve service delivery among government departments, agencies, businesses and citizens (Munyoka, 2019; Nhema, 2016). The major target of the public sector reforms in the context of e-government is to exterminate institutional constrictions related to the conventional methods of public service delivery. Even though the country seems to be committed to the implementation of e-government projects, still, the ability to provide comprehensive e-services is not attainable. The country compares relatively low with other countries in the world, the African continent as well as in the Southern African Development Committee (SADC) region (Munyoka, 2019). In fact, by 2018, the country was ranked 146 out of 193 in EGDI and last in SADC while the Online Service Index (OSI) stood at the mean value of 0.3246 (Dias, 2020). This ranking reflects a significant need in providing comprehensive e-government services.

2.5. Factors affecting e-government adoption, implementation and usage
E-government projects in developing counties face a variety of challenges during their implementation and utilisation but the severity of these issues varies from context to context (Mustafa et al., 2020). Generally, these challenges can be categorised as follows:

2.5.1. Infrastructure
Many studies have concluded that developing countries do not have adequate infrastructure to successfully deploy e-government projects (Baheer et al., 2020; Hanum et al., 2020; Heeks, 2003; Kanaan et al., 2019). Challenges such as low penetration of fixed-line telecommunications; inadequate electricity supply (Richardson, 2011) and low teledensity (Sareen et al., 2013) make it difficult to deploy e-government countrywide. This condition has resulted in e-government service gaps. The gaps are created in multifold: first and foremost, lack of infrastructure hinders the delivery of e-government services by acting as an obstruction for government departments and agencies to provide e-services; secondly, lack of infrastructure obstructs the demand for e-government services by impeding citizens to access e-government services; and lastly, unreliable infrastructure can degrade the performance of e-government systems; thereby, making it difficult to for users to obtain higher-level e-government services.

2.5.2. Interoperability
In the context of e-government, interoperable depicts the ability of independent systems and devices to communicate with each other and share data (Apleni & Smuts, 2020; Sulehat & Taib, 2016). Most of the e-government systems deployed in developing counties operate in 'silos'; the e-government landscape is fragmented within and across ministries, departments and agencies (Apleni & Smuts, 2020; Baheer et al., 2020; Mohlameane & Ruxwana, 2020; Nakakawa & Namagembe, 2019; Sulehat & Taib, 2016). This situation has made the realisation of e-government benefits merely a delusion. In consequence, the lack of interoperability results in the loss of entirely reaping the prospective benefits of e-government such as more efficiency; enhanced services to better serve citizens; and better accessibility of public services.

2.5.3. Digital divide
The digital divide is a dynamic and complex problem that is creating service gaps in developing countries particularly in the utilisation of e-government services. It is the gap between people who have access to the internet and those who do not (Alabdallat, 2020). The digital divide reflects the lack of and/or limited access to electronic services by citizens. It is regarded as a significant barrier to the implementation and utilisation of e-government since many communities and citizens do not have access to the internet and computing devices (Alabdallat, 2020; Chipeta, 2018; Idoughi &
Abdelhakim, 2018; Twizeyimana & Andersson, 2019b). This restricts the adoption and utilisation of e-government to those who have access to the technology and the requisite skills to use e-services. Therefore, those who do not have access to ICTs and necessary ICT skills cannot access e-services; and thus fail to benefit from e-government projects implemented in their service constituencies (Haider et al., 2015; Twizeyimana & Andersson, 2019; Verkijika & De Wet, 2018).

2.5.4. Human factor
The human factor is critical in the success of e-government. According to Farzianpour et al. (2015), once the infrastructure has been established, there is a need for ICT skills to enhance the effective implementation and utilisation of online services. Nevertheless, a range of studies has reported that the lack of ICT skills is the dominant human aspects under the barriers to e-government initiatives (Aneke, 2019; Khan & Ahmad, 2015; Owusu-Ansah, 2014). For instance, Owusu-Ansah (2014) reported that e-government has failed in developing countries due to inadequate ICT skills among government employees and citizens. Apart from lack of skills, various studies on critical success factors in the implementation of e-government in developing countries have reported the lack of expertise by government employees to develop, operate and maintain e-government systems (Aneke, 2019; Khadaroo et al., 2013; Layne & Lee, 2001).

2.5.5. Policy factor
According to Dias (2020), a policy is a premeditated plan of action aimed at guiding decisions and accomplishing judicious outcomes. The issue of policy as well as forms part of the factors that affect the implementation of e-government (Apleni & Smuts, 2020). This is because the deployment and use of e-government systems call for a variety of policies to regulate electronic activities. However, Islam (2013) noted with great concern that in developing countries there is a lack of clearly defined policy for e-government implementation. Very few countries (Singapore and Malaysia) have stand-alone policies for implementing e-government (Alabdallat, 2020; Apleni & Smuts, 2020; Bwalya, 2009; Dias, 2020; Nurdin et al., 2014; Zaied et al., 2017); the implementation of e-government is either driven by national ICT policies or it is the sole responsibility of the ministries, departments and agencies (MDAs). This factor demonstrates a major policy gap in the implementation of e-government projects in developing countries.

2.5.6. Funding
Funding is the priority factor for successful e-government adoption because “any e-government initiatives require funding to initiate and maintain e-government projects” (Apleni & Smuts, 2020, p. 19). However, most developing countries are struggling to fund their e-government initiatives except for few countries. They lack financial support in the implementation of e-government projects resulting in a funding dilemma even if governments have plans for the implementation of e-government (Fasheyitan, 2019; Khadaroo et al., 2013; Ziba & Kang, 2020). As a result, most e-government projects particularly in African countries are donor-funded. The reliance on donor support for e-government implementation often results in untenable funding in the event donor support is terminated; thus, impeding progress in the implementation of e-government (Khadaroo et al., 2013).

3. THEORETICAL FRAMEWORK
This study used the Technological- Organisational- Environmental (TOE) model to study the factors enhancing e-government service gaps in a developing country context. According to Defitri et al. (2020), “the TOE framework originates from the theory of adoption of new technologies, making [it] widely adopted in various studies as compared to other models” (p. 40). This framework provides key benefits for understanding the factors that exist in the context of technology, organisation, and environment in influencing the process of adopting technological innovation. Technological factors refer to the existing and new technologies, for example, telecommunications, electricity, computers, and bandwidth necessary for the implementation and usage of e-government services while the
organisational factors describe the attributes of an organisation such as top management support, e-government funding, skills and competences. The environmental context focuses on the external factors that drive the adoption and implementation of new technology policy and regulations. Furthermore, the TOE was adopted as the underpinning theory in this study because it was considered to unveil a wide range of factors associated with technology, organisation and the environment that may shape the implementation and usage of e-government services in a developing country. Also, as a generic theory, the TOE enabled researchers to choose the factors of each facet according to the characteristics of technological innovation (e-government) adopted. Thus, the analytical framework in Figure 1 forms the basis for investigating the factors enhancing e-government service gaps.

![Figure 1. The analytical framework for the study](image)

4. METHODOLOGY

A multiple-case study was adopted as the research strategy of the study in which the e-Taxation system was the primary case study with embedded three (3) units of analysis (government employees, business, and citizens). These cases were used as the primary sources of empirical data because it was assumed that they were adequate to provide sufficient data about the study (Yin, 2009). The selection of cases began by recognising the key units that could benefit directly from the deployment of e-government projects in Zimbabwe. The study used a multi-stage sampling procedure by employing stratified, purposive and snowball sampling techniques for the following reasons:

- Stratified sampling ensured that each subunit of analysis was represented in the sample.
- Purposive sampling also enabled researchers to select participants that showed the best ability to address the research question and to meet the research objectives of the study.
- Snowball sampling was used because the citizens who are users of the e-Taxation system were very difficult to find.

A total of 30 semi-structured interviews were conducted with government employees, managers of various business organisations and citizens who have direct contact with the e-Taxation system. The selected size was informed by Weller et al. (2018) who reported that 20 to 30 in-depth interviews are adequate to determine the saturation point of qualitative data. This study employed a template analysis technique proposed by King (2004) to code qualitative data from interviews transcripts. Template analysis is a technique within the thematic analysis framework that enabled researchers to develop a catalogue of codes to form an analytic template representing priori themes identified from the literature and presented in the analytical framework (Brooks & King, 2014).

The study focused on multiple stakeholders (users) to uncover multiple realities on the implementation and use of e-government in a developing country. From the onset, the researchers...
assumed that using a single stakeholder perspective would not reveal numerous factors enabling e-government service gaps. Accordingly, by focusing on multiple perspectives, the study diverted from previous studies which have investigated e-government in isolation by focusing their effort on a single perspective. Mostly, e-government studies have been centred on citizens’ perspectives despite the importance of other user groups. Also, e-government projects are designed and implemented to satisfy three major users: citizens, government employees and businesses (Haider et al., 2015; Ibrahim et al., 2016). Besides, these users have different opinions and values about e-government, too, which could result in different perspectives. Therefore, e-government evaluation should recognise divergent views of users.

5. FINDINGS OF THE STUDY
This section reports the findings from three (3) units of analysis on factors enhancing e-government service gaps in a developing country like Zimbabwe. The findings were presented using the thematic configuration (structure) of the template, explaining the meaning of themes, and illustrating with direct quotes from the data (Ryan & Bernard, 2003). The factors were coded and classified using template analysis based on three theoretical codes: technology, organisation, and environment. The factors are presented below.

<table>
<thead>
<tr>
<th>Codes</th>
<th>Themes</th>
<th>Supporting excerpts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technology</td>
<td>Lack of government-owned infrastructure</td>
<td>“In the case of Zimbabwe, the private sector owns approximately 75% of the total infrastructure deployed across the country” [Bus 1].</td>
</tr>
<tr>
<td></td>
<td>Lack of compatibility of computing devices</td>
<td>“Some of our gadgets hinder the electronic exchange or transfer of information as they are not compatible with the technology used in e-government projects” [Bus 2].</td>
</tr>
<tr>
<td></td>
<td>Lack of systems integration</td>
<td>“Most government departments use legacy systems that cannot easily integrate with other systems” [CIT 8].</td>
</tr>
<tr>
<td></td>
<td>Lack of electricity infrastructure</td>
<td>“The country lacks adequate electricity supply; electricity load shedding is very high in Zimbabwe, resulting in citizens failing to access internet services” [Bus 6].</td>
</tr>
<tr>
<td></td>
<td>Lack of access</td>
<td>“Several communities in rural areas are still underserved as far as internet connectivity is concerned; hence, they do not have access to the internet” [CIT 4].</td>
</tr>
<tr>
<td>Organisaton</td>
<td>Lack of e-government funding</td>
<td>“There is a lack of funding for e-government projects as developing countries like Zimbabwe have many competing priorities to finance” [Govt employee 5].</td>
</tr>
<tr>
<td></td>
<td>Budget disparity</td>
<td>“There is a lot of budgetary politics in the government of Zimbabwe; some government departments do not get sufficient budget” [Govt employee 7].</td>
</tr>
<tr>
<td></td>
<td>Lack of the desire to support and coordinate e-government</td>
<td>“The top management is not ‘aggressively’ lobbying for adequate resources to facilitate the deployment of robust infrastructure” [Govt employee 3].</td>
</tr>
<tr>
<td></td>
<td></td>
<td>“Each Ministry or government department is concentrating on developing its system and deploying individual infrastructure without considering the need to coordinate such activities with other departments or even the private sector” [Govt employee 7].</td>
</tr>
<tr>
<td></td>
<td>Design-reality gap</td>
<td>“In Zimbabwe, I think e-government service gaps exist because of skill gaps among e-government designers. Most of the e-government designers have limited knowledge and experience” [CIT 9].</td>
</tr>
<tr>
<td>Environment</td>
<td>Policy inconsistency</td>
<td>“There is a tendency to jump from policy to policy such that policy pronouncement becomes inconsistency with goals and aspirations of e-government” [Govt employee 12].</td>
</tr>
<tr>
<td></td>
<td>Lack of user-involvement</td>
<td>“There is an assumption that the designers of e-government systems know all the needs and expectations of the users in advance. The end users are not consulted during the design phase” [CIT 4].</td>
</tr>
</tbody>
</table>

Table 1. Codes, themes and supporting excerpts

6. DISCUSSION OF FINDINGS
6.1. Technology
6.1.1. Lack of government-owned infrastructure
It is worth mentioning that the single most striking observation to emerge from the empirical data compared to previous studies was the lack of government-owned infrastructure. Still, in cases where
the government owns the infrastructure, it is dilapidated and not able to match the needs of the modern-day e-government service provision. Drawing on the analysis of qualitative findings the government of Zimbabwe has not invested significantly in ICT infrastructure and largely relies on infrastructure from private players. This was echoed across cases:

Most of the infrastructure in Zimbabwe is not timely updated to suit the current needs of the end-users” [Bus 3].

“In the case of Zimbabwe, the private sector owns approximately 75% of the total infrastructure deployed across the country whilst the government does not have adequate resources to set up the infrastructure for e-government” [Bus 1].

“In terms of the ownership of ICT infrastructure, the private sector has more ownership compared to most government departments” [Govt employee 8].

This implies that the participants were concerned with the lack of government-owned infrastructure because relying largely on infrastructure from the private players becomes expensive and unaffordable for the government to sustainably run e-government schemes.

6.1.2. Lack of electricity infrastructure

The users of e-government are failing to access e-government due to inadequate electricity supply. The respondents were concerned with the lack of reliable electricity supply which could inhibit the continuous delivery of e-government services. The following excerpts form part of the narratives that were used to develop the theme of lack of electricity infrastructure:

“Power supply availability is a challenge in Zimbabwe. Most places do not have a reliable power supply infrastructure for offices; this makes it difficult to provide e-government services” [Govt employee 13].

“The country lacks adequate electricity supply; electricity load shedding is very high in Zimbabwe, resulting in citizens failing to access internet services” [Bus 6].

“Electricity load shedding is very high in Zimbabwe. Even in town, there are continuous electricity/power cuts; this makes e-government services not available on time” [CIT 7].

This finding implies that without a stable electricity supply, e-government systems cannot run smoothly and user satisfaction is likely to be minimized since the system might tend to be ordinarily offline. This claim seems to be plausible in the context of a developing country where electricity supply has remained a challenge for decades (Richardson, 2011; Ud Din et al., 2017). Thus, this gives credence to the fact that electricity is fundamental in the implementation and utilisation of e-government.

6.1.3. Lack of systems integration

Integration refers to the extent to which e-government systems can share information to enable citizens to access services from various departments and agencies using a single access point (Dias, 2020). In the literature, integration is identified as a key challenge for enabling the fully functional and higher maturity level of e-government in developing countries (Bayona & Morales, 2017; Owusu-Ansah, 2014). The participants across cases mentioned that e-government systems that have been deployed in government departments are not interoperable:

“System integration is lacking in e-government systems as most systems exist in ‘silos’. There is silo mentality in systems development, every MDA is concerned with the services it offers; hence, ignoring the need for system integration” [Govt employee 8].

“Every government department has its system which is not integrated with other departments; thereby, creating e-government service gaps” [Govt employee 13].

“E-government systems in Zimbabwe fail partly because they have been designed in such a way that they do not communicate with other systems deployed across ministries. Most government departments use legacy systems that cannot easily integrate with other systems” [CIT 8].
This implies that systems integration is one of the issues within the e-government domain that need to be managed by any government intending to derive added value from e-government initiatives (Nakakawa & Namagembe, 2019; Sulehat & Taib, 2016). Thus, without systems integration, MDAs that support each other will find it difficult to share critical data and information.

### 6.1.4. Lack of access

Research has shown that lack of access to the internet and technology is a cause for concern in the utilisation of e-government services in developing countries (Abu-Shanab & Khasawneh, 2014; Ohemeng & Ofosu-Adarkwa, 2014; Regmi, 2017). The majority of the population, particularly in developing countries, still has limited or no access to e-government services even though these countries have moved a great stride in e-government adoption. Similarly, the findings across cases revealed that the majority of citizens in Zimbabwe do not have access to the internet, e-government services and computing devices due to poverty, low levels of income and inadequate network coverage.

“Lack of access to the internet is also another factor; the charges for internet connectivity and data are beyond the reach of many ordinary citizens” [Bus 5].

“Several communities in rural areas are still underserved as far as internet connectivity is concerned; hence, they do not have access to the internet” [CIT 4].

“Most people in rural areas are poor and lag in terms of digitisation. Some of them could not afford a Smartphone, not even talking about the data bundles” [CIT 8].

This implies that those who do not have access to computers, network coverage or the internet are unable to benefit from e-government services. However, it should be noted that there is an interlocked relationship between infrastructure and access to e-government services. Lack of infrastructure results in lack of access because it deprives citizen to benefit from the implementation of e-government; hence, creating a phenomenon of e-government service gaps.

### 6.1.5 Lack of compatibility of computing devices

Most research on compatibility has focused on measuring the degree to which technology is consistent with the present values, demands and previous experiences of the prospective users (Abu-Shanab & Khasawneh, 2014; Ahmad & Campbell, 2015; Dhillon & Laxmi, 2015; Kumar et al., 2007; Layne & Lee, 2001; Muhammad, 2013; Zautashvili, 2018). However, this study provides a new understanding of the compatibility dimension in which it refers to the ability of different computing devices to access e-government systems. This is because users of e-government use different gadgets; so there is a need for assurance that they may be able to have access to the system despite using different computing devices.

“Some of our gadgets hinder the electronic exchange or transfer of information as they are not compatible with the technology used in e-government projects” [Bus 2].

Therefore, the compatibility of computing devices should be significantly considered in the development and deployment of e-government systems to provide user-centric services. Thus, e-government systems should be compatible with the computing devices of the users.

### 6.2. Organisation

#### 6.2.1. Lack of e-government funding

It is a widely held view that adequate funding is the factor that promotes the success of e-government implementation (Alabdollat, 2020; Alanezi et al., 2012; Khadaroo et al., 2013). The availability of sufficient funding is a significant factor towards the successful implementation of e-government because there is a strong correlation between funding and ICT infrastructure development, addressing the digital divide and human capacity development (Khadaroo et al., 2013; Ziba & Kang, 2020). The empirical data reveals that Zimbabwe is facing difficulties in financing e-government
projects due to competing priorities to finance; for instance, funding the everyday needs of the citizens in which the majority survive on government hand-outs.

“There is a lack of funding for e-government projects as developing countries like Zimbabwe have many competing priorities to finance” [Govt employee 5].

“Many developing countries fall into a dilemma of funding e-government programs due to lack of financial support even the government entity has a plan for providing e-government services” [Govt employee 2].

“There is a lack of funding in Zimbabwe to acquire the necessary infrastructure required for the full implementation of the e-government; the central government seems to have many other priorities competing for the resources” [Govt employee 7].

The findings of the current study are consistent with those of Alabdallat (2020) who reported that there is a lack of funding for e-government projects in developing countries due to many competing priorities to finance from constrained budgets.

6.2.2. Budget disparity
This study defines budget disparity as a discrepancy in the allocation of budget among the government departments; as a result, some departments are receiving lesser budgets than others. The case study findings point that successful implementation of e-government requires sufficient budget across government departments; otherwise, other departments will lag in the implementation of e-government projects; hence, resulting in e-government service gaps.

“There is a lot of budgetary disparity in the government of Zimbabwe; some government departments do not get sufficient budget because they are neither preferred nor favoured” [Govt employee 7].

“I have noted that the abilities of government departments to place services online and to use technology for automating processes are hampered by budget disparity” [Govt employee 5].

“At the same time, resources differ from ministry to ministry because some ministries receive better budgets than others; therefore, we cannot be at the same level in the implementation of e-government” [Govt employee 3].

The finding implies that government departments will always be at different levels of e-government maturity. This study is consistent with the literature that discusses the impact of budget on e-government implementation in general (Dhonju & Shakya, 2019), but not necessarily specific to the budget disparity.

6.2.3. Lack of the desire to support and coordinate e-government
In this study, the participants indicated that there is a lack of top management support and coordination in the deployment of e-government projects. Each ministry or government department concentrates on developing its system and deploying individual infrastructure without considering the need to coordinate such activities with other departments or even the private sector. The lack of coordination in systems development is likely to lead to MDAs competing in putting up ICT infrastructure while lack of coordination can restrain the establishment of appropriate e-government development networks.

“Lack of top management support ... has resulted in unavailability of the requisite infrastructure; the top management is not ‘aggressively’ lobbying for adequate resources to facilitate the deployment of robust infrastructure” [Govt employee 3].

“Lack of coordination in systems development lead to MDAs competing in putting up ICT infrastructure; hence, there is a lot of fragmented (silo) efforts in the deployment of e-government in Zimbabwe” [Govt employee 1].

This implies that the implementation of e-government in Zimbabwe is among factors hindered by the lack of the desire by the top management to support and coordinate the design and deployment of e-services.
6.2.4. Design-reality gap
The successful implementation of e-government projects demands the fusion of IT human capacities for designing, installing, maintaining and utilising e-government systems. The case study findings revealed that one of the challenges in e-government design is the lack of ICT skills and experience in government departments due to poor remunerations for IT personnel. The majority of skilled and experienced IT personnel are either employed in the private sector or in other countries. Most of the e-government designers have limited knowledge and experience; as a result, developing systems that are not ‘perfect’ and which do not meet the needs and expectations of the users. Businesses and citizens shared similar views regarding the design-reality gap.

“In Zimbabwe, I think e-government service gaps exist because of skill gaps among e-government designers” [CIT 9].

“Skills gap will always be there by virtue of our maturity in terms of e-government and poor remuneration” Development of such complex systems is mostly outsourced from consultants who have expertise in developing similar systems in other countries” [Bus 4].

This is why in developing countries we find private companies with better e-services than governments” [CIT 6].

“It appears that incompetent employees are appointed to develop and maintain e-government systems in Zimbabwe. As a consequence, e-government projects are outsourced from developed countries which according to Heeks (2003) fuels the design-reality gap if the project is adopted in its entirety by a developing country. So, e-government cannot be successfully deployed if government employees do not have adequate ICT skills and experience.

6.3. Environment
6.3.1. Policy inconsistency
Another drawback in the successful implementation of e-government in a developing context is policy inconsistency. This factor demonstrates a major policy gap in the implementation of e-government projects in developing countries. During the interviews, participants from the government stratum noted that the government of Zimbabwe always grapples with policy inconsistency.

“One other drawback is the policy inconsistency that the government of Zimbabwe grapples with; so nobody takes the government seriously when it outlines policies” [Govt employee 6].

“There is only too much rhetoric and very little traction on the factors obtaining on the ground in the implementation of e-government projects” [Govt employee 13].

“There is a tendency to jump from policy to policy such that policy pronouncement becomes inconsistency with goals and aspirations of e-government” [Govt employee 12].

“Midway into the implementation of one policy, the government usually shift goals and launch another policy to the puzzlement of e-government designers; leading to ‘half-done and later deserted projects” [Govt employee 11].

Although the country strives to digitise the public sector by coming up with e-government implementation policies, this aspiration has remained a mere declaration of the intent; in that respect, the obligatory vigour to drive the implementation of e-government in Zimbabwe is still missing at all levels. There is too much rhetoric and very little traction in the implementation of e-government projects. Besides, it is noted that in most cases, governments take more than a decade talking about implementing e-government flagship projects which do not take off as expected.

6.3.2. Lack of citizen involvement
The scoping of any information systems project requires the involvement of users. The main consideration of citizen involvement is to incorporate their opinions in the design of e-government
projects. The findings from the citizen stratum, however, revealed that the e-government design phase is not engaging with the citizens. As a consequence, designers are likely to develop e-government schemes that do not result in user acceptance and satisfaction.

“There is an assumption that the designers of e-government systems know all the needs and expectations of the users in advance. The end users are not consulted during the design phase; hence, at times they resist the adoption of e-government schemes” [CIT 4].

“The other challenge with most e-government schemes is that they are developed at the national level and lack engagement of the users who are supposed to benefit from such schemes. The users are not engaged; hence the failure of the users to embrace these schemes” [CIT 2].

“The e-government design phase is not engaging with the citizens. The opinions of citizens in the design of e-government are not incorporated; that is why it is not easily accepted” [CIT 5].

This implies that e-government projects fail largely due to the non-factoring of the individual requirements and needs during the design and implementation of e-government projects (Ahmad et al., 2012). The present findings seem to be consistent with other research which found out that user involvement is not prioritised in current e-government development projects (Abu-Shanab & Khasawneh, 2014). Similarly, Verkijika (2018) declared that e-government projects fail to provide comprehensive services because of a lack of engagement with the users to capture their needs and wants in the design phase.

7. CONCLUSIONS AND RECOMMENDATIONS

The study explored the opinions of government employees, businesses and citizens to understand the factors enhancing e-government service gaps in a developing country context from multiple perspectives underpinned by the TOE framework. The study identified 11 factors that deeply enhance e-government service gaps in a developing country. Since the study was underpinned in the TOE the factors that emerged from the findings were grouped under the TOE elements. These factors can be regarded as the baseline elements in the implementation and utilisation of e-government services because they act as barriers for governments to successfully implement e-government and prevent users to engage with e-government services. Furthermore, the factors hold both negative and positive outcomes; mostly because apiece, they have generative mechanisms to make a divergence of either enhancing or constricting e-government service gaps. Therefore, this study concluded that until the factors enhancing e-government service gaps are converted into enablers (enabling factors) for providing comprehensive services, e-government service gaps will continue to exist in developing countries.

While factors enhancing e-government service gaps may be contextual, a systematic literature review shows that most e-government challenges in the implementation and usage of e-government services fall in the wider factors identified in this study. The findings of this study show that lack of government-owned infrastructure, systems integration, e-government funding, the desire to support and coordinate e-government; design-reality gap and policy inconsistency are the critical factors enhancing e-government service gaps in Zimbabwe.

However, it should be noted that while the aforesaid factors were derived from the three units of analysis others were derived solely from each unit or two units. For instance, the lack of government-owned infrastructure was extrapolated from all units while budget disparity; lack of the desire to support and coordinate e-government; and policy inconsistency were derived from the government stratum only. This could be attributed to the fact that these elements appear to be internal factors with a direct impact on government departments and their employees in their effort to drive the implementation of e-government. The lack of user involvement was deduced from the citizen stratum. In contrast, the design-reality gap was derived from business and citizen strata; thus,
showing differences in the discernment of factors enhancing e-government service gaps among the strata.

The study provides the following recommendations:

- Developing countries need to have a dedicated budget to fund the deployment of infrastructure and e-government projects;
- Government departments should compete with the private sector in the ICT job market and offer better remuneration that keeps the best ICT employees working for their governments and drive e-government services;
- Ensure that citizens are part of the design phase by involving users in the design of e-government systems since the designers of e-government alone cannot fully comprehend the needs and expectations of the users;
- There is a need to convert factors enhancing e-government service gaps to e-government enabling factors;
- Priority should be raised in deploying government-owned infrastructure; e-government funding; and IT human capacity development.

8. CONTRIBUTIONS TO PRACTICE AND THEORY

This research contributes significantly to the implementation and utilisation of e-government services in Zimbabwe, as well as contributing to knowledge on e-government implementation in developing countries, particularly in Africa. Furthermore, the research provides a framework to assist governments in developing countries to surmount the challenges of e-government service gaps. This study will also enlighten the implementers and funders of e-government projects on factors that obstruct the successful implementation and utilisation of e-government services in a developing context which is known for highly failed e-government projects.

The study contributes to providing a strong theoretical understanding of the factors that enhance e-government service gaps explored in the research model. From the extant literature, no studies have explicitly focused on investigating factors that enhance e-government service gaps in the context of a developing country. To fill this gap, the study adopted the TOE framework for better understanding these factors. This study contributes to theory by classifying e-government service gaps into three (3) categories: Technology, Organisation and Environment. Thus, the findings provide theoretical contributions to the body of knowledge concerning the factors that contribute to e-government service gaps in a developing country.

9. LIMITATIONS AND SUGGESTED AREAS FOR FURTHER RESEARCH

The factors enhancing e-government service gaps were proposed based on the literature review and explored using a single-embedded case study; hence, it is hard to conclude that the factors revealed in this study are conclusive. Furthermore, this study was focused on the urban population in Harare, Bulawayo and Gweru where the population has access to the internet and e-government experience in the use of e-government services. Therefore, by focusing on the urban population the study could not get the views of the non-users of e-government who are likely to experience more service gaps compared to the urban population.

The study suggests that new insights on factors enhancing e-government service gaps could emerge if the research is undertaken again in more case studies. Furthermore, the study suggests that future research on e-government service gaps should include the marginalised communities.
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Authors’ contributions
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Data availability statement
The data that support the findings of this study are available from the corresponding author, M.G., upon reasonable request.

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INVESTIGATING PERSONALISATION-PRIVACY PARADOX AMONG YOUNG IRISH CONSUMERS: A CASE OF SMART SPEAKERS

Caoimhe O’Maonaigh, Trinity College Dublin, comaonai@tcd.ie
Deepak Saxena, BITS Pilani, deepak.saxena@pilani.bits-pilani.ac.in

Abstract: Personalisation refers to the catering of online services to match consumer’s interests. In order to provide personalised service, companies gather data on the consumer. In this situation, consumers must navigate a trade-off when they want the benefits of personalised information and services while simultaneously wish to protect themselves from privacy risks. However, despite many individuals claiming that privacy is an essential right to them, they behave contradictorily in online environments by not engaging in privacy-preserving behaviours. This paradox is known as the personalisation-privacy Paradox. The personalisation-privacy paradox has been studied in many different scenarios, ranging from location-based advertising to online shopping. The objective of this study is to investigate the personalisation-privacy paradox in the context of smart speakers. Based on an exploratory study with young Irish consumers, this study suggests a difference between the users and non-users of smart speakers in terms of their perception of privacy risks and corresponding privacy-preserving behaviours. In so doing, it also explains the existence of the personalisation-privacy paradox and offers insights for further research.

Keywords: Personalisation, Privacy, Paradox, Smart Speakers.

1. INTRODUCTION
Privacy is a concept that our society has long considered a right. However, with the introduction of smartphones and Big Data collection, the attitude towards privacy has arguably been altered. Despite many individuals still claiming that privacy is an essential right to them, they behave contradictorily in online environments by not engaging in privacy-preserving behaviours. This paradox is known as the personalisation-privacy Paradox. The personalisation-privacy paradox has been studied in many different scenarios, such as location-based services, e-commerce, and social media. This study explores the paradox in the context of smart speakers or smart personal assistants. The worldwide number of smart personal assistants’ users is expected to grow to 1.8 billion by 2021. Smart speakers, such as Amazon Echo and Google Home, have been becoming more and more popular in recent times with a typical U.S. household having 2.6 smart speakers on average, with 24% of the population owning at least one smart speaker (NPR, 2020).

Against this backdrop, this exploratory study investigates the personalisation-privacy paradox with the users and non-users of smart speakers. It compares the perceptions of a smart speaker user or non-user and investigates how these perceptions differ between the two groups. Hence, the research question for this study is: How do the users and non-users of smart speakers differ in their privacy perception and privacy-preserving behaviours?. To answer this question, this paper is organised as follows. Section 2 discusses the privacy risks associated with smart speakers and prior research conducted on personalisation-privacy paradox. Section 3 outlines the methodology in detail. Section 4 discusses the findings of the study, followed by a discussion in section 5. Finally, the last section discusses the theoretical and managerial implications, along with limitations and recommendations for future research.
2. LITERATURE REVIEW

2.1 Privacy vs Personalisation

Warren and Brandeis (1890) define privacy as ‘the right to be alone’. In other words, it allows humans the right to protect their thoughts, property and actions from the knowledge of others. However, with the introduction of Big Data and the Internet of Things, privacy has taken on a new meaning. Information privacy has moved from securing one’s personal information to deciding how much information is shared with whom (Smith et al., 1996). It allows consumers to control their information for the ideal representation of self to the outside world (Longo and Saxena, 2020). However, too much information control by individuals runs counter to the personalisation of online services. Personalisation may be defined as delivering appropriate content and services at the right moment to the consumer, consistent with their preferences and past behaviours (Ho and Tam, 2005; Lee and Rha, 2016). In order to provide personalised service, companies gather data from the consumer. Although personalisation benefits are an advantage for consumers, it requires consumers to disclose personal information (Culnan and Armstrong, 1999). In this situation, consumers must navigate a trade-off when they want the benefits of personalised information and services while simultaneously wishing to protect themselves from privacy risks. This trade-off is often termed as personalisation-privacy paradox.

In 2014, the BBC (Wakefield, 2014) reported that 91% of American consumers think they have lost control over how personal information is collected and used by companies. According to Symantec (2015), 57% of Europeans are worried that their data is not safe in the hands of companies. Interestingly, despite many individuals claiming that privacy is an essential right to them, they behave contradictorily in online environments by not engaging in privacy-preserving behaviours, seemingly resulting in a paradox. For instance, Norberg et al. (2007) demonstrate that despite their stated privacy concerns and intentions, users disclose a considerable amount of personal information. Studies (Acquisti and Grossklags, 2005; Grossklags and Acquisti, 2007) suggest that despite having data concerns, online shoppers are willing to give up their data as long as they receive something in return. This points towards a dichotomy between consumer attitude and consumer behaviour when it comes to privacy concerns. High level of privacy concerns should arguably lead consumers to participate in privacy protection behaviour. However, studies have shown that this concern does not affect consumer privacy behaviour (Kokolakis, 2017).

The personalisation-privacy paradox has been studied in many different scenarios, ranging from location-based services (Xu et al., 2009; Lee and Rha, 2016), e-commerce (Acquisti and Grossklags, 2005; Berendt et al., 2005; Grossklags and Acquisti, 2007; Norberg et al., 2007; Tsai et al., 2011) and social media (Blank et al., 2014; Young and Quan-Haase, 2013). In this regard, it is suggested that privacy behaviour is contextual, and personal data is not a coherent object which is valued the same by each person at all times (Acquisti et al., 2011, 2015; Nissenbaum, 2011). A context-based perspective on the paradox means that privacy concerns differ from person to person and situation to situation. Hence, it is suggested that privacy concerns alone are not adequate predictors of privacy behaviour (Acquisti and Grossklags, 2005) and once has to take contextual factors into account. To investigate the contextual nature of the paradox, this study focuses on the user and non-users of smart speakers. The next section discusses the risk associated with smart speakers and some recent works on privacy perceptions and behaviour.

2.2 Smart Speakers and Privacy Perceptions

The two main voice assistants that currently dominate the smart speaker market are Amazon’s Alexa and Google Assistant (Marketsandmarkets, 2020). The key to using a smart speaker is its voice recognition function. The smart speaker is ‘always listening’ until you use a ‘wake’ word (such as Hey, Alexa or Ok, Google) to wake it up and begin recording what is being said. The recording is sent, via the internet, to a main processing hub. For example, the Amazon speech files are sent to Amazon’s Alexa Voice Services (AVS) in the cloud. Here, the voice recognition software deciphers
the recording and then sends back the appropriate response to the speaker. It will use the voice command to complete tasks like playing music, answering questions, and controlling lighting and heating etc. While Amazon and Google have both admitted to hiring employees to listen to recordings to improve the speaker’s capabilities, it is claimed that all information is treated with the highest of confidentiality (Crist, 2019). Amazon and Google both claim that no personal information is sold to third parties for advertising (Crist, 2019).

Smart speakers are ‘always listening’, but they are not ‘always recording’. However, they can be accidentally activated when they mistake a noise for the command word. There have been instances in the past where a smart speaker has been caught recording everything that an owner has been saying (Russakovskii, 2017). Google has since fixed this issue; however, it highlights how easy it is for the speaker to accidentally start recording without the owner’s knowledge. Smart speakers are considered to be relatively secure as they all support WPA-2 encryption and use a secure Wi-Fi connection that prevents data from being hacked from the smart speaker (Panda Security, 2018). However, it is still possible for cyber criminals to control the device, though researchers are currently working on fixing this (Norton, n.d.). The biggest issue is that smart speakers are usually connected to a variety of devices, such as phones and other smart home devices. If a cybercriminal is able to hack into the speaker, they may be able to hack into all your online accounts.

While earlier works mostly focussed on the technical aspect of data security and information privacy, recent studies examine user perception of privacy with smart speakers. Studies suggest that the users have an inadequate grasp of the technology and business ecosystem underpinning smart speakers, resulting in incomplete and inaccurate mental models (Abdi et al., 2019; Huang et al., 2020). Moreover, the users are concerned on the extent of data collection and further sharing with third parties (Cha et al., 2021; Kowalczik, 2018; Lau et al., 2018; Malkin et al., 2019). Such concerns usually emerge from the lack of clarity on the data collection and sharing practices adopted by companies. In response, users usually adopt from one of the three broad coping strategies – acceptance, mitigation, or avoidance. At one end of the spectrum, some users prioritise convenience over their concerns, and accept the privacy risks (Abdi et al., 2019; Cha et al., 2021; Huang et al., 2020; Lau et al., 2018). Such users are deemed to possess technological optimism (Kowalczik, 2018). At the other end, the users try to limit their use of smart speakers by avoiding it altogether or intermittently turning it off for some time (Abdi et al., 2019; Huang et al., 2020). Finally, a small group of users try to mitigate privacy risk by making sense of and by trying to use customisable privacy settings available in the device (Cho et al., 2020). However, as Lau et al (2018) report, such privacy controls are often not aligned with the needs of the users, and hence, are not very useful for them.

3. RESEARCH METHODOLOGY

As smart speakers and smart homes are still a relatively new concept, this study seeks to examine the perception of young adults on smart speakers. This research builds upon existing research on the personalisation-privacy paradox but adds novelty by looking at smart speakers from the lens of users and non-users. Therefore, the main research question of this study is: How do the users and non-users of smart speakers differ in their privacy perception and privacy-preserving behaviours?.

To answer this question, a qualitative interviewing approach was deemed the most appropriate in understanding the attitudes of young Irish adults. The recruitment of the participants was done using a screening survey. To be an interviewee, a participant had to be a young adult (that is between the ages of 18 and 25 as defined by the Central Statistics Office in Ireland) and be aware of what a smart speaker was. As the aim of the interviews was to see if participants were concerned about privacy and smart speakers without the prompt of the interviewer, the survey was kept very vague to avoid self-selection bias. Options given in the answers were short and to the point. The survey was distributed via social media, email lists and through contacts. The survey allowed participants to submit their contact details to express their interest in being interviewed further and have the chance
to win a €10 Amazon voucher. Over 60 potential interviewees participated in the survey. Finally, ten respondents were contacted for the interviews. To balance the perspective, five users and five non-users of smart speakers were then selected for interviewing. Among the ten participants, five were male and five were female. Table 1 provides the details of the participants.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Occupation</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>NU1</td>
<td>Computer Science</td>
<td>M</td>
</tr>
<tr>
<td>NU2</td>
<td>Philosophy Student</td>
<td>F</td>
</tr>
<tr>
<td>NU3</td>
<td>Unemployed</td>
<td>F</td>
</tr>
<tr>
<td>NU4</td>
<td>Physics Student</td>
<td>M</td>
</tr>
<tr>
<td>NU5</td>
<td>Unemployed</td>
<td>F</td>
</tr>
<tr>
<td>U1</td>
<td>Doctor</td>
<td>F</td>
</tr>
<tr>
<td>U2</td>
<td>Sales Manager</td>
<td>F</td>
</tr>
<tr>
<td>U3</td>
<td>Technician</td>
<td>M</td>
</tr>
<tr>
<td>U4</td>
<td>Sales Associate</td>
<td>M</td>
</tr>
<tr>
<td>U5</td>
<td>Radiation Therapist</td>
<td>F</td>
</tr>
</tbody>
</table>

NU = Non-User, U = User.

Table 1. Participants in this study

Due to the time and contextual challenges that presented themselves during the timeline of this research, namely the COVID-19 pandemic, electronic medium was considered the most convenient and effective way to carry out the data collection. In total, eight out of ten interviewees were interviewed via video or audio call, and two were done in person. The interviews took between 20-30 minutes depending on the participant's knowledge and how in-depth their answers were.

Each interview started with a broad question along the lines of "tell me about smart speakers", or "where did you first hear about smart speakers". An opening set of questions were asked depending on whether they were users or non-users (See Appendix A). Follow-up questions were then asked depending on the answers to previous questions. The transcriptions created by Otter.ai were edited within 24 hours of the interview to fix any mistakes and note any contextual information during the interview sessions. Thematic analysis was conducted to analyse the interviews (Guest et al., 2011). The transcripts were read multiple times in order to get familiar with the content and develop an idea of overarching themes. The data was coded using in-vivo coding in order to keep the participants' own words in the analysis (Saldaña, 2015, Saunders et al., 2016). The next section presents the findings of the analysis.

4. FINDINGS

4.1 Perception on Privacy and Personalisation

Each participant was asked what privacy meant to them. The element of control is essential to a majority of participants, where they can decide whether or not their information is shared. NU4 used their idea of what privacy meant to them in their decision to not own a smart speaker, noting that with a smart speaker, "you never really know if your information is where they say it is". U4 shared a similar sentiment by expressing that the need for companies to ask for his consent was essential to him in terms of privacy. However, he believes that because the smart speaker has specifically asked for his consent, that he still has control, and his information is kept private. U3 has his whole house set up as a smart home, and yet because he lives alone, he still believes that his life is kept private:

Well, I live alone. So, pretty much anything that happens in my house I would consider private. Like I know that they say they record all these things, but they don’t have people paid to spend hours and hours, listening through them. It would take too many people. So, for the most part, everything I say or do in my house is still private. (U3)
Interestingly, U2 notes that she does not know what privacy means to her due to the age that we are living in.

When asked about personalisation features of the smart speaker and other online activities that result from the surrendering of data, the answers were a mixed bag. Users of the smart speakers favoured the voice recognition, some wishing that it would work a lot better than it does now (U5, U1). When U1 was asked what she would do in order to improve the smart speaker, privacy protection was not a concern for her; however, improved personalisation was. U5 and the majority of the non-users found benefits to only certain types of personalisation. This includes YouTube and Spotify algorithms where they suggest similar artists or videos. U5 believes that there is a benefit to a certain level of personalisation, however, that it can go too far where data is collected that she did not intend to be collected. In a similar manner, U4 notes:

So, what most people just deem as mainly inconsequential data is usually the stuff you actually find people feel more violated by when other services have it. Just your small day to day things. So, in that sense, by not sharing what I won’t ever feel that violation. So, where they’re okay with knowing like, okay, regularly searches for traffic to this one location, probably drives to it regularly from the Google Maps information. I’m okay with them figuring out that lives in location A, and works probably at location B, or really like shopping there. I’m okay with that level. (U4)

NU5 expresses a similar sentiment, stating that she is okay with clothes shops online recommending her items because she is in the clothes shop with an intent to buy. However, when she is scrolling through Instagram, and a recommended advertisement for something personal pops up it makes her uncomfortable. NU2 has a different opinion and stated that in the past she has bought items off of Instagram advertisements that were targeted to her based on her history on AliExpress. She finds it "actually kind of helpful even though it is just them using [her] information and putting up more stuff that they think [she] would like".

In contrast, NU3 and NU4 were heavily against the personalisation of online activity, with NU3 going as far as to say that she would sacrifice personalisation for the protection of her data. They both had similar opinions that if they wanted to know about a product or service, they would look it up themselves and do not need it to be suggested to them. NU4 finds that the personalisation features were not of value to him and feels that personalisation of YouTube, Netflix and Spotify accounts actually "closes you in even, like, in terms of your taste". He argues that this results in finding it hard to have a conversation with someone else because they are "taking in completely different information" than you are.

4.2 Perception on Personalisation vs Privacy Trade-off

Most users find the trade-off of privacy for the features of the speaker to be worth it. U2 finds the speaker ‘great’, ‘convenient’ and ‘easy’. U4 states that he is happy with the services that he is receiving for his information based on what he is aware that they use it for, as long as nothing comes out that they have breached their terms and services. He believes that he is comfortable with this trade-off as "all it is doing is taking things you are interested in, and rather than you having to find out about it, it provides that information to you". He is also very aware that the company benefits from their data and is comfortable with that as it means better service for him in the long run. U5 is the only user that says that she "begrudgingly accept[s] it" even though she is not overly satisfied with the trade-off.

The majority of the non-users are also aware and are therefore only willing to participate in trade-offs if they perceive some value in the service or product. NU1 states that the perceived trade-off of a smart speaker is not worth the information he would have to give up, whereas other personalised services (e.g., YouTube or Spotify) in his smartphone would be. NU4, who is not willing to give up personal information in any personalisation-privacy trade-off, states that he would be willing to give up his data for the "greater good of society", such as the COVID tracker app, but "definitely not for
personalised ads or anything" as he would "have no interest in that". NU3 is in-between admitting that she participates in the trade-off, not because she wants to but because she does it out of "laziness or convenience". She admits that although she is aware of the personalisation-privacy trade-off, she is unsure why she allows some personalisation on some services and not on a smart speaker.

In this regard, it is important to note that the aspect of control is essential to all participants when it comes to the trade-off. The permission and consent need to be willingly given in order for the participants to feel like they are still in control of their data. U5 notes:

> I feel like it has to be the information willingly given. Okay, is really the crux of it… I will trade my information for the benefit of getting what I’m looking for. But I don’t want my information taken from me to push things that I don’t want. (U5)

U4 echoes this sentiment by stating that he would like a "list of what they are using it for, and say, for optimization of [his] experiences, for ads, or other third parties, and like, as long as [he] know[s], [he] can choose to opt-in or opt-out".

4.3 Privacy-Preserving Behaviour

Finally, it is interesting to see if participants' perception of privacy and privacy protection matched their actions when it comes to their online activity. Despite not having an overall concern for privacy on social media, the majority of users still have their social media accounts set to private. There is a greater fear of people they did not know looking at their profiles and their pictures rather than companies having access to their data (U5, U1, U2). U4 reports that he disabled the voice recognition on his phone as he brings his phone into more private spaces and meetings with his employer. He has the privacy settings on his phone set to collect the barest minimum. All non-users admit to turning off their smart personal assistants on their phone (such as Siri, Google or Bixby). U4 and NU3 mention the VPN as a way to protect their data online. All users admit to allowing cookies on their online activity. In contrast, NU1, NU4 and NU5 do not allow cookies on their website visits.

The majority of users did not use any sort of privacy controls on their speakers. U1, U2 and U5 were not even aware of them. U5 turns off her speaker occasionally when she is having a private conversation but also admits that most of the time she turns it off to save electricity. U3 and U4 are the only users that seem to be aware of any privacy controls on their smart speakers. U3 reported being aware of them but does not use them, only deleting his logs every six months. However, he notes that if he were running a business from his household, he would turn off the smart speakers to avoid business conversations being recorded. U4 is much more privacy-conscious when it comes to his online activity. With regards to his speaker, he makes sure to leave it in the kitchen as he believes the kitchen is not a place where it would hear private details such as bank details or a PPS number. He keeps up to date with any privacy settings updates and has customized the settings so that he is in control of it. As well as this, he states that he would never install a smart speaker in every room, nor would he ever use the smart speaker for his private schedules.

5. DISCUSSION

Although all participants are aware of the alleged erosion of privacy in online environments, users and non-users rationalise their beliefs in different ways. Users rationalise their continued use of the smart speaker by weighing up the convenience benefits (Abdi et al., 2019; Cha et al., 2021; Huang et al., 2020; Lau et al., 2018) and noting that their information is everywhere anyway so a smart speaker will not make that much of a difference. Non-users do not feel smart speakers are of enough value to give up their personal information and feel that such devices are an invasion of privacy (Huang et al., 2020; Lau et al., 2018). This is consistent with the privacy calculus model (Kim et al., 2019, Kokolakis, 2017, Gerber et al., 2018) that suggests that consumers partake in a risk-benefit analysis before making a decision. If the anticipated benefits of providing data exceed the perceived worth of their data, the user will willingly disclose their data (Lee and Kwon, 2015; Xu et al., 2009).
Almost all participants mention a trade-off between the benefits of personalised services and the disclosure of their data. Non-users find that some personalised services are worth the risks, such as Spotify, Netflix, YouTube recommendations and the use of a smartphone. This is consistent with recent findings (Cha et al., 2021; Kowalczuk, 2018) that enjoyment facilitates adoption of smart speakers. However, non-users do not find that smart speakers offer worthy enough benefits. Therefore, their motivating factors against the adoption of a smart speaker include privacy concerns and a lack of perceived value that the smart speaker would offer in exchange for their data (Lau et al., 2018). Furthermore, they express that they are not as concerned with a privacy threat (since they are not using the device), they are more so concerned with the principle of their privacy being eroded by big companies and the feeling of surveillance anxiety (Kowalczuk, 2018).

In contrast, users adopt smart speakers primarily for their convenience and entertainment aspects (Cha et al., 2021). Though not as aware of the trade-off, they still mention it in a similar sentiment, stating that the benefits of the smart speaker that they have gained have been worth the collection of their data. There is also some evidence of users’ lack of knowledge about the data collection and usage (Abdi et al., 2019; Acquisti and Gross, 2006; Grabowski and Samfelt, 2016; Huang et al., 2020; Malkin et al., 2019). Many users attribute their lack of privacy concerns to lack of knowledge on the topic, trusting the company that owns the speaker and feeling that they are not particularly at risk for a breach in their privacy through the speaker. This supports the construct of privacy as trust (Mourey and Waldman, 2020; Waldman, 2018) meaning that privacy is not seen by the users in terms of data disclosure, but in terms of the trust on the data processor. Interestingly, the privacy controls in smart speakers remain mainly unused by most users, with some not even aware of their existence (Cho et al., 2020; Malkin et al., 2019). This may also be due to the fact that privacy controls reportedly do not fulfil the needs of the users (Lau et al., 2018). The findings also suggest that the users continue to use the service due to privacy fatigue (Choi et al., 2018). Users realise that any other company would also use their data for online advertising and tend to become cynical about their personal data collection (Lau et al., 2018).

6. CONCLUSION

6.1 Theoretical Implications

Our findings suggest that there is a difference between the users and non-users in terms of privacy concerns and privacy-preserving behaviour (Gerber et al., 2018; Lau et al., 2018). Privacy concerns lead non-users to participate in far more privacy controls than the users of smart speakers. Non-users are more focused on the morality of privacy invasion, rather than feeling vulnerable for a hack, whereas users seem unfazed and just want to use their speakers. Even though all participants feel that privacy is in having control over your data, users feel that they still have control as they consented to their data being used. Non-users feel that a smart speaker would take that control away. Perhaps for this reason, non-users engage in more privacy control measures that the users do.

The distinction between the users and non-users might help explain the personalisation-privacy paradox in the sense that while the non-users express privacy concerns and engage in privacy protection, it does not translate to privacy protection behaviour among the users who wish to enjoy greater benefits of personalisation. In this sense, the paradox is formed not due to inconsistent behaviour of the users but because the studies combine the data from the users and that from the non-users in their analysis. Highlighting the contextual nature of privacy, this calls for the studies on the personalisation-privacy paradox differentiating between the users and non-users of the technology.

6.2 Managerial Implications

In order for companies that own smart speakers to broaden their customer base, they need to address the privacy concerns that many non-users have. Understanding the concerns of non-users is important for companies to turn them into users. Existing research suggests that the users’ attitudes
towards the service improves when privacy controls are supported by the service provider (Tucker, 2014; Mourey and Waldman, 2020), and complemented with content controls (Cho et al., 2020). As our findings suggest, this may not result in the consumers actually making use of tighter controls, yet it may help in building trust on the company and its services.

Companies need consumer data in order to optimize services and personalise service to their customers. However, being transparent with this information is important to consumers. Companies should consider being clearer in their terms of conditions and not use too much “technical jargon” (U4) in order to draw in more customers and develop a level of trust. Disclosures on data collection are shown to improve trust in the service provider (Aguirre et al., 2015). Service providers need to clearly disclose what data is collected, how long it is stored for, how it is protected, why exactly this data is being collected, and who has access to this data (Malkin et al., 2019). Recently enacted General Data Protection Regulations (GDPR) may provide a suitable guideline in this regard. Understanding and catering for consumers privacy concerns will help companies expand their customer base. Educating consumers on the trade-off between data and services will make consumers feel in control of their data, thus increasing the chances of them having a positive experience with their smart speaker.

6.3 Limitations and Future Research

This study should be seen as the first step towards understanding the complexity of the personalisation-privacy paradox in relation to smart speakers. However, a number of limitations of this study are to be highlighted. Due to time and resource constraints, the sample for this study was rather small, therefore limiting the generalisability of this study. All participants were Irish between the ages of 18 and 25, limiting the diversity of the sample. Due to purposive sampling, the interviewees were selected based on their relevance to the study and were not randomly selected, thus resulting in a potential bias. Finally, since the results are qualitative in nature, although offering valuable insights into the research of the paradox, they do not offer definitive results that represent the population.

This study is one of the first to look at the paradox through the lens of the smart speaker and therefore can be built upon. First and foremost, the results need to be generalised by conducting a large-scale quantitative study on the differences among the users and non-users of smart speakers. Second, illustrating the contextual nature of privacy, this study primarily refers to the attribute of being a user or a non-user. Further research could expand on this list of characteristics to include variables such as age, gender, cultural background, and technological acumen.

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7. **Appendix A: Interview Opening Questions**

**Users**
- Which smart speaker do you have?
- Why did you decide to get that one?
- So, what is your overall perception of smart speakers?
- Where do you keep your smart speaker? Why?
- When do you first hear about smart speakers?
- Why did you get a smart speaker?
- How has your experience been with the speaker so far?
- Would you be able to explain how a smart speaker works to someone who has never heard of a smart speaker?

**Non-users**
- What is your overall perception of smart speakers?
- When do you first hear about smart speakers?
- Why do you not own a smart speaker? Have you ever considered buying a smart speaker?
- Have you ever interacted with a smart speaker?
- Would you be able to explain how a smart speaker works to someone who has never heard of a smart speaker?
EXPLORING MULTI-DIMENSIONAL EVENTS CHARACTERIZING TECH START-UP EMERGENCE IN THE NIGERIAN ENTREPRENEURIAL ECOSYSTEM

Emmanuel Okoro Ajah, American University of Nigeria, Yola, Nigeria, emmanuel.ajah@aun.edu.ng
Chidi Ononiwu, American University of Nigeria, Yola, Nigeria, chidi.ononiwu@aun.edu.ng

Abstract: Most countries across the globe identify technology-based start-ups as a driving force for job creation, economic growth and national development, and a critical tool for economic sustenance during pandemic crises like covid-19. However, its emergence have been argued to be problematic. Especially in a developing economy like Nigeria, where tech start-up founders are faced with diverse form of constraints and environmental uncertainties. Extant literature indicated that studies are been conducted to explain tech start-up emergence. However, such studies are fragmented with findings that are determinants to tech start-up emergence, with several determinants studied in isolation, and the emergence as linear and unidimensional events. Consequently, neglecting multi-dimensional perspective, which aggregate the dimensions of events characterizing tech start-up emergence. Given the iterative, event-based process, and interactive-dependent nature of tech start-up ventures to create activity-based products/services in an open, uncertain, nonlinear and dynamic environment, we argue that little are been known about tech start-up emergence. Thus, by drawing from synthesize literature review, activity theory, and exploratory case study design we identify opportunity discovery and selection; team formation and domain consensus; bootstrapping; minimum viable product development and market experimentation feedback as interdependent multi-dimensional events constituting tech start-up emergence in Nigerian tech start-up ecosystem.

Keywords: Tech Start-up Emergence, New Venture Creation, Technology-Based New Venture, Entrepreneurship, Nigeria Tech Start-up Ecosystem.

1. INTRODUCTION

It is evident globally that technology-based start-ups (hereafter-called tech start-ups), is a driving force for job creation and economic growth and as such, considered as socio-economic tool and mechanism for national development. Kirkley (2016) describe it as a tool that indicate the state of economic health and prosperity of a nation. With focus on Nigerian tech start-up ecosystem, a community of interdependent and interactive actors (Motoyama & Knowlton, 2017), with significant attractive market, and ranked one of the top three tech start-up ecosystem in sub-Saharan region (David-West et al., 2018; Onoja, 2020). Recently in Nigeria, tech start-ups played a critical role in contributing to economic sustenance and well-being of the people during the year 2020 Covid-19 pandemic lockdown. During the lock down, most economic activities were shut down for months. However, Nigeria tech start-up ecosystem were busy, as many tech start-ups emerged during this period, with the aim of proffering solution to essential services that were disrupted by lockdown. For instance, uLesson platform was founded in 2019 to help students at home during the pandemic, it provided learning solution that is of high quality, affordable, and easily accessible to students in Nigeria and across Africa (Jackson, 2021). Consequently, tech start-ups as a digital social
enterprise became a rescue medium for people in Nigeria to survive the covid-19 pandemic lockdown challenges.

However, literature indicated that failure of tech start-ups abounds, though with few successful ones. Examples of failed tech start-ups in our context include OLX, Efritin, WeChat, Easy Taxi (Nairametrics, 2020). Nigerian OLX tech start-up, a vibrant new venture that matches demand and supply of products was short down in 2018; Secondly, Easy Taxi, a popular taxi hailing tech start-up also closed shop in 2016 (Nairametrics, 2020). Nascent entrepreneurs involved in the activities of developing tech start-ups (Diakanastasi & Karagiannaki, 2016), consistently “contend with extreme uncertainty in the early phases of development. This “creates unforeseen contingencies as conditions evolve” (Townsend, 2012, p. 151 ). The alarming failures, suggest that tech start-ups gestation process is problematic (Reymen et al., 2015). Gestation process is a development process that spans through ideation to commercialization in start-up life cycle (Reynolds & Miller, 1992). This argument suggests that start-ups struggles for existence against prevailing uncertainties, as they go through gestation (Salamzadeh & Kesim, 2015). Such uncertainties manifest in the form of poor infrastructures, unfavorable government policies, duplicate government taxes, even in the absence of amenities that the payment of such taxes should have provided due to corruption, political instability, and lack of investors (Erik, 2013).

Thus, the unequal flux of low success to high failure rate experienced in tech start-ups has attracted the attention of scholars, professionals, policy makers, across the globe. Consequently, its negative effect on economic growth and national development is alarming, thus, we argue that it is critical to understand necessary actions required to develop a viable tech start-up (Park, 2005). Corroborating this argument, Yang et al. (2017) suggest the need to further investigate tech start-ups emergence, to enhance understanding of how to survive gestation challenges. Secondly, Cantù et al. (2018) assert the need for deeper depth of knowledge, to help mitigate current mortality rate. We discover from literature that many studies have been conducted, yet, most prior studies focus on fragmented studies of the determinants of tech start-up emergence (Shepherd et al., 2020). This suggests that most studies view tech start-up gestation as a unidimensional event (Brahma et al., 2018; Gartner, 1985), which hinder better understanding of the collective activities that are likely to be highly interdependent and contradictions that birthed tech start-up emergence. (Lichtenstein et al., 2007).

Razmooz et al. (2020) emphasize that fragmented studies are not sufficient for an in-depth understanding of tech start-up formation. Hence, we investigate the diverse dimensions of events that reveals the aggregation of the conducted interdependent activities describing how viable tech start-up emerge. The multi-dimensional events are sequence of different happenings that emerge as founding team conduct interactive and recursive activities. This happenstance, hierarchically emerge in phases, and culminated to a viable tech start-up. Thus, to identify the series of events, and understand how the recursive activities underlying the events occur, we draw from extant literature and activity theory (AT). We adapt the six elements of the activity system, to analyze the sequence of unpredictable dimensions of events as we ask the following research question (RQ): What are the multi-dimensional events that describe viable tech start-up emergence in Nigeria tech start-up ecosystem? The outcome of this study contributes to literature, advances theory, enlightening nascent entrepreneurs on the activities and events that are critical, and further enlighten policy makers’ in developing right policies.

The remaining parts of this paper is structured as follows: firstly, we review literature for theory background of the investigation. Secondly, we select and describe the methodology appropriate for the investigation and we analyze the collected data set for the study. Thirdly, we present our findings from the dataset. Fourthly, we engage in discussion of the findings, finally, we conclude by describing contributions of the study to existing body of knowledge, in practice and in advancing theory, and further render suggestions for future study.
2. THEORETICAL BACKGROUND

We adopted activity theory (AT), because it possesses the power to describe the “complexity [experienced] in human activities” (Hite & Thompson, 2019, p. 2). Activity theory originated from a Russian scholar and psychologist called Lev Vygotsky, whose model is the first generation activity theory. However, many generations have emerged, and we draw from Yrjö Engeström perspective, called the third generation of activity theory (Engestrom et al., 1999; Madyarov & Taef, 2012). This is because it enables interactivity between multiple activity systems that culminates to a common outcome. Focusing on our phenomenon, it enables the description of the recursive activities transformation to multi-dimensional events represented as object of activity.

![Activity System Describing Tech Start-up Emergence](image)

*Figure 1: Activity System Describing Tech Start-up Emergence, as adapted from (Engestrom et al., 1999)*

Thus, we use AT to describe various interactive and recursive gestation activities causing each dimension of event, by mapping founding team activities to corresponding interactive elements in the activity system as shown in Figure 1. Activity systems are guided by some fundamental principles (Bharosa et al., 2012; Engestrom et al., 1999), which include: (1) activity system, identified as the unit of analysis (Bharosa et al., 2012; Murphy & Rodriguez-Manzanares, 2008). (2) the activity system is exposed to diverse perspective and views, leading to multiple voices and choice of interest in the activity systems, and is caused by division of labor, thus, creating multiple view from the actors (Madyarov & Taef, 2012; Murphy & Rodriguez-Manzanares, 2008). (3) activity system is dependent on their own history, as they engage in the analysis of human activities through mutual influence between human actions and institutional structures (Bharosa et al., 2012; Madyarov & Taef, 2012). (4) contradiction plays a critical role as it generates changes and tensions within the activity systems to drive desired outcome (Bharosa et al., 2012; Madyarov & Taef, 2012). (5) activity systems have the potential for expansive possibility (Engestrom et al., 1999; Murphy & Rodriguez-Manzanares, 2008). The interactive activities triggers contradictions manifest as disturbances, tensions and conflicts, within or between activity systems. Such contradictions confronts nascent entrepreneurs within and between activity systems, influencing founders actions that leads to desired transformations in a system (Madyarov & Taef, 2012). Examples of contradictions in activity systems include primary, secondary, tertiary, and quaternary levels of contradictions (Madyarov & Taef, 2012). Where “the primary contradictions arise within the elements/nodes of the activity system … Secondary contradictions occur between the nodes of an activity system, and tertiary and quaternary contradictions occur between different activity systems” (Madyarov & Taef, 2012, p. 81).

Particularizing AT to our phenomenon of interest, we adapt the activity system to describe how founding team interacts with actors in the ecosystem; how they orchestrate activities that drives the sequence of multi-dimensional events as object of activity that culminates to tech start-up. Literature
has shown that tech start-up emergence is a progressive gestation process, that is characterized by unpredictable multi-dimensional events (Gartner, 1985; Reynolds & Miller, 1992). Such events include opportunity emergence (Jones & Barnir, 2018), behavior and cognitive factors (Baron, 2007), opportunity confidence (Dimov, 2010), founding team experience, and industrial context (Li & Dutta, 2018), business planning in venture emergence (Long et al., 2016), and action place in venture creation (Gordon, 2012). This amplifies the need for aggregated in-depth investigation of the culminating multi-dimensional events involved. We illustrate our findings from literature in Table 1, depicting the outcome of our systematic literature review. Thus, we conceptualizes tech start-up emergence into four phase events. Such events include opportunity discovery and selection, team formation and domain consensus, bootstrapping, and MVP development and market experimentation feedback.

<table>
<thead>
<tr>
<th>Culminating Events as Object of Activity System</th>
<th>Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Opportunity Discovery and Selection</strong></td>
<td></td>
</tr>
<tr>
<td>- Economically viable opportunity is the reason entrepreneurs indulge in entrepreneurship (Politis &amp; Gabrielsson, 2006).</td>
<td>(Atherton, 2007; Baron, 2007; Becker &amp; Dodo zu, 2015; Carolis &amp; Saparito, 2006; Dimov, 2010; Fiet &amp; Patel, 2006; Gruber et al., 2008; Harper, 2005b; Jones &amp; Holt, 2008; Jones &amp; Barnir, 2018; Park, 2005; Politis &amp; Gabrielsson, 2006)</td>
</tr>
<tr>
<td>- Opportunity discovery is the prerequisite for entrepreneurship (Park, 2005).</td>
<td></td>
</tr>
<tr>
<td>- “Discovery cannot occur without [adequate] information” (Fiet &amp; Patel, 2006, p. 216). Therefore, information triggers opportunity discovery, which leads to the creation of a tech start-up (Ford &amp; Sullivan, 2008).</td>
<td></td>
</tr>
<tr>
<td><strong>Team Formation and Domain Consensus</strong></td>
<td>(Baron, 2007; Becker &amp; Dodo zu, 2015; Diakanastasi &amp; Karagiannaki, 2016; Ford &amp; Sullivan, 2008; Middleton &amp; Nowell, 2018; Samalopanan &amp; Balasubramaniam, 2020).</td>
</tr>
<tr>
<td>- To achieve emergence of a viable tech start-up in the face of environmental challenges, it requires the effort of an entrepreneurial team, rather than the effort of a single entrepreneur (Diakanastasi &amp; Karagiannaki, 2016).</td>
<td></td>
</tr>
<tr>
<td><strong>Bootstrapping</strong></td>
<td>(Patel et al., 2011; Perry et al., 2011; Waleczek et al., 2018).</td>
</tr>
<tr>
<td>- A sequence of actions taken by a founding team, to enable them access necessary resources, capable of influencing the transformation of discovered opportunity to a valued product/services in a target market (Patel et al., 2011).</td>
<td></td>
</tr>
<tr>
<td><strong>MVP Development and Market Experimentation feedback</strong></td>
<td>(Adamczyk, 2017; Becker &amp; Dodo zu, 2015; Bhave, 1994; Carmine et al., 2014; Ford &amp; Sullivan, 2008; Isabelle et al., 2016; Morris &amp; Kuratko, 2020).</td>
</tr>
<tr>
<td>- Minimum viable product (MVP) emerges from the sets of product development activities carried out by the founding team (Carmine et al., 2014). Developed MVP is tested in the market to ascertain its acceptance, reasonable traction, and further obtain feedback for possible product modification, with the aim of meeting the needs of the target customers (Ganesaraman, 2018).</td>
<td></td>
</tr>
</tbody>
</table>

Table 1: Tech start-up Emergence as an Outcome of Culminating Events.

3. METHODOLOGY

“Research conducted within the activity theoretical framework calls for a research design that would afford an in-depth study of an activity system or a constellation of interacting activity systems” (Madyarov & Taef, 2012, p. 84). This informs our choice in selecting case study as the appropriate
methodology for this investigation (Walsham, 1995; Yin, 2018). Thus, it allows us to investigate series of events that are context-based and real life situated (Benbasat et al., 1987).

3.1 Case Description

Nigeria tech start-up ecosystem provides platform for socio-economic development of Nigeria. It hosts technology hub that provided support to founders and tech start-ups. Examples of the technology hubs include CC-hub, Hub-one, Next-hub, and Venier-hub. The technology hubs provide some services to the founders during tech start-up gestation; such services include accelerator services, incubator services, and workspaces to aid infrastructural needs of the founders. These hubs are mainly clustered in Lagos, the commercial capital of Nigeria. Making Lagos a tech-based entrepreneurial ecosystem and attractive city to nascent entrepreneurs and investors. It is worth noting that the large addressable market in Nigeria is responsible in attracting interest both locally and internationally ecosystem. However, the ecosystem experiences environmental uncertainty and resource constrain, which explains why only few states out of many states in Nigeria are hosting tech start-ups in their numbers within Nigeria tech start-up ecosystem. Yet, the number of tech start-ups that succeeded are few as record shows high failure experiences, at the rate of 61% (Onoja, 2020). The high rate of failure is due to poor infrastructure, scarcity of funds, political instability, high Government tax, unfavorable policies, high barrier to entry and lack of adequate skilled and experienced professionals. However, It is on record that Nigeria tech start-up ecosystem has experienced tremendous growth and recognition in Fintech, Healthtech, and Agritech, across the globe in the last five years (StartupUniversal, 2020).

3.2 Data Collection

The data used in this study emanated from three tech hubs (i.e. CC-Hub, Next-Hub, and Hub-one), which was selected within Nigeria tech start-up ecosystem. We conducted a semi-structured interview as primary source of our data, with the respondents consisting of tech start-up founders and co-founders. We further engaged in observation of the activities carried out by the founding team, and accessed the corresponding archival documents available, to enhance the data collected.

<table>
<thead>
<tr>
<th>S/ N</th>
<th>Tech Start-up</th>
<th>IT Artifact Developed as Product/Service</th>
<th>Interviewee Position</th>
<th>Number of Years On</th>
<th>Technology Hub</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AA</td>
<td>Retail Lender (Fintech) Application</td>
<td>Founder</td>
<td>Three (3)</td>
<td>CC-Hub</td>
</tr>
<tr>
<td>2</td>
<td>BB</td>
<td>Shopping Mall Advertising Appl.</td>
<td>Founder</td>
<td>Five (5)</td>
<td>CC-Hub</td>
</tr>
<tr>
<td>3</td>
<td>CC</td>
<td>Digital Marketing Application</td>
<td>Co-founder</td>
<td>Four (4)</td>
<td>CC-Hub</td>
</tr>
<tr>
<td>4</td>
<td>DD</td>
<td>Software Consulting Application</td>
<td>Founder</td>
<td>Four (4)</td>
<td>CC-Hub</td>
</tr>
<tr>
<td>5</td>
<td>EE</td>
<td>Art Market Application</td>
<td>Founder</td>
<td>Three (3)</td>
<td>CC-Hub</td>
</tr>
<tr>
<td>6</td>
<td>FF</td>
<td>Ecommerce Application</td>
<td>Co-founder</td>
<td>Three (3)</td>
<td>Next-Hub</td>
</tr>
<tr>
<td>7</td>
<td>GG</td>
<td>Financial Service Application</td>
<td>Co-founder</td>
<td>Three (3)</td>
<td>Next-Hub</td>
</tr>
<tr>
<td>8</td>
<td>HH</td>
<td>Property-tech Application</td>
<td>Founder</td>
<td>Two (2)</td>
<td>Hub-One</td>
</tr>
<tr>
<td>9</td>
<td>II</td>
<td>Ecommerce Solution</td>
<td>Founder</td>
<td>Three (3)</td>
<td>CC-Hub</td>
</tr>
<tr>
<td>10</td>
<td>JJ</td>
<td>Digital Media Application</td>
<td>Co-founder</td>
<td>Four (4)</td>
<td>Hub-One</td>
</tr>
<tr>
<td>11</td>
<td>KK</td>
<td>Fintech (Osusu) Application</td>
<td>Founder</td>
<td>Four (4)</td>
<td>Hub-One</td>
</tr>
<tr>
<td>12</td>
<td>LL</td>
<td>Financial Advisory Application</td>
<td>Co-founder</td>
<td>Three (3)</td>
<td>Hub-One</td>
</tr>
</tbody>
</table>

Table 2: Sample Respondents of tech start-ups interviewed in the empirical situation.
During participant observation, we observed participants in three selected tech hubs consecutively, for a period of 6 months in two phases of 3 months each and we recorded our observation in our field notes. The process of data collection lasted for nine (9) months, from January to September 2020.

We conducted interviews for twelve (12) people consisting of founders and co-founders. Each of the interview took an average of forty-five (45) minutes. The questions asked during the interview were open ended, which encouraged the interviewees to express in detail their view regarding series of actions taken as they engage in recursive activities (Walsham, 1995). Some of the questions we asked include:

*What motivated you to engage in creating a tech start-up? What are the key activities for the entire process? How did you develop the product/services for the tech start-up? How did you acquire the necessary resources needed for the development of tech start-up?*

The interview proceeded with interviewees introducing and elaborating their tech start-up goals, how the idea were discovered, the development process, team formation, fund raising, market experimentation, and the kind of value their products provided to the expected customers. Table 1 presented the details of the tech start-ups that were investigated. However, the names of the tech start-ups where replaced with letters for anonymous purposes and to strengthen confidentiality.

### 4. DATA ANALYSIS AND FINDING

We focused on the collected data, transcribed the audio data to English text, and engaged in analyzing the transcribed audio data using thematic analysis (Braun & Clarke, 2006). Themes, and overarching theme where identified and properly grouped. Adopting AT, enables the investigators to engage activity system in providing description of the emergent sequence of critical events (Hardman, 2005). Our findings indicate that the events that culminate to viable tech start-up, emerges as a transformation of the action taken by founders towards resolving various tensions and disturbances arising from contradictions experienced in the activity systems. The experienced contradictions manifested among founders, founders and stakeholders, and from market experimentation feedback. Table 3 below depict contradictions experienced at each phase, and how the founding team orchestrate actions to resolve them.

<table>
<thead>
<tr>
<th>Contradictions experienced in the activity systems</th>
<th>Excerpts from interview</th>
<th>Emergent Events in Phases</th>
<th>Outcome of Culminated Events</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emanate from divergence views of founders in activities conducted when evaluating discovered opportunities, This generates tensions that led to the team orchestrating actions carried out to resolve tension, thus, leading to the emergence of economic valued opportunity.</td>
<td>“For us in EE to arrive at our business idea, it took a lot from each of the founding team, because we had some disagreement on which product will have high traction, we then engage in further market research to reach a consensus”.</td>
<td>Phase:1 Opportunity Discovery and Selection Event</td>
<td></td>
</tr>
<tr>
<td>Tensions are being experienced among the team members while conducting activities, where a team member is influenced by</td>
<td>“I had to let a team member live the team at the beginning of this start-up because he fill,</td>
<td>Phase:2 Team Formation and Domain</td>
<td>A Viable Tech Start-up Emergence</td>
</tr>
</tbody>
</table>

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the magnitude of task they engage, and in turn, seek for review of equity offer allocated to them. The team resolves it by replacing such member with a more focused and goal fit individual, thus, the emergence of right team.

<table>
<thead>
<tr>
<th>he is offering so much for the percentage of equity I offered him, he started creating problem, and that was not healthy for us, so I had to let him go”</th>
<th>Consensus Event</th>
</tr>
</thead>
</table>
| This event emerge as founders take actions to resolve tension arising from limited resources, and disturbance from family and friends who decides to change their mind and request for the fund they invested. | “My cousin created issues, when he demanded for profit or we return his money after one year of investment, the team acted by seeking for new angel investor”.

**Phase: 3**

Bootstrapping Event

| Disturbance arises during product development, caused by task conflict between the founders when executing task. Another tension arises from market feedback, which drives the desired changes and modification of the product to meet the needs of the customers. Thus, the founders orchestrates action to resolve this tension, which leads to the emergence of a viable product in the market. | “The first time we introduced our prototype to the market, the comments almost discouraged us, but we hold on to the fact that some people said they need the product, if we can modify some aspect”.

**Phase: 4**

Minimum Viable Product Development, Market Experimentation Feedback

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Table 3: Contradictions as Driving Force for Tech Start-up Emergence

Founders’ engages in experiential learning from the feedback of conducted market research and prototype experimentation. Experiential learning provides critical information that act as driving force for continuous iterative activities, which play a critical role in resolving generated tensions and disturbances experienced. Thus, focusing on Figure 2,3,4,5 we describe in detail the activities driving the multi-dimensional events that culminate to viable tech start-up emergence by starting with opportunity discovery and selection of events.

### 4.1 Phase 1: Opportunity Discovery and Selection Events

**Subject (Founding Team):** The founding team is responsible for the series of iterative actions taken to search and evaluate opportunities that are transformable to innovative products/services. The founders focus on the prevailing challenges in Nigeria market to discover opportunities, which they evaluate for economic value. Excerpt, “We began by searching, we identified a problem, and we desired to solve it. As we keep building solutions around it, we try to be very close to our customers, we try to understand how they like to be served, what exactly they need, so we can make necessary adjustment to keep re-inventing our product to fit the market”.

**Rules:** The founders ensure they keep necessary government regulations and policies guiding the sector of interest. In some cases, conditions placed on some business makes it difficult for them to venture. Thus, founders collaborate with people who can provide those requirements. Excerpt, “You also need to look at the regulatory constrains for the discovered business idea, and how to meet those regulatory requirements”.
“Regulatory requirement can sometimes be an impediment ... We partnered with people with the financial resources; in return we offer them percentage of the venture equity”.

**Community:** This includes founders, customers, business advisers, mentors, investors, government institutes, and competitors. The founders approach potential customers in the target market, to discuss and scrutinize opportunities discovered, by interacting with them to understand existing challenges, and identify how to transform the opportunities discovered. Furthermore, the founders interact with stakeholders within the ecosystem, for further evaluation. Excerpt, “We are creating a world where everyone and anyone can invest in real estate through blockchain technology. We are working with several real estate partners and stakeholder in the sector”.

![Figure 2: Activity System for Opportunity Discovery and Selection](image)

**Rule:** Government regulations and policies guiding the sector

**Tool:** Prior Knowledge, Experience, ideas, and Founders cognition

**Subject:** Founding team

**Object:** Opportunity Discovery and Selection

**Outcome:** A constituent dimension of event, of an emergent tech start-up

**Division of labour:** Various task and roles assigned to founding team members toward the discovery and evaluation of a viable opportunity

**Community:** The actors or stakeholders within the entrepreneurial ecosystems

**Figure 2: Activity System for Opportunity Discovery and Selection**

**Tool:** The founders uses cognitive abilities, prior knowledge and experiences, as tools within the specific domain of interest, as they search for marketable opportunity. Excerpt, “We all have domain experience in what we do; it was easy for us to navigate all the problems we probably have faced as we search for marketable opportunity within our environment. So experience also is key”

**Division of labor:** The founder engages services of experts, business advisors, and skilled workers to evaluate the identified opportunities. Such that some are responsible in making enquiry from the prospective customers, on how tenable a particular opportunity is to the target market. Another is responsible in converting this idea to an innovative product design, while some other are responsible for developing business plan and marketing strategies needed. Excerpt, “There is a lot to benefit from synergizing and exchanging expertise. So I think in this tough environment, attempting to do it alone might not be enough”.

### 4.2 Phase 2: Team Formation and Domain Consensus Event

**Subject (Founding Team):** In this phase, the founding team begins to search for complementary team members needed to transform the selected opportunity to a product fit for the target market. Illustrating, “It is important for the founder of a tech start-up to form a team, by engaging in partnerships that saves you money and time. Engage in partnership that opens door for you, links you up with other bigger organization”.

**Rule:** There are conditions for partnership, the founders engage in reaching agreement with the prospective member on the equity offer, agree on terms and condition of work, and agree on contribution they are bringing to the team. Then, they seal the alliance with a sweat equity, a percentage of equity for collaborating. Excerpts, “Number one thing for me is to have a very good
team and ensure fairness in equity allocation to members of the team. I do not hoard equity from the team. For example, you find some founders who want to hold 80% of the equity and they are very stingy with what they can give out and that in turn affect what they can achieve”.

**Community:** The team consists of various personnel who complement each other in expertise and in finance. It involves business advisors, highly skilled people, experienced people, and expatriates in the domain of interest. Excerpt, “I feel like I did not do it alone, I had a partner at a time and when we collected money from people, they became partners too. Therefore, it made it more of a teamwork and not just an individual thing”.

![Activity System for Team Selection and Consensus](image)

**Figure 3: Activity System for Team Selection and Consensus.**

- **Tool:** The founders use their social skills and experiences as tools in convincing prospective team members to join the team. Excerpt, “I had to bring in a tech expert to become a co-founder, which enables me to understand the technical side over time to grow my skills”.

- **Division of labor:** For instance, “As an entrepreneur, you need to surround yourself with a solid network of associates, people who are more experienced than you in different fields. I am lucky to have such kind of support structure too”.

**4.3 Phase 3: Bootstrapping Event**

**Subject (Founding Team):** The founding team as subject engages in bootstrapping activities to acquire necessary resources needed to transform the selected opportunity to a viable tech start-up. They directly invest their personal funds and interact with families and friends to persuade them to invest funds, and other kinds of resources needed to achieve viable tech start-up. Excerpt, “Am not a fan of I want to take 100% control of my business because when we started, I realized the level of my strength, that I can’t do it all by myself and that I would be needing help from others. So I immediately reached out to the people am going to need their help, which cost some equity, which is not a problem for me, because I would rather own 20% of a 10-Billion-dollar business than own a 100% of 1-million-dollar business”.

- **Rule:** To bootstrap successfully, the founding team focused on ensuring that cultural values and norms binding them to their families and friends are maintained, also personal commitment to ensure trust are established and strengthened. Excerpt, “If an idea comes to your head ... you have to put your own skin in the game. If you are a technical founder who build the product, that might be your own equity commitment in the business, it might not really be cash because you spent sleepless nights in building the product”
**Community:** These includes family members, friends, skilled and technical personnel, who are willing to offer their resources to support the development of the tech start-up. “You have to identify skilled and technical experts who believes in your idea; you also have to be in the good books with family and friends because they are usually the first point of call when you are cash trapped”.

![Figure 4: Activity System for Bootstrapping.](image)

**Tool:** The founders uses social skills and social networks within and outside the ecosystem, by engaging in profitable interaction and association with family members, friends and colleagues. Excerpt, “Leveraging on people is critical in this environment, if you cannot leverage on people and get things done free or for differed payment or at a subsidized rate, then you will not be able to do it as a lean start-up”.

**Division of Labor:** Each member of the founding team is tasked to convince and attract rich and skilled family members or friends that can invest finances or skills towards the development of the tech start-up. Excerpt, “I feel like I did not do it alone, I had a partner at a time and when we collected money from people, they became partners too. Therefore, it made it more of a teamwork and not just an individual thing”.

### 4.4 Phase 4: Minimum Viable Product Development, Market Experimentation Feedback

**Subject (Founding Team):** The founders are responsible in setting up a team, technically capable of developing product/service prototype, which later undergoes acceptance and viability test in the market. Minimum viable product (MVP) development emerges from the recursive activities carried out by the team by engaging technical expertise in developing a prototype. After developing the prototype, it is experimented in the market to ensure viability, possible traction, and obtain feedback for necessary modification. Excerpt, “The founder conceptualizes the ideas and then build a sort of Minimum Viable Product (MVP) that is tested in the target market”.

Thus, during the initial entry to market, the founding team interacts with the market forces by sampling continuously the MVP and proposed customers to understand the needs of the market (Morris & Kuratko, 2020). Consequently, market experimentation, allows the founders to engage in “learning from what does not work, and experimenting with alternative approaches, the entrepreneur is able to discover where the real opportunity lies” (Morris & Kuratko, 2020, p. 8 ). “Founders need to be observant of the market and the product, understand your market and try to ensure that product is fit for the market, and the market wants it. By engaging on a proper market survey before developing the final product”.

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**Rule:** The rule observed in this event are the ideal practices of professional code of conduct (i.e. formal practices) in developing IT artifacts. Another rule is ensuring constant communication with target customers during IT artifact development. The next rule observed is the government policies guiding the development of a specific product, especially in the area of quality control and quality assurance. For instance, developing financial service Application (e.g. Osusu App.), requires founders ensuring that policies guiding financial services are adhered to as the IT artifact is been developed. Excerpt, “When starting to develop a product for a business, you must not stop the product development because of unfavorable policy guiding the business. However, if it is a highly regulated sector, please ensure to get the license needed for you to operate in that sector”.

**Figure 5: Activity System for MVP Development and Market Experimentation Feedback**

**Community:** The community include founding team who develops the product, prospective customers who test and provide feedback to the founders on how the MVP meets their needs with necessary modification. Again, part of the community are government institutions regulating the specific sector the founders are venturing, and other stakeholders within the ecosystems. Excerpt, “It is a whole lot of energy that has to go into market validation, R&D to ensure that the solution you are providing is much needed, and not just assuming that it is needed. You must be able to proffer solution to local challenges, which meets government regulations, which can stand competitors product, and can easily attract investors in the immediate community”.

**Tool:** The tools are expertise, skills, and developed IT artifact introduced to the market. Excerpt, “Another thing is as much as possible; you continue to develop and modify your MVP till you have customers. Nothing speaks for itself like having customers who are using your product or service”.

**Division of Labor:** Tasks are being distributed to the team members. For instance, some are responsible in coding, fixing of any observed bug, and modification of code for new features; some members of the team are responsible in physically managing the development process of the product; some are responsible in communicating with the customers, as the MVP is been tested in the market. While some are responsible in analyzing feedback from the market; and others are responsible in ensuring that the outcomes of the feedback are properly implemented to suit the desires and needs of customers. Excerpt, “Developing a start-up is more than having a great idea; it is being able to come up with the right team that can actually execute the business idea in to a viable product … Hence, you need to get a group of people with requisite knowledge, experience and expertise that can actually translate your idea to something tangible and acceptable to the target market”.
5. DISCUSSION

The outcome of our empirical investigation suggest that tech start-up gestation consist of four critical phases, catalyzed by continuous feedback from the market. Our findings reveal how tech start-ups emerge from a hierarchical sequence of events, driven by interdependent recursive activities conducted by the founding team and other stakeholders in the ecosystem.

![Diagram](attachment:multi-dimensional-events.png)

**Figure 6: Multi-dimensional events culminating to emergent Viable Tech Start-up.**

Our findings in phase 1 suggest that opportunity discovered in a target market is a prerequisite for entrepreneurship (Park, 2005), and does not support founders creating innovative opportunity from their thought and prior experience. Therefore founders in our context, embrace only discovered opportunity as raw material required to achieve entrepreneurship (Baron, 2007), and the reason they indulge in entrepreneurial activities (Politis & Gabrielsson, 2006). They evaluate and scrutinize the identified opportunities to ensure they select opportunity with true economic value (Harper, 2005a). This outcome corroborated the result of some prior fragmented studies that focus on opportunity recognition (Bhave, 1994). However, this result is only a fragment of the dimensions of events that constitute tech start-up emergence. The second phase involves bringing together a group of people that possess complimentary skills, with the aim of collectively applying domain knowledge to creating a viable tech start-up (Middleton & Nowell, 2018). Our finding shows that appropriate team formation is another dimension of event that is critical to the emergence of a viable tech start-up (Diakanastasi & Karagiannaki, 2016). As we discovered in our context, it is practically difficult for a single founder to develop a tech start-up because the context is plagued with uncertainties caused by various market forces. More people are usually involved, to enable the provision of needed knowledge, other resources and necessary relationship that will facilitate meeting various environmental demands necessary for the emergence of a viable tech start-up (Ford & Sullivan, 2008). Emphasizing further, our findings support Diakanastasi and Karagiannaki (2016) who argue that achieving emergence of a viable tech start-up requires the effort of entrepreneurial team, rather than the effort of a single entrepreneur. Therefore, each member of the team provides skills, experiences and capabilities that compliments the short fall of others within the team (Middleton & Nowell, 2018).
Thirdly, resource acquisition plays a key role in tech start-up emergence. Its absence have led to failure of many tech start-ups during gestation (Baron, 2007). Founders often face challenges for necessary resources in our context. Thus, phase three reveal the key process of gaining access to needed resources (i.e. financial and humans) without engaging in borrowing that requires collateral in our context (Patel et al., 2011). Thus, founders engagement in “bootstrapping activities used either for venture development or product development” (Patel et al., 2011, p. 423 ), and it includes the acquisition of needed resources from “relatives and friends, using credit cards, withholding salary, working in other businesses, and employing relatives for nonmarket-based salary” (Waleczek et al., 2018, p. 3 ). In the final phase, our result shows that minimum viable product (i.e. Prototype) development is the outcome of activities carried out by the founding teams with the aim to provide product/service that meets the unmet needs of the market (Carmine et al., 2014). The developed MVP is experimented in the market, to create learning opportunity for the founders, to ascertain the product/service viability in the market. Our finding support the view that market experimentation activity is critical in establishing communication between founders and the customers concerning the product under development (Adamczyk, 2017; Ganesaraman, 2018). In addition, it helps to solve the issues resulting from customers’ choice dynamics. Consequently, received feedback from the market enables founders to ensures that “adjustments are being made as the individual figures out what works in practice and comes to better understand the market opportunity” (Morris & Kuratko, 2020, p. 3 ). Therefore, initial entry to market enables the founding team to interacts with market forces by sampling continuously the prototype, and proposed customers to understand their unmet needs (Morris & Kuratko, 2020). However, our finding shows that acceptance of a product can only be, if it is being discovered from the existential challenge in the market. This suggest that creating product without properly engaging initial market research will lead to tech start-up failure in our context. As the events interact, they create contradictions that lead to the transformation of the desired outcomes (Madyarov & Taef, 2012).

6. CONCLUSION AND FUTURE STUDIES
The outcome of this study contributes to theory, and in practice. It provides description of tech start-up emergence in Nigeria. In practice, this study is relevant, as it enlightens nascent entrepreneurs on how to act during development of a viable tech start-up in an uncertain market. Further, it added empirically, to existing literature, by enhancing the narrative regarding fragmented studies on the determinants of tech start-up emergence. By exploring cumulatively, the sequence of multi-dimensional events characterizing the emergence of a viable tech startup in an uncertain environment. Future study will seek to identify causal mechanisms that must exist for the events to occur.

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AN EXPLORATION OF FACTORS INFLUENCING THE ADOPTION OF ICT ENABLED ENTREPRENEURSHIP APPLICATIONS IN NAMIBIAN RURAL COMMUNITIES

Elizabeth Ujarura Kamutuezu, Namibia University of Science and Technology, eukamutuezu@gmail.com
Heike Winschiers-Theophilus, Namibia University of Science and Technology, hwinschiers@nust.na
Anicia Peters, University of Namibia, anicia.peters@gmail.com

Abstract: Digital services have the potential to improve rural entrepreneurs’ access to wider markets and increase their competitiveness among other benefits. Moreover, during the ongoing Covid-19 pandemic in which movement and physical contacts have been limited, businesses relied much on digital services. However, many Namibian rural entrepreneurs have not been able to use digital services to maintain their livelihood. Therefore, this study investigated the factors affecting the adoption of ICT enabled services by rural entrepreneurs. The study applied a cross-sectional survey of 77 respondents comprising 14 rural entrepreneurs and 63 rural community members from four sites. It was found that the five main factors affecting the adoption of digital services by rural entrepreneurs are a lack of awareness of digital services, electricity, skills to navigate smart devices, high cost of both devices and mobile internet and cybercrime. We recommend a tailor-made training program for rural entrepreneurs which includes raising awareness of digital services and associated benefits, capacity building on digital skills and best practice for cybersecurity. In addition, we propose that the Namibian Government should enhance digital inclusion through a policy initiative to reduce the cost to make both data and smart devices affordable for the poor and rural communities.

Keywords: Digital Services, rural communities, adoption, entrepreneurship, Namibia

1. INTRODUCTION
ICT became a pillar of socio-economic development worldwide and a necessity during the pandemic. The inequalities of access to digital services and technologies have been felt more than ever. Many African countries have been battling with political uncertainty, economic adversity, social inequalities, urban-rural migrations, and underdeveloped technical infrastructures [20]. While there is an extensive body of literature focusing on the adoption of ICT by Small Medium Enterprises (SMEs) in the global south and governments recognising the significance thereof, little attention was given to rural areas in developing countries [1,9]. Moreover, many studies were conducted by researchers from developed countries with narrow exposure and lack of contextual understanding, mostly using positivist quantitative approaches with limited explanations of factors influencing ICT implementations [37]. While acknowledging the opportunities and benefits of ICTs, it is important to investigate the adoption levels, the barriers to adoption and devise alternatives to reduce the barriers in order to unpack ICT enabled services’ contributions that improve people's lives. This study, therefore, aims to fill a research gap through an empirical investigation focusing on Namibian rural entrepreneurs. The aim of this study is to examine the factors influencing the adoption of ICT enabled applications and services for rural entrepreneurship activities in Namibia and recommends initiatives to overcome barriers to ICT adoption by rural entrepreneurs.

The Namibian Government has prioritised the deployment of ICT infrastructures to rural areas to bridge the digital divide between its urban (48%) and rural (52%) population. This is encapsulated...
in the broadband policy targeting 80% population coverage by 2021[26]. Namibia is boasting a 120% mobile phones penetration, which is higher than the World (67%) and Africa (81%) respectively and an internet connection of 51% while Africa has an average of 34%. Social Media usage has increased to 31% in 2021 [13]. COVID-19 has significantly increased mobile phone and internet usage across Namibia in many spheres of life. Due to lockdowns and limitations on movement, many people were communicating online, with the tertiary education sector nearly entirely transferred to an online teaching mode [10]. With the agricultural sector being a dominant player in the economy, the usage of ICT enabled services will play a significant role in promoting entrepreneurship and economic growth in rural areas by diversification of the rural economy embedded into competitive agriculture and forestry industries, and improved quality of life [21]. Generally, the high mobile penetration holds a prospect for Namibia to adopt ICT in rural areas [29] and yet during the pandemic, Namibian farmers were unable to travel to pay the workers or use online/cellular banking facilities to send the money to workers to buy the farming necessities. Thus, it needs to be determined whether and how the spread of smartphones enables access and effective use of the internet to reduce poverty [34]. The availability of digital services alone will not have a significant impact unless rural communities’ competencies and capacities are improved to use and adopt [28]. Thus Namibia needs to capitalize on the high mobile penetration and improve rural communities’ competencies addressing the barriers to use and adopt ICT enabled services to stimulate entrepreneurship activities for employment creation and poverty reduction [29]. Unfortunately, the Government of Namibia has not undertaken policy directives and initiatives to encourage rural entrepreneurs to go digital to transform the economy digitally and to achieve immense diversity by making use of ICT enabled services.

Figure 1:2018 Global ICT Services Comparison [11]

2. LITERATURE REVIEW

2.1 ICT Enabled Entrepreneurship

There is a consensus that ICT is imperative in national development and that no country can be a player in the global space without digital platforms. However, it is still to be determined whether or more importantly how ICT can work for the marginalised. While ICT is an inevitable tool for an organisation’s operations, the marginalised can leverage ICTs in particular through the usage of mobile phones [25]. For example, Tanzanian rural smallholder farmers have used cell phones to obtain agricultural information, transfer money and conduct communications [24]. Harris [5] contends that ICT for development and developmental technology projects failed the marginalised by being irresponsible to their needs and the challenges they face. ICT is perceived as an isolated
sector and not yet mainstreamed in developmental agendas and has the minutest funding. However, ICT is crosscutting all the sectors as an enabler for development. Walsham [34] postulates that the new ICT-enabled models can transform the dynamics of the developmental trajectory through digitalisation. However, ICT4D has also been widely criticised as to who derives the benefits, who determines the agenda, and who defines what development means [25]. The main criticism is that the approaches for ICT4D are top-down with limited involvement of the communities and little consideration for their needs and aspirations [35]. It can be opined that we can't decouple ourselves from the digital age but there is a need to contextualise ICT strategies for development to maximise the benefits offered by ICT in particular to rural entrepreneurs. Parida et al. [24] are optimistic that digitalisation eliminates traditional challenges brought about by geographical or physical factors that disadvantage rural entrepreneurs. ICT enabled services can compensate for the remoteness and isolation of rural entrepreneurs and mainstream them into the digital economy. According to Savira and Fahmi [28], rural entrepreneurship is a catalyst for rural development as it creates new opportunities for employment creation, increases community income and diversifies the rural economy. Social and digital entrepreneurship concepts are manifested in developmental strategies to enhance internal economic activity through the provision of online banking, e-commerce and adoption of ICTs in private agricultural supply chains which lead to better provision of financial services to citizens and businesses, and improved efficiency in enterprises operations [34]. The emergence of digital entrepreneurship is captured in many studies of [2,6,24 30] which highlights the benefits of entrepreneurs adopting ICT enabled services or using the internet optimality which include: increase sales, cost reduction, high productivity and enhanced quality of goods and services.

2.2 Covid-19 effects
COVID-19 had ripple effects with devastating impacts on global economies, supply chains and especially social entrepreneurs’ businesses were unfavourable due to border closures and lockdowns [32]. The rural- based SMEs were the most affected. The resilience of entrepreneurs is pivotal to cope and adapt during the COVID-19 devastating period. Resilience is an essential concept in entrepreneurial crisis management as it aids in understanding how businesses adapt or resist change and are, therefore, gaining much attention from academics [32]. For example, 73 entrepreneurs in the UK adapted their business plans successfully and took on new business opportunities during the lockdown by developing new products and services in the digital space [32]. Entrepreneurs who embraced digital services persisted and some even flourished while the ones without digital capabilities perished like the small businesses located in rural areas especially in developing countries. The COVID-19 pandemic has changed the business climate across the world. The significance of digital platforms is immersing, with an increase of online retail sales from 19.4% to 24.6% between August 2019 and August 2020 in China’s online market, in Kazakhstan retail sales increased from 5% in 2019 to 9.4% in 2020 and Thailand massive downloads of shopping apps rose 60% in just one week during March 2020 [33]. With the uptake of e-commerce across regions, many consumers and businesses in the global south haven’t capitalized on pandemic-induced e-commerce opportunities due to persistent barriers of costly broadband services, lack of digital skills, low income and low interest in e-commerce [37]. The reality of the new normal is underscored by digital entrepreneurship as an alternative to do online business with limited contacts between buyers and sellers. Social entrepreneurship on the other hand played a pivotal role in the provision of food and shelter to marginalised communities during the COVID-19 pandemic [3]. For example, in Namibia, guesthouses and hotels were used as shelters for homeless and quarantined people and local gardening projects provided for immediate food supplies.

2.3 Rural Adoption of ICTs
Adoption of ICTs in rural areas has shown to be more complex considering the conditions of digital infrastructures, but also the socio-cultural and educational context. SMEs capacity to adopt ICT enabled services is undermined by the lack of financial resources and lack of ability to recognize and optimize the benefits that ICT enabled services may offer to the business [9]. A lack of
awareness by the underprivileged population about digital services and their potential for sustainable development requires awareness-raising interventions [15]. Small-scale farmers need training as they lack expertise in using cell-phone devices effectively for businesses [17]. Digital literacy was found to be the main challenge in creating opportunities for self-reliance and self-employment [4]. The conceptualisation of digital services that can support new or existing rural businesses has equally shown to be a challenge, in terms of developing business plans encompassing digital marketing for example the absence of 24/7 affordable Internet access, online payment facilities, and English language barriers excluded rural entrepreneurs’ full participation on digital marketing space [14]. In summary, studies have revealed that low or lack of ICT adoption can be attributed to a variety of reasons including infrastructure, skills deficiency, cost, limited awareness of benefits, language barriers and an uncertain environment. Some of the barriers can be reduced through policy and regulatory interventions that provide incentives for the operators to invest in rural areas which are less profitable [22].

3. METHODOLOGY

3.1 Design and Sample
The study adopted a cross-sectional survey of 77 respondents comprising 14 rural entrepreneurs and 63 rural community members from four villages (sites). The selected respondents were regarded as active role players (Community) and key informants (Entrepreneurs). Two questionnaires, one for entrepreneurs and another for non-entrepreneurs were used for the survey that was conducted from August to November 2020 at Okomunbonde (Omaheke region), Otumborombonga (Otjozondjupa region), Oniipa (Oshikoto region) and Bordeaux (Hardap region) sites in Namibia. The four sites were selected due to their geographical distribution representing the East, West, North and South of Namibia; moreover, these sites were constructed in 2019 with 3G networks, thus the communities had less than a year of online experience using the Internet. A non-probability convenience sampling technique was used to select the participants subject to their availability and willingness to participate in the study.

3.2 Study Location

Bordeaux
Bordeaux is situated in the Hardap region and the tower constructed at a commercial farm. There are very few people living in the area and the majority are farmworkers. The main economic activities are livestock and pig farming. The site is privately owned and there are no entrepreneurship activities found, thus no entrepreneur was interviewed.

Okomunbonde
Okomunbonde is located in the northeast of the Otjinene constituency. The mobile tower also connects Okamuina and Ozongaru communities which are respectively five and seven kilometers away from the site and the survey included all three areas. The main economic activity is agriculture with a focus on small-scale farming with both livestock and crop production. Okomunbonde has no schools, a clinic or a supply of grid electricity grid. The water supply is from the borehole with a diesel engine operated community water pump. The community has an organized water point committee that collects fees per head of livestock to maintain the borehole, the engine and expenses such as buying of diesel, servicing of the engine and paying the caretaker

Oniipa
Oniipa is an old place founded in 1872 by the Finnish Mission and located north of Namibia in the Oshikoto constituency. The town was administered by the Ondonga Traditional Authority until 2004 when it was declared a settlement area and administered by the Oshikoto Regional Council. In 2015, Oniipa was upgraded to a town and constituted its Town Council. There are also several small entrepreneurs operating such as carwashes, salons and food outlets. Besides the MTC tower, there
is also a Telecom Namibia mobile tower. The town has a computer training centre which is fully functional and a hospital.

**Otumborombonga**

Otumborombonga is a village situated in Otjozondjupa in the Okakarara constitution. The main economic activity is agriculture with a focus on small-scale farming of both livestock and crop production. The village has about 150 homesteads with a daycare and a gas station.

### 3.3 Data collection instrument and procedures

Data was collected using a researcher-administered questionnaire with statements anchored on a five-point likert scale. The respondents were briefed about the purpose of the study and consent was obtained. They were informed that their participation in the study was voluntary and the information collected would be used for the study and will be treated as confidential. The researcher administered the questionnaire by posing questions/statements to the respondents, listening to the responses and recorded them on the questionnaire which had five possible choices for each statement (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree). The survey was conducted in English, Otjiherero, or Afrikaans, as chosen by the informant. All questions required to be answered. Besides obtaining demographic data of sex, age and employment status, two guiding questions were posed to the respondents: *What could prevent you from using digital services?* and *What could you propose as an intervention(s) to overcome the problems to adopt digital services?* The two questions of "factors preventing adoption" had 10 items while "interventions to adopt digital services" was measured using 7 items. Items were adapted from the previous studies of [1,2,9,18]. The responses on items used in the measurement of the variables of the study, “what prevents you from (barriers to) using digital services” displayed in Table3A, and “interventions to adopt digital services” displayed in figure 2 were coded on a five-point Likert scale, ranging from strongly disagree (1) to strongly agree (5).

### 3.4 Data Analysis

In the data interpretation, the rating for proposed interventions was trimmed and responses rating 1-2 were regarded as disagreement while responses rating 3 are neutral responses and rating from 4-5 regarded as agreement. A descriptive statistic for all ten variables was examined using the Statistical Package for Social Sciences software (SPSS) that was used to create inferences to the research participants. Descriptive statistics are statistics that can be used to describe variables or generalize information from a sample and SPSS software is a widely accepted package for analysing in social sciences [16]. Therefore, to reduce the likelihood of presenting misleading results it is a good practice to use descriptive statistics using a systematic approach [12]. The main purpose of this analysis is to know to what extent is the adoption of ICT enabled services influenced by the ten independent variables and that those measures should be taken based on the results obtained using SPSS. In addition, a multiple regression analysis was done to measure the relationships between independent and dependent variables and to test for respondent’s different answers to the research questions. This analysis is suitable to presumed the significance of one dependent against two or more independent variables and to provide a prediction about the dependent variable based on its covariance with all the concerned independent variables [16].

### 4. FINDINGS

**Distribution of respondents**

The distribution of respondents according to the region, gender (male/female) and category (entrepreneur/ non-entrepreneur) are presented in Table 1.
The respondents’ characteristics consist of sex, age group, and employment status of the respondents. As seen in Table 1, the majority of respondents were male representing 51% while female respondents were 49%. Most respondents belonged to the age group of 26-40 (53%) while respondents in the age group of 18-25 were 18% while those in the above 40-years age were 18%. It was found that 53% of the respondents were employed while 47% were unemployed. The majority of respondents are from the age group of 26-40 years and this is due to their active participation in economic activities and exposure to modern technologies. This finding is consistent with the previous study outcome that due to the novelty of technology the younger individuals are presumed to be more inclined to access the internet than older ones [15].

Factors influencing ICT Adoption among Rural Entrepreneurs in Namibia

Descriptive Statistics and Multiple linear regression were used to assess the factors that influence the adoption of ICT enabled services and the result is presented in Table 2A and 2B respectively.

<table>
<thead>
<tr>
<th>Sites</th>
<th>Entrepreneurs</th>
<th>Non Entrepreneurs</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td>Bordeaux</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Okomumbonde</td>
<td>1</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Oniipa</td>
<td>4</td>
<td>2</td>
<td>15</td>
</tr>
<tr>
<td>Otumborombonga</td>
<td>2</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>7</strong></td>
<td><strong>7</strong></td>
<td><strong>31</strong></td>
</tr>
</tbody>
</table>

Table 1: Number of participants

Table 2A: Factors influencing ICT Adoption among Rural Entrepreneurs in Namibia

Looking at descriptive statistics for the 10 variables above, respondents mostly agreed with “Lack of awareness” to be their major influence preventing them from using digital services/internet. Respondents mostly disagree with “Social Influence” to be the major influence that could prevent someone from accessing digital service/Internet. With a combined percentage disagreement of 70.1% and total participants of 54 out of 77.
<table>
<thead>
<tr>
<th></th>
<th>Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unstandardized Coefficients</td>
</tr>
<tr>
<td>(Constant)</td>
<td>0.894</td>
</tr>
<tr>
<td>High cost to connect to the internet</td>
<td>0.066</td>
</tr>
<tr>
<td>Lack of Access to Smart devices</td>
<td>0.096</td>
</tr>
<tr>
<td>Lack of skills to use the internet</td>
<td>0.265</td>
</tr>
<tr>
<td>Lack of electricity supply to charge the devices</td>
<td>0.045</td>
</tr>
<tr>
<td>Security concerns/ Safety of internet</td>
<td>-0.087</td>
</tr>
<tr>
<td>Limited access to high-speed internet</td>
<td>0.008</td>
</tr>
<tr>
<td>Limitation to purchase recharge services</td>
<td>0.065</td>
</tr>
<tr>
<td>Lack of awareness</td>
<td>0.312</td>
</tr>
<tr>
<td>Social Influence</td>
<td>0.046</td>
</tr>
</tbody>
</table>

Table 2B: Factors influencing ICT Adoption among Rural Entrepreneurs in Namibia

The model linking factor limiting the use of digital/internet services to promote adoption was significant with R-square = .604, p < .001. Lack of skills and lack of awareness have a very significant influence on adoption (p < .001); while access to smart devices significantly influences adoption at p < .1 (p= .074).

Alternatives to reduce barriers to ICT adoption

As seen from Figure 2, the majority 70 (90.9 %) of respondents proposed electricity supply, creation of awareness on digital services 69 (89.6%) while 68 (88.3%) proposed reduction of cost of the internet; 67 (87%) proposed the provision of training on how to use internet and 61 (79.2 %) proposed creation of Cybersecurity awareness.
5. DISCUSSION

The study found that the low adoption of ICT enabled services by rural entrepreneurs is influenced by a lack of awareness of digital services, Lack of skills, lack of electricity supply and lack of access to smart devices and Cybercrime. Hence the adoption of digital services is not optimally realised to stimulate entrepreneurship activities for socio-economic development. Conceptually, ICT enabled services adoption drives generativity, creates value chains of products and services and enables borderless participation of geographically dispersed audiences and enables entrepreneurs to connect with customers and producers; cyberspace creates some fair market participation opportunities to all participants in the economy [8]. Notably, besides the various benefits deriving from using digital services, it is presumed that rural communities are not optimally using available digital services to promote and stimulate entrepreneurship activities but mostly, they use them for communication and social media purposes [18]. Conversantly, the decision to either use ICT application or not is influenced by various factors which include economic, technical, political and social [9]. Namibia has a high mobile phones penetration rate and broadband policy initiatives to connect rural areas but it lacks a policy directive that promotes rural digital entrepreneurship.

The study conducted by Sanga and Buzingo [27] contends that for people to make use of the technologies, they have to be aware of them. In this regard, there is no ambiguity that awareness is considered as one of the major constraints of ICT adoption among rural-based SME entrepreneurs [17]. Musingafi and Zebron [22] argue that the selection of the type and use of ICTs must be based on appropriateness to the needs and expectations of the end-user. Due to a lack of awareness of online marketing, online shopping is low and this will be detrimental to rural entrepreneurship. The COVID-19 pandemic dictates limited face-to-face interventions. Therefore, if rural enterprises continue not using digital platforms, they will face challenges to reach the target markets and maximising the sales of goods and services. It has been argued that the active participation of communities is required for the successful adoption and use of ICTs, however not just as beneficiaries but as people who need to trust and use services and technology tools. Kyobe [17] highlighted that the lack of power supply has remained a major problem in Africa and predominantly in rural areas. Thus, ICT devices are reliant on electricity, and the shortage of electricity supply causes disruptions in the operations [4]. The power supply is a key facet of digitalisation transformation. We also found that lack of know-how to use smart devices and to browse on the internet limit the ability of users to connect to the internet and this also contributes to cybersecurity fears as a rural community is not able to apply the necessary cybersecurity measures. This concurs with the findings by [2,21] that ICT skill deficiencies among rural communities impede the usage hence low adoption as users will adopt the technology if it is easy to use because these skills are a prerequisite for usage. The study by [1] found that there was a strong positive correlation between ICT knowledge and skills and ICT adoption. Most rural communities are unemployed or have low income thus their ability to procure smart devices and data is limited. We contend that a high adoption rate of digital entrepreneurship in rural areas will nurture employment opportunities and increase the income of rural communities. It will also serve as motivation for young entrepreneurs to stay in rural areas and actively participate in rural development.

5.1 Conceptual ICT Adoption Model

From the empirical data collected, five key barriers to ICT enabled applications and services were identified and possible interventions are proposed. In light of the factors influencing the adoption of ICT by rural entrepreneurs, a conceptual framework has been developed and is shown in Figure 3. This suggests some possible interventions that could promote ICT enabled services adoption in rural areas. To the end, actors are identified to ensure that the proposed interventions are implemented to reduce the barriers of ICT adoption. The roles and responsibilities of each actor are outlined in the recommendations.
6. CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion
Rural entrepreneurs play a pivotal role in Namibian’s economy in employment creation and mitigation of the rural-urban migration. This study found that rural entrepreneurs in Namibia are facing the same challenges as per the findings of other studies of [4,21,38]. For this study, the most dominant factors are a lack of awareness of the importance of ICT, lack of skills, lack of electricity and cybercrime. A conceptual model for these five main factors is proposed with alternative interventions for possible mitigation of the identified challenges. Conversely, the model will only be feasible if interventions are undertaken to address the observed challenges. These factors are similar to findings in other developing countries as stated by Kyobe [17] that in developing nations the adoption of ICT is mainly influenced by the income and wealth of an individual, its computer and internet skills and infrastructure. The digital entrepreneurs have prospects and are a solution in embracing the future and using ICTs for boosting business growth will be pivotal for rural entrepreneurs to recover from the impacts of COVID-19. In this paper, we have argued that ICT provides information about access to market and business, brings financial services literally to the fingertips of rural consumers, enhances social cohesion and creates collective and shared platforms for the communities to exchange know-how and ideas. We thus conclude that high-quality internet provision can help unlock the potential of rural areas, and can make them more attractive places to live. During COVID-19, ICT systematically enabled the connection of people to people, business to customers and government to citizens.

As stated by Lwago [20] that many studies assessed the contribution of ICT for development in diverse perspectives such as poverty reduction, sustainable livelihoods, economic growth, and the view of development as freedom. The new knowledge can lead to improved utilization of ICT enabled services and addressing socio-technical challenges for adoption. This study mapped the contribution of ICT to development, by assessing the factors influencing the adoption of ICT
enabled services while providing insights to the developmental agencies, government and service providers to take cognizance of pertinent factors that could influence the optimal usage of available ICT enabled services by the community and reaping the associated benefits. The study has some significant implications for rural-based entrepreneurs to make use of benefits derived from ICT enabled services such as improved marketing strategy. This study is a value-addition to the existing information systems literature in three ways of providing a succinct account of the impact of digital platforms in rural settings; provides a future research agenda for digital entrepreneurship in the context of developing countries and provides a deep understanding of the ICT4D literature in respect of linkage between development, technology and people.

Limitations include a rural communities sample focusing on entrepreneurs. The survey was only conducted at four sites, so findings have limited generalisation but can be used to build some hypotheses for the other areas. Future research should devote more attention to more entrepreneurs in both rural and urban areas with a specific target on youth and women entrepreneurs. Furthermore, a bigger size sample size is recommended for more reliable and valid results. There is a need to implement the possible interventions to test and validate the proposed conceptual ICT adoption model for rural entrepreneurs.

### 6.2 Recommendations

Based on the finding that there is low usage of ICT enabled services for entrepreneurship activities by rural communities especially online marketing and online shopping, there is a need for the Namibian government and Internet Society to promote the use of the internet to benefit entrepreneurship activities in rural areas. The stakeholders need to and design fit for purpose digital services and develop need-specific applications for rural entrepreneurs that are simple and easy to use. Winschiers-Theophilus et al. [35] advocates for a consultative and participatory approach before and during deployment of projects to rural areas. This enables the affected communities to provide their needs and aspirations and the bottom-up approach will inter alia increase awareness before the deployment of technology and enhance the motivation for the adoption of such technology. For a meaningful development of suitable ICT enabled services, the real needs and requirements are to raise awareness about ICT to the population that lives under difficult conditions in remote locations [21]. Considering the low or lack of skills by rural communities to use smart devices and to navigate the internet for socio-economic purposes. There is a need for the government, service providers and Internet Society and other stakeholders to initiate programmes that will lead to enhanced capacity of the rural community digital skills and literacy. The training initiatives should also include raising awareness of available digital services and cybersecurity awareness, the latter will enlighten the rural entrepreneurs of the associated benefits of using the internet for business purposes and equally equip them with essential cybersecurity measures to protect them when online. We suggest proper coordination between service providers and the Ministry of Mines and Energy to prioritise the rollout of rural electrification to the sites that are planned for the construction of the mobile tower. It is recommended that electricity should be made available to the sites before mobile networks construction to have a high power mobile network for better internet speed and constant electricity supply to the community to charge the devices. Lastly, the Government should also consider reducing the import taxes on ICT devices that will eventually reduce the price of devices to the end-users.
REFERENCES


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ASSESSING GENDER BIAS IN THE INFORMATION SYSTEMS FIELD:
AN ANALYSIS OF THE IMPACT ON CITATIONS

Silvia Masiero, University of Oslo, silvima@ifi.uio.no
Aleksi Aaltonen, Temple University, aleksi@temple.edu

Abstract: Gender bias, a systemic and unfair difference in how men and women are treated in a given domain, is widely studied across different academic fields. Yet, there are barely any studies of the phenomenon in the field of academic information systems (IS), which is surprising especially in the light of the proliferation of such studies in the Science, Technology, Mathematics and Technology (STEM) disciplines. To assess potential gender bias in the IS field, this paper outlines a study to estimate the impact of scholarly citations that female IS academics accumulate vis-à-vis their male colleagues. Drawing on a scientometric study of the 7,260 papers published in the most prestigious IS journals (known as the AIS Basket of Eight), our analysis aims to unveil potential bias in the accumulation of citations between genders in the field. We use panel regression to estimate the gendered citations accumulation in the field. By doing so we propose to contribute knowledge on a core dimension of gender bias in academia, which is, so far, almost completely unexplored in the IS field.

Keywords: Gender; Information Systems; gender bias; citation impact

1. INTRODUCTION

Gender bias is an unfair difference in the way men and women are treated in a particular domain. Psychology has studied gender bias primarily in behavioural terms (Ceci & Williams, 2011; Al-Gazali, 2013), explaining it as a tendency that produces behaviours that penalise women, and favour men, in given contexts. Studies of gender bias have been often formulated in relation to employment, where gender has been found to affect employment opportunities, expectations and career progression across industries (Shen, 2013; Annabi & Lebovitz, 2018). Among these studies, biases are present as recurring patterns: women, research has shown, are comparatively less prone to enter industries that are perceived as gender biased, and more incline to leave such industries (Handley et al., 2015).

Having originated in relation to employment, research on gender bias has diffused to academia, where numerous studies have been conducted to assess gender bias across academic fields. In these studies, gender biases have been found associated with the key dimensions of academic careers including hiring decisions (Reuben et al., 2014), publication quality perceptions (Knobloch-Westerwick et al., 2013), peer review (Helmer et al., 2017), citations (Lariviere et al., 2013), and tenure decisions (Jaschik et al., 2014). Importantly, these studies have often been designed to capture subtle biases, whose silent nature makes it difficult to detect and punish them as outright discrimination (Ceci & Williams, 2011). While covering many different fields, studies of academic gender bias are especially concentrated in Science, Technology, Mathematics and Engineering (STEM) disciplines, where multiple forms of gender bias are found (Handley et al., 2015).
Against this backdrop, we first overviewed studies of gender bias in IS by conducting a literature review of the top journals of the field (known as the Association for Information Systems - AIS Basket of Eight).\footnote{https://aisnet.org/general/custom.asp?page=SeniorScholarBasket, accessed 23 March 2021} Drawing on data for all papers ever published in such journals, our review presented a disconcerting picture: out of 7,260 papers for all years, only eight make some reference to gender bias, and out of these only four offer some form of scientometric studies (three focus on journal publications, one on editorial boards). The contrast with the plethora of studies of gender bias in STEM is strong, and greater disconcert emerges from the strong signals of gender bias that emerge in non-scientometric studies of IS (Adam, 2002; Wilson, 2004; Gupta et al., 2019; Winter & Saunders, 2019). Such a contrast between perception of bias and studies of it leads to the question: 

\textit{Does gender bias exist in the IS field, and if so, how is it manifested?}

To address the question, we focus on research citations that are especially important for academic researchers and can tell about unconscious biases against a gender. Specifically, we aim to estimate the impact of scholarly citations that female IS academics accumulate vis-à-vis their male colleagues. We do so with a study of the AIS Basket of Eight journals: drawing on a database of all papers published in these journals, we plan to study the impact of citations of female vs. male scholars using panel regression and controlling for the length of an academic career, number of publications and network centrality of scholars. The analysis, currently in progress, aims to reveal whether the IS field is biased in favour of male scholars, measuring bias on a dimension that is central to academic careers.

The work-in-progress paper is structured as follows. We first offer a landscape perspective of how gender is dealt with in the IS literature, illuminating the gap left by the absence of scientometric studies of gender bias. We then put forward our research design to study gender bias, describing our dataset and the analysis currently in progress. In the conclusion we outline the expected contributions of this work, which sets to provide one of the first analyses of citation impact of gender in the IS field.

2. LITERATURE REVIEW

Our review of the literature aimed at understanding, in the first place, how gender features in top journals of the IS field. To do so, eight keywords (gender, gender bias, gender discrimination, gender inequality, male bias, stereotyping, sexism) were used to search all AIS Basket of Eight journals, resulting in 312 papers that include at least one such keyword in the title, abstract, or keyword list. Both authors then independently coded each paper as “relevant” or “not relevant” to gender-related research, defined as any form of IS research bearing some form of relation to gender. Conflicts in classification between the two authors were resolved by discussing each case individually, which led us to a final set of 86 relevant papers.

We then conducted a thematic literature review of all 86 papers, which led us to recognise three thematic clusters of gender-related research in IS. A first cluster of 55 papers (Type 1) views gender as an explanatory variable, used to research various topics in the IS field such as technology acceptance, use or user behaviour. In 19 of these papers, gender is the main variable in the research, whereas it is a secondary or control variable in the remaining 36 papers. A second cluster of 23 papers (Type 2) deals with gender imbalances in the IT industry, investigating its causes, consequences and interventions taken against it.

While Type 2 papers deal with the IT industry, a third cluster of only eight papers (Type 3) takes issue with gender imbalances in the IS academia, in several cases referring explicitly to gender bias. Three of such papers contain scientometric studies of IS journal publications (Gallivan et al., 2007; Avison et al., 2008; Avison & Myers, 2017) and one of editorial boards (Burgess et al., 2017),
declaring concern for gender imbalance but without proposing action to address it. The four remaining papers instead all address gender bias in different forms: Adam (2002) presents a critical framework on gender-asymmetric power relations, while Wilson (2004) proposes a framework for critically studying gender in IS research. Among the two most recent publications, Gupta et al. (2019) present evidence of gender bias from a survey of AIS members, whereas Winter and Saunders (2019) show how gender influences the career choices of an IS academic.

Viewing our literature review in the light of gender bias research outside IS, and especially in STEM disciplines, two points are striking. First, the thinness of the body of research engaging gender bias – and calling it by its name – in the IS field is disconcerting: only eight papers out of 7,260 present some engagement with the phenomenon, and only four contain scientometric studies. Second, this paucity clashes with empirical accounts of gender bias in the IS domain, which accounts such as those by Gupta et al. (2019) and Beath et al. (2021) are particularly powerful in revealing. The gap between perceived bias and lack of research on it leads to our research question on gender bias in the IS field.

3. RESEARCH DESIGN

As noted above, gender bias can be studied through multiple methods and along different dimensions. For instance, qualitative interviewing can reveal how gender bias is experienced by individual scholars, whereas quantitative studies can assess its prevalence in a field or a journal. In this research, we adopt an econometric approach to estimate the impact of gender on scholarly citations that female IS academics accumulate vis-à-vis their male colleagues. We intend to use panel regression to estimate the impact of gender bias on the citations of papers published by female academics in the field. We chose the dimension of citation impact due to its centrality to academic careers, matched by the availability of usable citation data for all papers in the AIS Basket of Eight journals.

3.1. Data collection

To empirically identify gender bias in IS publishing, we use data from the Microsoft Academic Graph (MAG). MAG is the most comprehensive dataset on scientific publishing that attempts to map all academic publications, their authors and citations as a graph (Herrmannova & Knoth, 2016; Wang et al. 2019). We draw from MAG details of all 7,260 publications in the AIS Basket of Eight, including their authors and citations. However, we also need to know the gender of each of the 8,197 authors in the data. We first used the GenderAPI service, a widely utilised service for gender attribution, to assign gender to each author based on first and last name. In our dataset, the service provides a gender attribution (female or male) in 6,104 cases with 95 percent or more confidence. We manually check and correct 2,093 cases in which the attribution is either missing or less than 95 percent confident to ensure reliable gender attribution. As a result of this process, we construct an author-month panel dataset that traces each scholar’s publications, citations, and network centrality.

A limitation of the GenderAPI service is its binary attribution of gender, resulting in inability to capture non-binary gender realities (Callis, 2014). Aware of this limitation, we reviewed existing studies of gender bias across fields in order to find services that account for non-binary identities. While such a research has been so far unfruitful, the use of Internet search in combination with GenderAPI (Marrone et al., 2020) helps us mitigate the limits of the service, and input from gender studies research is currently being sought to make sure we take all steps needed to reflect non-binariness.

3.2. Data analysis

Our identification strategy is based on the following insight. The pinyin (the official romanisation system for Mandarin language in mainland China) romanisation of Chinese names is generally gender neutral, whereas in most other languages the first name of a person tends to reveal the
person’s gender. Since there is a substantial number of Chinese scholars in the field of IS, name-related knowledge can be reasonably used to identify the causal impact of gender bias.

Since non-Chinese scholars cannot easily recognise the gender of Chinese academics from their romanised names, there should be no difference in how non-Chinese scholars cite Chinese male and female academics. However, when non-Chinese academics cite non-Chinese scholars they may be implicitly aware of the author’s gender and thus show bias against female authors. Any difference between how non-Chinese authors cite other non-Chinese vs. Chinese authors may thus stand for a gender bias, given that we control for a few factors, listed below, that may otherwise account for such differences. These run from the fact that the samples of non-Chinese and Chinese scholars may be different with respect to factors that affect the number of citations a scholar accumulates.

We use time fixed effects to account for changes in the overall citations over the years. On an individual level, we use the length of an academic career, the number of publications, and network centrality to control for the visibility of a scholar in the field. If the differences in citation patterns persist after controlling for these factors, the remaining differences can be attributed to a prejudice against female scholars based on their first name. It is also possible that gender bias is strongest against junior academics and diminishes among senior scholars who have established their presence in the field. Ultimately, if gender bias disappears as the female scholar becomes better known in the field, we may see that senior female scholars receive relatively more citations as their male colleagues, since they have had to work harder to make their name and thus produce higher quality papers.

At the time of writing, we are in the process of checking the 2093 cases in which the GenderAPI attribution is either absent, or assigned with a level of confidence lower than 95 percent. Once this process is complete, we will run the analysis to detect the influence of gender on citation patterns, seeking to understand whether findings of gender-biased citation patterns in fields such as STEM (Lariviere et al., 2013) do, or do not, find confirmation in the IS field.

4. EXPECTED CONTRIBUTION AND RELEVANCE TO THE TRACK

The IS field is characterised by substantial anecdotal evidence of gender bias, however accompanied by a striking paucity of scientometric studies of it. The research proposed in this paper aims to contribute to filling this gap, examining gender bias under a dimension, the impact of citations, on which academic careers are substantially predicated. Since IS is the field within which a substantial part of ICT4D research is developed, questions in this study have direct relevance for ICT4D research, offering a method that can be replicated for journals specific of the ICT4D field. By way of example, Davison (2021) offers a study of the AIS Basket of Eight editorial boards vs. the editorial board of the Electronic Journal of Information Systems in Developing Countries, finding significantly higher representation of female editors in the latter rather than in the Basket of Eight journals.

Currently in progress, our work opens several further problems for research. One further question that can build on our study is whether Chinese scholars may present any form of bias towards Chinese female authors, given that they may often recognise the gender from the original (non-transcribed) Chinese name. More questions pertain to the intensity of gender bias in the IS field as related to other fields of academia, and whether its manifestations, strikingly under-investigated so far, mirror those found in fields such as STEM. With our suggested research method, applied to a field where so limited research on gender bias is present, we hope to create more interest for gender bias in IS research, maximising the focus of the field on the topic and setting the basis for its study in ICT4D research works.
REFERENCES


M-GOVERNMENT, WILAYA AND WOMEN’S EMPOWERMENT IN THE KINGDOM OF SAUDI ARABIA

Norah Humus Alotaibi, The University of Sheffield, nhmalotaibi1@sheffield.ac.uk
Dr Salihu Dasuki, The University of Sheffield, s.dasuki@sheffield.ac.uk
Dr Efpraxia Zamani, The University of Sheffield, e.zamani@sheffield.ac.uk

Abstract: With the loosening of the male guardianship system (Wilaya) in the Kingdom of Saudi Arabia (KSA), this study examines the contribution of m-government to the empowerment of Saudi women. We employ the key concepts of Sen’s Capability Approach (CA) to understand how m-government services in the KSA have provided opportunities for women to become empowered. The findings of the study indicate that m-government contributes towards women’s empowerment by providing opportunities to participate in social and economic activities. However, there are also key social and cultural factors that impede the use of m-government services for empowerment, and we found these to include religious beliefs, Saudi traditions and customs, and husbands’ jealousy. The study makes some important contributions to theory and practice by being the first study to focus on the use that Saudi women make of the opportunities now available to them to access government services through m-government applications and to address the cultural barriers which may function to prevent their access.

Keywords: m-government, women’s empowerment, Saudi Arabia, Capability Approach

1. INTRODUCTION

With the advancement of Information and Communication Technology, governments are adopting electronic government (e-government) in order to provide efficient and effective government services to their employees, citizens, businesses and other organisations. However, with the rapid penetration of mobile technologies in everyday life, governments began shifting their focus towards the use of mobile phones for the delivery of their services and the provision of information to engage with citizens from anywhere at any time so that the latter can fully participate in political and social processes and reforms (Abu-Shanab & Al-Jamal, 2015; Lee et al., 2006).

There is large body of literature on e-government (Hsieh et al., 2013; Lee et al., 2011; Alawneh et al., 2013), however, studies focused on m-government are still very limited (Almaiah, Al-Khasawneh, Althunibat, & Khawatreh, 2020) in the Middle East and North Africa (MENA) context (Alharbi, Halikias, Yamin, & Basahel, 2020). The Kingdom of Saudi Arabia (KSA), the focal case of this study, is a highly influential country within the MENA region and has devoted a substantial amount of resources providing m-government services to its citizens (Alssbaiheen, & Love, 2015).

Yet there are only a few studies about m-government in the KSA, and the majority focus on m-government adoption and acceptance. In addition, scholars have argued that the adoption of m-government differs between men and women, with women usually being disadvantaged and having less access to e-government (Alzahran et al., 2018). M-government studies focusing on the KSA usually do not place an emphasis on women (Almarashdeh & Alsmadi, 2017; Alotaibi & Roussinov, 2017; Alonazi et al., 2019). Having said this, the KSA, which is a traditionally conservative Muslim country, places high value on male guardianship, female honour, male-female segregation and male-
dominated practices, which continue to shape the use of m-government by women (Samargandi et al., 2019).

Today, there is a debate on whether m-government empowers or disempowers marginalised groups such as women (Gaur & Avison, 2015). There is a call for more studies to examine the experience of women using m-government, especially in the MENA region where the influence of Islam strongly shapes the gender roles (Ojediran & Anderson, 2020). To address this, our study asks: How do women use m-government to empower themselves? We interview women in the KSA, and examine the social, economic and political opportunities arising from their use of m-government services.

The KSA presents a compelling and unique case to examine the empowerment opportunities offered to women by the use of the m-government services. First, the KSA is a traditional Muslim country that struggles with equality for women due to religious doctrine. Second, the Saudi government has recently made reforms through its Vision 2030 to diversify the economy and encourage non-oil sectors with the goal of creating economic opportunities for women. Third, the government has loosened the restrictions placed on women by male guardianship in order to empower and elevate the status of women. We employ the Capability Approach as the theoretical lens as it argues for the freedom of women to lead the lives they value. To the best of our knowledge, our study is the first that investigates the contribution of m-government towards women’s empowerment in Saudi Arabia, which is particularly important considering that the Saudi government has recently relaxed the Wilaya system, i.e., the male guardianship system that regulates the behaviour and movement of women, requiring them to seek the permission of a male relative for many of their activities. The study makes important theoretical and practical contributions for m-government studies and our findings have implications for policy makers and those who promote m-government services to empower Saudi women.

The remainder of this paper is structured as follows: the subsequent section presents a review of literature on women’s empowerment and its relationship to m-government, followed by a discussion on the Capability Approach. The research method is then presented. We then discuss our case study and our findings, and finally, we offer a discussion of the theoretical and practical implications.

2. LITERATURE REVIEW
2.1 Women’s Empowerment

Women’s empowerment focuses on women having the opportunity to be able to pursue their choices and create social change (Pandey & Zheng, 2019). The empowerment of women is one of the United Nations’ key Sustainable Development Goals (United Nations, 2015). However, there is still no clear pathway as to how gender empowerment can be achieved, possibly due to the lack of a clear conceptualisation of the term ‘women’s empowerment’ (Nguyen & Chib, 2017). Some development scholars and activists view it from a perspective that focuses more on increasing women’s access to employment opportunities, health care and education (Stavrou et al., 2015; United Nations, 2015) with less emphasis being placed on the agency of women to make choices in their lives (Nguyen & Chib, 2017). Recently, however, the concept of gender empowerment has been redefined, with greater emphasis placed on non-economic aspects and particularly on the agency of women (Donald et al., 2017).

This conceptualisation of women’s empowerment resonates with Sen’s (1999) Capability Approach (CA), which defines agency as “the freedom to achieve whatever the person, as a responsible agent, decides he or she should achieve” which is central to the process of development (1999, p. 18). In addition, Sen notes that “extensive reach of women’s agency is one of the more neglected areas of development studies, and most urgently in need of correction” (ibid). In Information Systems (IS) studies, most development researchers have drawn upon the CA to conceptualise gender empowerment and show how technology as an artefact provides opportunities for women to create social change and pursue their choices (Pandey & Zheng, 2019).
Kumar, Karusala, Ismail and Tuli (2020) stress that measuring this empowerment is not purely a matter of looking at economic factors but at social welfare and how it is what women can do with the means offered to them (like m-government apps) that is key. These authors draw on ideas by Nussbaum (2011) to suggest that the agency of women in the Global South should take into account the severe gender inequalities of the region and include aspects of agency such as emotions related to the lack of freedom to express themselves without anxiety and fear (Kumar et al., 2020). In this study, empowerment, as conceptualised by Sen, serves as the theoretical basis to understand women’s empowerment in a traditional, male-dominated, Islamic society. In the following section, we provide a review of the relationship between m-government and women’s empowerment.

2.2 M-Government and Women’s Empowerment

As developing countries continue to adopt e-government, many scholars have attempted to examine the developmental impact of e-government and most have shown that it has the potential to empower citizens by accessing information regarding various sectors of the economy (Hoque & Sorwar, 2015; Adaba & Rusu, 2014). This can improve people’s ability to make a living, and ultimately, enhances human development.

Within developing contexts, telecentres are quite prominent and often used for accessing government services online. Taking a gender perspective, scholars have investigated their impact on women’s empowerment. For example, Lwoga and Chigo’s (2020) study in Tanzania shows that telecentres support women by increasing their income, saving money and voicing their concerns. Similarly, Hansson et al. (2010), show that telecentres in Sri-Lanka create new communication channels and career opportunities for women, and Alao et al. (2017) show that telecentres in rural South Africa empower women by enhancing their information capabilities, thereby improving their economic standards, their connections with friends and families, and ultimately their attainment of ICT literacy skills. Using mobile phones to access services potentially increases the ability to do this from anywhere. However, when considering the use of mobile phones for accessing such services in Ghana, Ojo et al. (2013) indicate that mobile phones alone are insufficient to provide women with opportunities or satisfy their information and livelihood needs as low levels of literacy are an important barrier.

Within the MENA region, and specifically the KSA, there is a paucity of research investigating the role of either e- or m-government for the empowerment of women. Saudi studies on m-government have focused mainly on the adoption or acceptance of m-government by both genders (Alrowili et al., 2015; Alotaibi & Roussinov, 2017; Alonazi et al., 2019). More importantly, scholars use quantitative methods, such as surveys, and focus on the single aspect of gender gap in m-government access. Such approaches do not help with understanding how women in this region are using m-government to improve their lives in light of significant social restrictions (Moussa & Seraphim, 2017).

In this study, we focus on women’s voices to understand their experiences of using m-government services and to explore how such services contribute towards women’s empowerment. In what follows, we present Sen’s Capability Approach, which helps us understand the opportunities provided by government services for women to be empowered.

3. **Sen’s Capability Approach**

The CA framework is specifically suited to the context of our study due to its focus on social change in terms of enhancing individual wellbeing (Robeyns, 2016). The CA emphasises human freedom, which refers to the effective opportunities individuals have to enhance their well-being, and further critiques other development theories that emphasise wealth as central to happiness. The CA framework consists of two important elements: capabilities and functionings. Capabilities are the freedoms an individual has to attain a set of functions, whereas functionings are the “beings and doings” that an individual values (Sen, 1999, p. 18). The distinction between capabilities and functionings is between opportunities on the one hand and achievements on the other, respectively.
(Robeyns, 2005). However, Alkire (2005) noted that it is important to focus more on capabilities than functionings because individuals value having choices.

Commodities, such as goods and services, are a major constituent of the CA, because they are a means for enhancing individual wellbeing (Alkire & Deneulin, 2009). However, the ability to generate these capabilities is influenced by three sets of conversion factors, namely: personal conversion factors, e.g., gender, age, education; social conversion factors, e.g., social norms, public policies, power relations; and environmental conversion factors, e.g., infrastructure and climate (Robeyns, 2005). Achievements are based on an individual's choices from a set of capabilities, which is influenced by conversion factors (ibid). Another key feature of the CA is the difference between agency and wellbeing. Agency refers to the freedom to set and pursue one’s own goals and interests (Sen, 1985), well-being relates to one’s quality of life (Robeyns, 2005).

Within the area of Information Systems, and specifically the Information and Communication Technology for Development (ICT4D) domain, the CA has been applied as an evaluative framework to understand the contribution of ICT to human development (Zheng & Walsham, 2008), and has been applied within the context of e-government. For example, Adaba and Rusu (2014) used the CA to examine the impact of an e-government initiative for e-trade facilitation in Ghana. The study showed that the e-government initiative provided individuals and businesses with the opportunity and choice to lodge import and export declarations electronically which, in turn, enhanced the freedom of job creation. Also, Maiye and McGrath (2010) applied the concepts of CA to assess the Nigerian government’s introduction of an electronic voter’s registration system to enable participation in registration and polling activities. Their findings showed that the system expanded people's freedom to engage in development activities, but the sustainability of the developmental potentials were hindered by conversion factors such as lack of knowledge-building activities and lack of trust.

However, few studies have evaluated e-government initiatives using the CA framework from a gender perspective. Lwoga and Chigona (2020), for example, examined the use of telecentres by rural women in Tanzania, and showed that telecentres may enable women to build some capabilities (social, financial, human and political capabilities), but equally, they may inhibit others due to choices made and conversion factors, thus resulting in diverse development outcomes. Building on existing work by Lwoga and Chigona (2020); Maiye and McGrath (2010) inter alia, we apply the CA approach to examine the use of m-government services by women in Saudi Arabia.

4. METHODOLOGY

Following an interpretive approach, we conducted interviews with 30 Saudi women with the aim of understanding their use of m-government services and whether and how the use of such services contributes to their empowerment. The lead author, who is a Saudi citizen, used her personal contacts to recruit participants. Participants had to be (a) over eighteen years old (b) mobile phone owners and (c) m-government users. The interviews took place in January 2021, were conducted in Arabic and later translated to English. All transcribed data were uploaded to the Nvivo12 software package. Each interview lasted approximately 45 minutes and was conducted online due to Covid-19 restrictions. Prior to the interview, we sought informed consent, explaining the purposes of the research. To preserve confidentiality and anonymity, the names of the participants have been replaced with pseudonyms and any identifying information has been removed.

The CA framework guided the design of the interview questions, which were divided into three sections. The first covered demographic details; the second covered questions on participants’ perceptions regarding empowerment, their use of m-government services and the opportunities derived from their use of m-government; and the final section focused on the factors affecting their use of m-government services.

After engaging with 30 participants, no new findings emerged from further probing and we stopped data collection, as the principle of data saturation had been satisfied. Data analysis for this study
was influenced by the concepts of Sen’s Capability Approach, following a thematic analysis (Braun & Clarke, 2006). We began by carefully reading the transcripts to identify any ambiguities and obtain a summary of the themes discussed by the women. Next, we merged these codes into broader categories. We particularly searched for, and identified, themes reflecting the m-government services used by the women, the opportunities provided to the women that contribute to their empowerment as a result of using the m-government services, and lastly, the factors affecting their use. In summary, our themes related to commodities (e-government services), the capabilities provided by the m-government services, and lastly, the conversion factors that influence their abilities to generate capabilities from the m-government services. Finally, the themes were reviewed and agreed upon by all the authors to ensure the analysis reflected the focus of the research. At the end of the analysis process, we produced our report as shown in the analysis section.

Table 1 Participants’ Demographic Information

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<tr>
<th>Demographics</th>
<th>Frequency (n = 30)</th>
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<tbody>
<tr>
<td><strong>Age</strong></td>
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<tr>
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<td>10%</td>
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<td>26 – 35</td>
<td>9</td>
<td>30%</td>
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<tr>
<td>36 – 45</td>
<td>12</td>
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<td>46 – 55</td>
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<td>13%</td>
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<td>56 – 65</td>
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<td>3%</td>
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<tr>
<td>66 +</td>
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<td>3%</td>
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<tr>
<td><strong>Education</strong></td>
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<td></td>
</tr>
<tr>
<td>Bachelor</td>
<td>18</td>
<td>27%</td>
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<tr>
<td>Masters</td>
<td>2</td>
<td>7%</td>
</tr>
<tr>
<td>PhD</td>
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<td>7%</td>
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<tr>
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<td>7%</td>
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<tr>
<td>Secondary education</td>
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<td>17%</td>
</tr>
<tr>
<td>British fellowship</td>
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<td>3%</td>
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<td><strong>Marital Status</strong></td>
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<tr>
<td>Single</td>
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<tr>
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<td>8</td>
<td>27%</td>
</tr>
<tr>
<td>Married</td>
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<td>33%</td>
</tr>
<tr>
<td>Widow</td>
<td>3</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Employment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Housewife</td>
<td>9</td>
<td>30%</td>
</tr>
<tr>
<td>Unemployed</td>
<td>2</td>
<td>7%</td>
</tr>
<tr>
<td>Retired</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Employed</td>
<td>18</td>
<td>60%</td>
</tr>
</tbody>
</table>

5. CASE STUDY CONTEXT

5.1 M-government in Saudi Arabia

Saudi Arabia recognises that ICTs support its economic growth. According to the National Transition 2020 and Saudi Vision 2030, ICTs are a key tool for economic development and for further diminishing the country’s economic dependence on oil (Vision 2030, 2020). The government has started to transform all its traditional services into digital, in order to meet citizens’ needs and expectations. According to Vision 2030, “Saudi Arabia has made remarkable progress in e-government over the last decade” (Vision 2030, 2020). The country has expanded its online services to include employment programmes, online job searches, e-learning services, traffic, passports and civil affairs, online payment services and online issuance of commercial registers. The rapid diffusion of mobile technologies has made the KSA the second biggest market in the Middle East.
for smartphones, with approximately 23 million smartphone users, allowing the transition from e-government to m-government in order to provide transparent, effective and convenient online channels between the government and citizens, accessible in a mobile environment (Alonazi & White, 2019). Currently, the KSA is making efforts towards facilitating a society built on knowledge, speed of response and interactivity, thus the quality and efficiency of m-government services are crucial (Gov. Saudi, 2020).

However, the adoption of Saudi m-government for citizens’ empowerment has been problematic due to the slow adoption rate among citizens, particularly among women (Alghamdi & Beloff, 2016; Alotaibi et al., 2016). One of the main reasons for this is the male guardianship law that limits women from utilising government services that could enhance their social, economic and political wellbeing. However, with new reforms relaxing this law, it is pertinent to explore the impact of m-government on the empowerment of Saudi women and whether any improvements have been achieved. The following section provides an overview of the male guardianship system.

5.2 Wilaya – The Male Guardianship System in Saudi Arabia

All women in Saudi Arabia, irrespective of their age, are under the authority of a legal guardian who is a male relative and usually referred to as Wali al-amr. These male relatives, such as husbands, brothers and fathers, make an array of key decisions on behalf of any women under their watch. The women are also under the authority of other male relatives who have less control than their Wali al-amr. In addition, a male relative referred to as mahram (escort) has the authority to receive a woman who leaves her marriage due to domestic violence, or accompany her abroad on a government scholarship. Government institutions and agencies may ask a male relative to act as a woman’s mu’arif –someone who is legally allowed to verify the identity of a woman covering her face, or carry out a range of important activities such as reporting a police case on her behalf and so on. A legal guardian can also act as a mu’arif or mahram. However, in 2019, the Saudi government legally enabled Saudi women to access government services as equal citizens and apply for their own government documents such as ID cards and passports, and allowed them to travel independently without the male guardianship system limiting their agency and freedom (Salaebing, 2019, Human Rights Watch, 2016).

6 FINDINGS AND ANALYSIS

We applied the concepts of commodities, capabilities and conversion factors as pillars for our analysis with the aim of examining the contribution of m-government services to Saudi women’s empowerment. Absher and Yesser are the two m-government services used by our participants, and following the Capability Approach, these two services can be seen as the commodities that may help women enhance their status and lead to their empowerment. In other words, m-government services are resources which allow Saudi women to choose things (such as passports, driving licences ID cards etc..) which gives them the freedom to do the things they value (such as travelling abroad to gain academic qualifications), and the extent to which they are empowered to do this depends on ‘conversion factors’ (such as the norms and values held by their family about such matters).

6.1 Commodities

In 2005, a programme called ‘Yesser’ was launched with the aim of developing e-services that would link up the different ministries and ensure that all Saudi government agencies had their own websites (Alshehri & Drew, 2010). Since then, many ministries have launched websites, such as the Ministry of Health (www.moh.gov.sa), the Ministry of Labour (www.mol.gov.sa) and the Ministry of Education (www.moe.gov.sa).

‘Yesser’ in Arabic means ‘make it easy’, and the programme aims to provide services and information that citizens can access easily (Alghamdiv, 2016). The e-government programme was launched by the Ministry of Communication and Information Technology (MCIT) in partnership
with the Ministry of Finance and the Communication and Information Technology Commission (CITC). The overarching aim of Yesser is to reduce the digital divide in the Saudi community and transform the country into a digital society by delivering information through electronic channels and to improve response times among government services (Yesser, 2006).

The Absher app is the official mobile application that delivers government services to all citizens and residents. It is available in both Arabic and English and has been designed with special consideration for the security and privacy of user data. Users can safely browse and update/renew visas for their employees, and perform a range of services online. It can be used for job seeking, applying to attend the annual Hajj Muslim pilgrimage, updating passport information and reporting electronic crimes. In addition, it provides a gateway to 160 services, including making appointments, renewing passports, applying for residency cards, IDs, driving licenses and others. Currently, Absher has more than 11 million users across the KSA (MOI, 2020).

6.2 Capabilities

6.2.1 Opportunities for Mobility and Economic Activity

Using the Absher system, women are able to apply for or renew their passports without the permission of a male guardian. The ability to acquire a passport independently provides women with freedom of movement, making it possible for them to travel within and outside the country, pursue academic studies or attend business conferences. As one divorced, employed, participant noted:

“I was never able to travel abroad with my kids because my male guardian was totally against it and would not sign the documents. Now, I just applied and obtained a new passport on Absher for myself and the children and immediately the lockdown is eased we are taking a holiday in Dubai.”

In addition, women can access Absher to apply for a driver’s license which further enhances their economic freedom. Many women can drive for the first time and even own a car in their own name. Participants noted that being able to drive saves them the cost of using public transportation. In the past, women relied on their male guardians or hired foreign male drivers, which could be very expensive. Women who could not afford a chauffeur often had to give up on economic opportunities outside their home, as noted by this participant:

“I sell traditional beauty products and before I could not always get to my clients due to the high cost of transportation and having to seek permission every time from my male guardian. However, now I have officially registered my business on the Ministry of Commerce website, without needing anybody’s permission, obtained a driving license and bought a car. So now I can save money and easily visit customers and attend business conferences.”

Obtaining a driver’s license means that women can register on government websites as taxi drivers and provide their services to other women clients. Thus, they now have the opportunity to generate income without depending on others. One of the participants who did not have a degree and was previously unable to get a job said:

“Thank God for Absher. I am a divorcee with no source of income and depended on my male guardian. Sometimes he did not provide the financial support I needed. With Absher, I was able to get a driving license and get a car loan, so now I work as a taxi driver and earn money to support myself.”

Lastly, under the new system, women now have the opportunity to upload their CVs to Absher and seek employment through the government.
6.2.2 Opportunities for Self-Identification

The Absher system enables women to register and obtain a national ID card online. This in turn enables them to carry various necessary activities independently. This was not possible in the past, as women could only be registered under their male guardian’s national ID card. The new system allows women to register births and deaths, open bank accounts and more importantly register their own children and enrol them in school. According to one of the participants, having a national ID card and the ability to access it via their mobile phones helped solve a lot of problems associated with male guardianship:

“Before, there was nothing to prove that they were my children, but now there is a new family record attached to my ID card, so I can change my children’s school easily. Because registration was in the name of the male guardian, previously only their father could apply to schools, but now the family record allows me to apply to the schools that I want for my children.”

Some divorced participants mentioned that having the ability to obtain a national ID card with information about their children stopped their ex-husbands refusing to enrol their child in school as a form of punishment for the women. Another widowed participant noted how she was now able to put money in the bank for her children:

“Under the old system, the children’s uncle would be their Wali and be responsible for them. I could not interfere with this. I mean, even school registration, applying for their papers, opening their bank accounts and registering them for university had to be done by their uncle. With the new change, I am now solely responsible for my children. Before my husband died, he was in a coma, and it was before the decision to allow a woman to act without a guardian. I went to deposit an amount in my older son’s account. However, the bank told me I was forbidden to deposit something in my children’s accounts without the written consent of their father. So what about after he died? How difficult that situation was for me! Now I am responsible for them - not their uncle.”

Using Absher allows women to book hospital appointments for themselves and their children and also access their medical records and provide consent where necessary. Further, it provides support for online consultations with doctors, which was especially beneficial during the pandemic:

“The Ministry of Health has just announced a 24/7 hotline to answer questions about various diseases which is an excellent step and was very helpful to me personally because I cannot leave my home for prolonged periods, so viewing medical instruction videos and having online consultations comes in handy.”

6.2.3 Opportunities for Better Education and Voicing Concerns

Some participants mentioned that in the past their male guardians refused to give consent or sign their documents to allow them go abroad to further their education. However, through Absher, one participant, who is a lecturer, was able to apply and secure a PhD scholarship without such obstacles:

“I wanted to obtain a PhD in order to gain promotion at the university. But my uncle kept refusing to give consent, stating I must marry first. However, with the new system, I simply applied and I will start my PhD in October. It has always been my dream to be called ‘doctor’.”

Another participant noted that her male guardian kept taking advantage of his authority over her to extort money from her as a condition for allowing her study in the university. However, the new system has now enabled her to secure a university admission and begin her studies:

“Two years ago, my uncle, who is against women having a formal education, asked me for a large sum of money as a condition of allowing me to enrol for a degree, but he never approved or signed..."
my documents. But now, with the new system I have been able to start my degree and will be finishing in 2024, God willing.”

The Absher system further enables women to report their concerns and inappropriate behaviour. For example, one of the women explained how she was able to report, via Absher, a man who directed abuse to her while she was driving:

“I was driving when a male driver insulted me and called me names because I was driving. I immediately took a video and his number plate and reported the case. The case was dealt with and he was fined and asked to make a formal apology to me”.

Others mentioned that the system allowed them to report cases of discrimination towards them by institutions as well as individuals hence empowering them to voice their concerns about things that mattered to them.

6.2 Conversion Factors
The participants’ ability to generate capabilities is influenced by conversion factors. The analysis of the empirical material shows that the relaxation of the male guardianship law (social conversion factor) enables women to generate capabilities using m-government services. However, there are other social conversion factors that may also hinder women from using m-government services towards building their capabilities.

For example, some of the women reported that it was against their religious values to use m-government services:

“Not only because using Absher is against Saudi customs and traditions, but because it isn’t permissible from a religious perspective as it involves mingling with men, not to mention the fact that you have to show your face for the photo. Women like me believe that a woman exposing her face is against the rules. Absher involves me taking off my Niqab for the photo and exposing my face for men to see.”

Other women noted that they respect tradition and still hold a strong belief in male guardianship. They further noted that a woman should respect her male guardian and seek his permission and that it is the responsibility of men to carry out these activities. Others mentioned the issue of jealousy from their partners who believe that a woman should always be under the authority of a man:

“My husband refuses to let me take up a scholarship as it means travelling while he is at work and he would not let me go out alone because of jealousy. He feels other men might see me or make advances to me. He still believes in the male guardianship law and despite the law reform he made it clear I could not go. I cannot apply for a scholarship or request a driver's license in case he checks my phone. My husband is very jealous.”

**Table 2 Summary of Findings**

<table>
<thead>
<tr>
<th>Commodities</th>
<th>Conversion Factors</th>
<th>Capabilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-Government Platforms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Absher</td>
<td>Religious Beliefs</td>
<td>Mobility</td>
</tr>
<tr>
<td>• Yasser</td>
<td>Traditions and Customs</td>
<td>Economic activities</td>
</tr>
<tr>
<td></td>
<td>Jealousy</td>
<td>Self-identification</td>
</tr>
<tr>
<td></td>
<td>Social (relaxation of male Guardianship)</td>
<td>Responsibility for own children/Childcare</td>
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<td></td>
<td></td>
<td>Better health care</td>
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<td></td>
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<td>Education</td>
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495
7 CONCLUSION
The CA used in this study is part of the human development approach which emphasises that the aim of human development is to enhance peoples’ lives by allowing them to access a variety of choices, such as being healthy, being knowledgeable and participating in their community. Such development means aiming to eradicate the barriers that restrict peoples’ agency, like illness, illiteracy, lack of civil freedoms and poor access to resources. This framework emphasises that social change should encourage peoples’ capability and provide them with social, economic and political freedom to choose and enjoy their own lives and what they are and do (Alkire & Deneulin, 2009).

In the context of this study, the obstacle was lack of access to resources, as Saudi women were not allowed to access m-government services without male permission before 2019. This means that the previous system, which only allowed males to directly access m-government and controlled women’s access, reduced Saudi women’s quality of life. Legally, Saudi women now have the freedom to access government services as equal citizens to apply for their own government documents such as ID cards and passports, as they can travel independently without the male guardianship system limiting their agency and freedom.

The study findings show that the use of m-government services enhances the capabilities of women to attain empowerment. These capabilities are related to mobility, economic activities, self-identification and responsibility for children, health care, education and having a voice. Using the CA, our study shows that accessing m-government services contributed to the freedom of women to participate in social and economic activities that could lead to their empowerment. However, the abilities to generate capabilities from the m-government services were hindered by social conversion factors such as religious belief, tradition and customs, belief in male guardianship, and lastly, male jealousy. In sum, while m-government services have improved the capabilities of women in the KSA, what remains to be seen is whether women will be fully empowered, considering the strong Islamic beliefs and traditions that continue to shape the way of life.

As a contribution, the study adds to the literature on ICT4D and women’s empowerment by providing insights into the use of m-government by Saudi women. To the best of our knowledge, no study in the field has been conducted in the Saudi context. In proposing areas for potential ICT4D research, the limitation of this study is acknowledged. The study was carried out under severe time constraint with a small sample size. However, there is scope for conducting a longitudinal study. Future studies could further investigate how conversion factors also influence the intention of women to use m-government for their empowerment.

Although care was taken to make sure that the sample of participants represented Saudi women from a range of backgrounds, economic and marital statuses and educational levels, there were no systematic comparisons made between these groups. In order to explore how Saudi women from different socio-economic groups experience empowerment afforded by m-government and how the barriers to that empowerment (such as the Wilaya system) operate within these groups, the authors would recommend further comparative research with samples stratified by specific socio-economic factors such as income, occupation, marital status and so on to identify their influence on empowerment.

REFERENCES


WOMEN’S SOLIDARITY AND SOCIAL MEDIA: SISTERHOOD CONCEPT IN #LASRESPONDONAS, A FACEBOOK GROUP IN PERU

Juan Bossio, Communications Department, Pontificia Universidad Católica del Perú, jfbossio@pucp.pe
Illari Diez, Communications Department, Pontificia Universidad Católica del Perú, illari.diez@pucp.pe

Abstract: Women in Peru are exposed daily to gender violence and exclusion. Several feminist groups have used social media to share information, debate, denounce, organize, and provide help to victims. This contribution analyzes the meaning of female solidarity, sisterhood or sororidad, as a feminist political concept among members of one feminist Facebook group. We reviewed the how various feminist and sisterhood concepts clustered together in the group communications by reviewing group publications and comments as far as interviewing key former and current members. The sisterhood concept was found to be central to feminist practice.

Keywords: feminism, social media, Facebook, Peru, sisterhood, sororidad

1. INTRODUCTION

This paper is about the meaning of female solidarity, or sisterhood, and how it is related to other feminist concepts among members of a feminist Facebook group. Analytical constructs employed are the evolution of Latin American and Peruvian feminism, characteristics of virtual communities, and the use and appropriation of social media by social movements.

Firstly, though we refer to a feminist movement, we recognize there are many forms of feminism, with their corresponding ways to think, live, or act. In Latin America, feminist movements reflect specific cultural, ethnic, social, and linguistic diversity with particular characteristics that encompass demands beyond the fight for gender equality (Rivera, 2018; Sardiña, 2020). This diversification began in the 20th century, but in recent decades has passed through important changes. In the 1990s, there predominated a liberal feminism that gained some gender equality rights for women, but was adapted to neoliberalism (Coba & Herrera, 2013). At the beginning of the 21st century, these feminist movements began to address globalization and included a critique of American Westernization, along with racism and the aftermath of colonialism (Gargallo, 2007).

Thus, Peruvian feminist movements have passed through three waves. From 1911 to 1933, feminist women were focused on the fight for the right to vote, women’s access to equal educational opportunity, and support for other causes like the rights of workers and indigenous people (Barrientos & Muñoz, 2014). From 1973 to the present, the feminist struggle focused on a demand for equal citizenship in every aspect. During the 1970s, women held street demonstrations to gain visibility (Barrientos & Muñoz, 2014) and institutions arose to address women’s workplace issues (Vargas, 1985). Starting around 1978, new autonomous groups appeared and joined the left to find solutions to women’s problems from a Marxist perspective (Vargas, 1985). In the 1980s, women embraced a more general sense of rights. During the 1990s feminist movements became complex and fragmented, bringing new forms of expression (Vargas, 2004). The third wave, arising in parallel to the second wave, from 2003 to the present, saw a definition of feminism in terms of sexuality. Although, the Peruvian state promoted many norms that support equal opportunities, such as protections against domestic violence and sexual assault, this didn’t result in practical outcomes.
in key aspects of women’s lives, including domestic and sexual violence, and abortion (Barrientos & Muñoz, 2014). In this context, groups that defended sexual diversity rights adopted themes of feminist radicalism. There is an ongoing debate about whether to defend gender identities when fundamental conditions of women haven’t reached an acceptable minimum (Barrientos & Muñoz, 2014). Between the second and third waves there are coinciding themes regarding legal abortion, violence, patriarchy, child pornography, etc. Questions that divide feminists have to do with the relation (or not) between patriarchy and capitalism, the inclusion of trans women as feminist subjects, regulation or prohibition of sex work, and other issues.

Within these feminisms, one concept present and established as a practice is the notion of sisterhood. The word used by feminists in Spanish —where sisterhood and brotherhood share the same term: hermandad— is sororidad. Sororidad could thus be understood as the construction of relationships of complicity, mutual support, and solidarity among women to generate support networks across broad areas of life (Torcuato et al., 2017). Further, from Lagarde’s perspective, sororidad is defined as ethical, political, and practical aspects of contemporary feminism. It urges women to seek positive relationships and political alliances with other women, with an aim to conduct specific actions against oppression and provide support to gain empowerment (Lagarde, s.d.). Sororidad implies that women who practice it must see each other as equals (Lagarde, 1990, 2001 as cited in Ojeda, 2013).

The case presented in this paper is a Facebook group called #LasRespondonas (#LR) created in 2016 by feminist women in Lima, Peru. It gets its name from statements of the former cardinal Cipriani calling women ministers who promoted free distribution of emergency contraceptive pills “Respondonas” or “Backtalkers” (Diez, 2020a). It was created as a space for feminist debate and as a project incubator, moreover, #LR was considered a sororidad space above all else. This centrality is the reason why this case was chosen among others such as Bolsa de Trabajo Feminista - Peru, aló compita? or Feministas buscando casa - Peru. The group grew rapidly to 20,000 members in a few months. Some anticipated projects didn’t materialize, and others happened separately. Since 2018, the group has been used for feminist debate, accusations, and requests for help (Diez, 2020a).

Secondly, online communities have been conceptualized as associations of people who interact around shared interests in a non-private way, using a common language and led by shared norms (Agostini & Mechant, 2019; Brown et al., 2007; Jin et al., 2010). The shared interests could be shaped around social problems, as well as other common issues (Suazo et al., 2011). These communities can have different size or scope (Preece, 2001). Preece considers an online community to be “any virtual social space where people come together to get and give information or support, to learn or to find company” (p. 348). These virtual spaces could be of many kinds, such as online chat rooms, social networking sites, and weblogs, among others (Ridings et al., 2002). Organizations, including online communities, emerge or “drift” rather than following preestablished plans, as the environment changes (Ciborra et al., 2000). Consequently, the value of the community isn’t from the platform itself, it is contained in the information, ideas, and content shared by members during discussions and interaction (Jin et al., 2010). Another important aspect of online communities is the ‘online homophily’, understood as the shared demographic characteristics of its members, such as gender, age, and education (Ruef et al., 2003). The appearance of agents with extreme beliefs who primarily interact among themselves is more likely to happen in large networks or communities (Madsen et al., 2018). In other words, it leads to the formation of clans that bring comfort to members and avoid disagreements (Törnberg, 2018).

Thirdly, from a socio-technical perspective, artifacts are socially constructed, situated, and contingent (Siri, 2008). Systems and platforms are designed for some purpose, but users reshape them by processes of adaptation (Walsham, 2001). The social change agent is not the technology itself, but the uses and sense construction built around it (Grint and Woolgar, 1997). Participatory culture preexists Social Network Systems (SNS), but they have been enhanced and reshaped by how SNS are used (Jenkins, 2006). Since the 1970s, online communities have connected people who share interests, feelings, or ideas (Rheingold, 2000); they have rapidly adapted and transformed over
the interval (Brown et al., 2007). One example of their capacity for adaptation is the rise of social movements on these platforms.

Social movements are groups of people that face collective challenges to common objectives; there is solidarity among their members and an interaction with authorities, opponents and elites (Tarrow, 1994). An important part of this interaction is through public representations of worthiness, unity, numbers, and commitment (WUNC) (Tilly & Woods, 2009). Requests for recognition, including that of feminists, has been a feature of demands from social movements, and are even more important nowadays (Castells, 2012; Melluci, 1996; Tilly & Woods, 2009; Treré, 2015). Today’s movements make an intensive use of Internet resources and platforms, especially social media, thus becoming net movements (Castells, 2012; Jenkins et al., 2016; Postill, 2018). Indeed, it should be noted that feminism is one of the first international movements to appropriate IT (Gajjala y Oh, 2012). Social movements act through repertoires (Tilly & Woods, 2009); some have evolved or adapted to digital terrains as “digital escrache” (denunciation campaigns on social media) or slogans rendered in hashtags. Others are new, such as video mapping, hashtag campaigns like #MeToo, or hashtag crashings like those recently made by Kpoppers (Bossio, 2020; Jenkins et al., 2016; Treré, 2015). Furthermore, digital media is increasingly used to share opinions, coordinate actions, learn tactics for street action (e.g., tutorials on how to defuse tear gas canisters), or to express or give solidarity (Bossio, 2020; Treré, 2015).

The relevance of this article is supported by two principal aspects. The first one is the context of the case study. Peruvian women are daily exposed to gender violence and unequal access to work, education, etc. For example, in the first two months of this year, there have been 23 femicides and 51 femicide attempts (MIMP, 2021). The second one is the scarcity of studies of the use of digital media by feminist movements and sororidad in Latin America in general and Peru in particular. For example, in Peru, Caballero (2018) showed how a group of Facebook was used to connect offline networks, which facilitate the adherence of people and the emergence of the ‘Ni una menos’ mobilization. Furthermore, Soto (2019) described how in that Facebook group women could share sensitive disclosure and generate sororidad. Finally, Diez (2020a, 2020b) studied the transition of sororidad from online to offline spaces through feminists interaction in #LasRespondonas and the security construction to guarantee it. The absence of major studies on these convergent topics highlights the need to contribute visibility to positive and negative aspects of the use of social media by feminist movements. Then, this paper seeks to provide an exploratory approach -from an specific case- to the use of digital media for discussing sororidad and other feminist political concepts in Latin America.

2. METHODOLOGY

The main question of this article concerns to how is sororidad understood and how this concept relates to others among members of a feminist Facebook group. Using a qualitative netnographic approach (Hine, 2015; Pink et al., 2015), we combined interviews of key participants and analysis of Facebook posts and commentaries.

The following categories were defined to organize the research and answer questions about:

- **Sororidad definition by activists,**
- Subjects and beneficiaries of sororidad,
- The place of sororidad among other concepts,
- Ways in which sororidad happens,
- Absence of sororidad in feminist interaction,
- Sororidad and social media,
- Sororidad as a political tool.
2.1. Data and sample selection

The key respondents to the interviews were chosen for their knowledge of the #LasRespondonas Facebook group (#LR). The first informant was Nani Pease, a founder and former member of the group; the second was Laura Balbuena, another founder; and the third was Mariana Velasco, a moderator. It is important to highlight that they allowed to be named.

Posts to analyze were identified by searching on key terms related to sororidad and feminism found in the Facebook group. The combinations of ideas used were: ‘political sororidad’, ‘feminism and sororidad’, ‘political feminism’, ‘sororidad’, ‘is not sororidad’, ‘victim and sororidad ’ and ‘#YoTeCreo’ (believe the victim).

Criteria for choosing posts to analyze included date of publication (posts from 2018 onwards), relevance or relation to the defined categories, and discussion content. Excluded were posts with few relevant comments, reposts, or publicity.

Honoring the commitments to moderators and the group, we sought authors permissions to include their posts and comments in the sample. All authors were contacted via messages through the platform. One author communicated that she didn’t want her posts and comments to be considered, but the majority of authors whose content wasn’t considered did not reply. From the 16 publications and 380 comments initially selected from 98 women, we were authorized to use 143 posts and/or comments.

2.2. Materials

The interview guide asked about respondents’ experiences at #LR, related sororidad and feminist concepts, how sororidad is carried out in practice, its role in political action, actors and roles in sororidad formation, and how it is shaped by social media.

The analysis of posts and comments was carried out using a list of concepts related to sororidad, with the aim to identify which of them appear connected to it during the group debates, either explicitly or implicitly. The list of concepts was created considering the known theory and an assessment of the content. Related concepts arose during the analysis. The final list of categories included: patriarchy/sexism, deconstruction, empowerment, intersectionality, ethics, representation, activism, #YoTeCreo (hashtag in support of the claims of a female victim of violence), sex work, normalization, commodification/objectification, stigmatization, respect, empathy, security/privacy, confidence, acknowledgment, sisterhood (hermandad), help, and feminist debate (how to debate within the group).

The first level of analysis allowed us to identify the most common concepts and to exclude 14 comments that lacked a connection to sororidad. The analysis presented in the next section considers 129 items (12 posts and 117 comments). Finally, four posts and their comments were selected for a content analysis because of the richness of the debate they contain including all the most considered concepts. This analysis focused on the definition of sororidad encountered, how the concepts identified were used, and limits to sororidad.

3. RESULTS

For context, this section begins with an introduction to the Facebook group and its purposes. Then it looks at the concepts related to or aligned with sororidad, followed by how the concept is understood at #LasRespondonas. Those results are based on how sororidad is a political concept and tool for feminism. Finally, we consider the relation between social media use and sororidad practice.

3.1. Evolution, functionality and debate on #LasRespondonas

According to interviewees, the group adapted and evolved, taking on a life of its own. As it grew, the founders asked members to become moderators. #LR was originally a group mostly populated
by cisgender women, but because of the presence of transgender women and some debates, trans moderators were included. Another change was to the type of group; initially it was an open group, but when some people started taking screenshots or sharing sensitive information (testimonies of violence, identity of victims, etc.) it was decided to make it private. As well, moderators campaigned to eliminate suspicious profiles and enforce the admission process. To gain access, women had to be added by a group member and answer screening questions.

As stated above, #LasRespondonas is a space of sororidad, which becomes evident when one of the group members posts a request for help. Some of the situations that generate requests are gender violence, depression, unwanted pregnancy, and economic problems (Diez, 2020a). When a request is posted, group members begin to offer helpful comments. For example, they make supportive statements, add to the visibility of the post using the word ‘up’ so more people can see it, narrate personal experiences to show emotional support, give needed information or share where it can be found, give advice, and offer direct help (Diez, 2020a). While in some circumstances help provided on the post is enough to solve a problem, in others tangible support like clothes, money, pills for pregnancy interruption, accommodation, etc. are needed. In that case, group members usually communicate through a private space, like Facebook Messenger or WhatsApp to coordinate a way to meet in person (Diez, 2020a).

This interaction generates relationships between the women of the group. They begin to know each other personally, identify commonalities, build friendships, empathize, and give more help. This is possible because there is a feeling of confidence: they feel that they will always receive help when needed. Also, they feel that they won’t be judged when talking about their problems.

Nevertheless, at times the debate becomes intense, and it would appear there is no sororidad. Although as Laura said, “conflict is needed in order to grow”, friction arises when some kind of consensus, like the right to abortion, is questioned. While those shared ideas are not negotiable, moderators believe that abrasive reactions work against sororidad because they silence participants who may leave without having the chance to change their views. They believe there should be empathy and understanding toward those who come to a feminist space, and the context of their ideas should be considered. As Nani, who left #LR after dozens of such debates, said: “there should be the right to not be clear, not have a manual with all the answers, or to share doubts”. Other tough debates arise when views from different sides of the feminist movement collide over issues like domestic or sex work. When those debates intensify, ad hominem remarks pop up—for instance, “procurer” for those who advocate regulations for sex work.

Such attacks and interventions about how the debate among feminists should proceed were coded on our sample as “Feminist Debate”. This became the most common category, which partially describes around 30% of posts or comments analyzed. On the other hand, combating violence against women was the issue that produced unity out of diversity.

### 3.2. Concepts related to sororidad

The interviewees identify several concepts as being related to sororidad: feminism, solidarity, empathy, respect, fellowship, mutual care, avoid judging the victim, not revictimize, recognition of the other, recognition of differences, deconstruction, confidence, believe the victim, and sisterhood.

Apart from “Feminist Debate”, the most common themes were respect, empathy, intersectionality, patriarchy/sexism, believe the victim (#YoTeCreo) and sisterhood; these were followed by deconstruction, commodification/objectivization, sex work, stigmatization, help, acknowledgment, activism, ethics, and normalization. Some themes would be associated with feminist theory as patriarchy, a system ruled by men; intersectionality, the consideration of social facets that combine to produce discrimination; deconstruction, the process of critiquing a person’s own beliefs/feelings/thinking associated with living in a patriarchal society; commodification, valuing women as things; stigmatization or normalization, seeing violence or other women’s problems as normal. The rest concern political or practical issues, some related to collective action, such as
belonging the victim and activism, others to the building of relationships among feminists or women as respect, sisterhood, acknowledgment and ethics, or to active sororidad empathy and help.

![Figure 1. Categories assigned to posts and comments](chart)

The concepts above are related to sororidad in different ways in feminist debates. For instance, one post looking for a live-in maid opened a debate about whether this work regime was enslavement of women and whether seeking it could be considered anti-feminist. Some said that those who hire women under this regime are using them to be able to personally grow themselves; others argued that this regime was helpful for women who live far from their workplace, etc. Also, there were two forms of ‘debate’: a respectful one, asking for empathy, and another that used aggressive language and sarcasm. This second form of debate was indicated as an example of lack of sororidad. In a similar way, another post debated about sex work and sororidad; it was said that exploiting or humiliating women is not sororidad. So, it can be observed that sororidad is linked to intersectionality, empathy, and the attitude and actions on a debate.

Another example was provided by a post which used the Medusa myth to discuss topics such as patriarchy, commodification, and sororidad. There are two sides of the myth. On one hand, Athena represents a patriarchal woman, who doesn’t practice sororidad because she judged and punished Medusa for being a sexual assault victim. Moreover, Medusa is perceived as a monster when she is the victim. On the other hand, Athena is seen as a wise person, who made Medusa ugly so that men would leave her alone. This perspective highlights that in a patriarchal society where it has been normalized that beauty can attract harassment (commodification of women) and female victims of sexual assault are stigmatized, being ugly becomes a protection. Then, sororidad is linked to support and non-judgment of women victims of violence.

3.3. How is sororidad conceived in #LR?

Solidarity among women is commonly referred to in English as sisterhood. But since it is a core feminist concept in Spanish as sororidad, we choose to use that term. It implies actions such as help, support and care, and feelings of sisterhood and fellowship. As a product of feminist history and action, sororidad can be understood from a political and/or theoretical perspective. The construct of
sororidad allows members to introspect to understand and act as allies for outward-facing actions. While sororidad is conceived as a feminist practice, it encompasses all women.

To perform sororidad requires actors to empathize, and as a consequence avoid behaviors like judgment, exposure, or evaluation of a victim. Sororidad is to tell an unknown woman: “you are not alone”, to show care for the other, and create a shared space of confidence. Sororidad implies seeing other women around you as allies and not as competitors.

However, there can be tensions within a group when sororidad is not a generally shared value. All interviewees declared that sororidad should be universal (it shouldn't be conditioned by the qualities or history of those who need it), but they also realize that it is a goal. As mentioned above, some tense debates drift far from the spirit of sororidad, but there are also deliberate arguments against universal sororidad. Moderators realize that some #LR members think that they can't act with sororidad towards right-wing women, religious believers, patrons of housekeepers, policewomen, xenophobes, women that didn’t act with sororidad in the past, intolerant women or transgender women. There is a mixture of feelings and ideologies supporting these exclusions. From one perspective, this could be explained as a misunderstanding of feminism; from another, there are context issues or life experiences that give rise to this. Both moderators suggest an empathic approach to these exclusionist feelings, offering different ways to deal with them. However, there is a controversy between the idea of ‘educating’ or having a dialogue with those women to see if they can change their minds and excluding them from the group to avoid conflict.

3.4. Sorority as a political tool

As mentioned, sororidad can also be viewed in political terms. According to Laura, “sororidad is feminism in action”: without sororidad feminism is just a theory, not a political movement. For moderators, the bases of feminism are community feeling, sisterhood, and willingness to help. Sororidad is what unites women, what makes them believe in themselves and others. Thus, sororidad is viewed as a practice, a feeling, and a central feminist concept.

It helps women to advocate for change as a way of life, and of political collective action that maintains unity in spite of differences. Moreover, sororidad is a survival tool for women in a patriarchal society that excludes them, pays them less for their work, doesn't protect them from violence or abuse, and cuts their social benefits—in short, a society that doesn't guarantee the fulfilment of their basic rights. Examples are a lack of publicly funded childcare or access to birth control in a country where abortion is illegal.

Sororidad also becomes a political position when women are victims of violence. As Nani points out, the role of women in that context is to take care of the victims, support them, and give them strength during the process of bringing legal charges; in other words, sororidad means not to replicate patriarchal violence, revictimize, or judge. To pose questions and investigate the facts is the job of a judge, not of a feminist.

3.5. Sorority and digital media

The relationship between social media and sororidad depends on who, how, and for what reason media are being used. Social media can become a hell when it provides tools to revictimize women who have suffered violence or generate disputes among allies. On the other hand, it can be a space for discussion and allyship, providing an opportunity for various forms of help: legal, medical, economic, or psychological, in terms of allowing accusations of abuse to spread.

Nani observes that there is an “automatic empathy activation” but affirms that it must be nurtured to become practical. She warns that interactions on social media can produce misunderstandings and needless disputes because of unconsidered reactions and assumptions about the characteristics and motivations of other participants. While responding to content in groups like #LR, members forget they can’t really see the reactions of others. Thus, an element of restraint and empathy, trying to think from the other person’s perspective, is essential to building a healthy community.
Other important issues concern security and privacy. Internet content is easy to spread but hard to contain. In these cases, it is urgent to protect the identity and testimony of victims. For sororidad to manifest on #LR a secure space (understood as “a virtual environment that, while not completely risk-free, is intended to minimize or control risks, and to generate a feeling of security and confidence in members to maintain their well-being when they interact in the space”) is required (Diez, 2020b, p.14). Group members then feel they will receive the help they need without being judged. This allows them to ask for help, share information, offer help, and meet face-to-face (Diez, 2020b).

4. DISCUSSION AND CONCLUSIONS

This case of study allows a practical understanding that sororidad shows the same characteristics in digital spaces and offline spaces. The notion that sororidad is conceived around the actions of help, support, care, and the feeling of sisterhood and fellowship can be seen as network construction between women (Torcuato et al., 2017). Similarly, it can be seen as a more political, ethical, and practical form of feminism (Lagarde, s.d.). This is because it is not thought of as simply a glue for feminists and the base of the movement but is understood as feminism itself in action, in the Facebook group and beyond. It leads women to act against patriarchy and promote actions to guarantee the fulfillment of their rights (Lagarde, s.d.). Thus, sororidad is a survival tool for women in a system that doesn’t fully support them (Lomnitz, 1978).

However, the question of who should be included in the practice of sororidad is a delicate one. As discussions have shown, sometimes sororidad is lost, or its universality is questioned. This arises from the diversity of feminist movement demands (Sardiña, 2020) and the evolution of the movement itself (Barrientos & Muñoz, 2014), showing that offline political beliefs are reflected in digital spaces.

Accordingly, the #LR group has drifted, coalescing from the multiple goals it had in the beginning, through its explosive growth to its settled/established usages: feminist liberation, denunciations of perpetrators, and assistance (Ciborra et al., 2000). Furthermore, as its members have accommodated/adapted certain functionalities of the platform to give visibility to urgent announcements by adding visibility functions to certain comments (“up-leveling”) so they appear more often on members’ walls, they provide an interesting case to prove how people appropriate this tools to its own interests as said by Walsham (2001). One issue important to moderators and members has been to build a secure digital space for all. Just a space free of revictimization and without filtered information would stimulate women to share their worst experiences and look for help from others (Diez, 2020b). So, moderators changed the group to a secret one and enforced an admission process to avoid the intrusion of aggressors or infiltrators to the extent possible.

Moreover, #LR provides a good case to understand the characteristics of a virtual community as a) it is a large virtual community (Preece, 2001) built around its members’ social interests (Suazo et al., 2011; Preece, 2001); b) the public interaction between women in it is led by norms such as to respect each other, not to share information, etc. (Agostini & Mechant, 2019; Brown et al., 2007; Jin et al., 2010); c) its members seem to have an ‘online homophily’ because the majority of them are women (Ruef et al., 2003), however, they have differences in education or feminist sophistication level, as cited by our interviewees; d) it manifests the construction of a cluster with some extreme beliefs—which is not always open to disagreement— as some members just want to share the space with other people who think as they do (Madsen et al., 2018; Törnberg, 2018). This poses a challenge to moderators: to maintain free and critical digital interaction that is respectful, and to practice sororidad among members.

Although, #LR itself is not a social movement, it gives the opportunity to interpret it inside the feminist movement in Peru. Members share challenges and objectives and there is a sense of solidarity (here, sororidad) among them (Tarrow, 1994). However, the group hadn’t developed towards an organization that produced WUNC demonstrations (Tilly & Woods, 2009). In that way,
#LR is more like a sharing space inside the movement. It could be argued that performing sororidad as a political action is a repertoire (Tilly & Woods, 2009).

Finally, #LR case allow to continue proving the increase in use of the digital platform as a political terrain for diffusion of ideas, debate, and organized action, both face-to-face and digital, resulting from widespread use, adaptation, and appropriation of SNS (Bossio, 2020; Castells, 2012; Jenkins et al., 2016; Postill, 2018). Also, it reinforces that identity or ‘identities’ of intersectionality and gender issues are considered crucial to this kind of groups, as has been reported worldwide (Castells, 2012; Jenkins et al., 2016; Melluci, 1996; Postill, 2018; Tilly & Woods, 2009; Treré, 2015).

In conclusion, since patriarchy can be claimed as a central concept for feminist theory, from the analysis of #LR, it can be argued that sororidad is correspondingly central to feminist practice in daily life as in political action.

4.1. Limitations and future research

This research has been limited to some extent by concerns for sources and subjects’ willingness to collaborate. The sample of posts and comments includes only those who have agreed to be included. That permission wasn’t granted for four posts and more than a hundred comments they generated. Thus, a selection bias can be assumed.

Considering the relevance of the discussion on trans inclusion it would be interesting to interview the trans woman moderator of the group. Furthermore, after realizing the importance of how debate is conducted in this virtual space, it is clear that interviewing some people with outlying positions or behavior would have been useful.

Finally, this research opens other questions. How closely tied to Peruvian culture is the way in which these feminists debate? What can be done to promote energetic but not harmful debate? How is sororidad conceived in other feminist groups? What else can be said about the debate on the universality of sororidad?

REFERENCES AND CITATIONS


https://www.researchgate.net/publication/220208633_Predicting_continuance_in_online_communities_Model_development_and_empirical_test


THE ETHICAL IMPLICATIONS OF DIGITAL CONTACT TRACING FOR LGBTQIA+ COMMUNITIES

Izak van Zyl, Cape Peninsula University of Technology, vanzyliz@cput.ac.za
Nyx McLean, Cape Peninsula University of Technology, mcleann@cput.ac.za

Abstract: The onset of COVID-19 has led to the introduction of far-reaching digital interventions in the interest of public health. Among these, digital contact tracing has been proposed as a viable means of targeted control in countries across the globe, including on the African continent. This, in turn, creates significant ethical challenges for vulnerable communities, including LGBTQIA+ persons. In this research paper, we explore some of the ethical implications of digital contact tracing for the LGBTQIA+ community. We refer specifically to the digital infringement of freedoms, and ground our discussion in the discourse of data colonialism and Big Tech. We propose a critical intersectional feminism towards developing inclusive technology that is decentralised and user controlled. This approach is informed by a feminist ethics of care that emphasises multiple lived experiences.

Keywords: digital contact tracing; LGBTQIA+; ethics; privacy; Big Tech.

1. INTRODUCTION

In this research paper, we respond to Track 7 of the IFIP WG 9.4 2021 conference, namely, Feminist and Queer Approaches to Information Systems (IS) in Developing Countries. Taking a continental (African) perspective, we argue that the technological containment strategies around the COVID-19 pandemic create serious implications for vulnerable populations in the LGBTQIA+ (lesbian, gay, bisexual, transgender, queer/questioning, intersex, asexual/ally, and other) community. Particularly, we argue that the widespread introduction of contact tracing mechanisms by governments and affiliated organisations infringes on the privacy, freedom, and rights of these and other groups. This occurs through obtaining – and potentially exploiting – sensitive information that could otherwise be used to denigrate, punish, and physically harm or kill vulnerable people. We frame this discussion within the broader discourse of data colonialism, where Big Tech assumes its newfound role as public health policymakers (Sharon, 2020).

In what follows, we review the seminal literature in the domain of digital ethics and Big Tech in the context of the current pandemic. Specifically, we examine digital contact tracing and its intrusive possibilities for members of the LGBTQIA+ community across Africa. We refer here to Africa not only in a geographic sense, but primarily in the cultural historical sense of it being a casualty of deliberate underdevelopment through colonisation (Rodney, 2018). We discuss the historical persecution of vulnerable communities on the continent and argue against the current and potential digital infringement on LGBTQIA+ freedoms. Furthermore, we critique the role and influence of big technology companies in this context. We conclude the paper by highlighting theoretical and practical approaches through which to promote collaborative and empathetic technological development with LGBTQIA+ communities.
2. DIGITAL CONTACT TRACING AND PRIVACY

With the global onset of COVID-19, governments have introduced far-reaching measures to contain the virus. These have included contact tracing as a familiar means to fight infectious disease outbreaks, as historically in cases like Ebola and SARS. Contact tracing, in principle, involves highly targeted control, whose purpose is to prevent further infection. Often coupled with treatment and isolation, contact tracing is a severe form of targeted control and is typically effective in cases with low rates of infection (Eames & Keeling, 2003). According to Dar and colleagues (2020, p.2), contact tracing conventionally occurs in three steps or phases:

1) Identification: identify those persons an infected patient came into personal contact with.
2) Listing: maintain a record of the contacts of the infected patient(s) and inform those persons.
3) Follow-up: further examination, treatment, and isolation of contacts, and especially those who test positive.

Contact tracing is not always a good control strategy. It may be less successful in high-risk and heterogeneous groups, with many potential transmission routes and a high incidence of infection (Eames & Keeling, 2003). The authors go on to indicate that, “[if] the tracing process is significantly slower than the infection process then, no matter how large a proportion of contacts is eventually traced, it will be impossible to keep pace with the epidemic; there is a trade-off between tracing speed and tracing efficiency” (ibid., p.2570).

In their analysis on the effectiveness of contact tracing strategies for COVID-19, Kretzschmar and colleagues (2020) recognise that typically, (manual) tracing efficiency is reduced through testing delays that may occur in especially low-resource or dense population settings. However, they find that such delays could be minimised through app-based (digital) technology, thus enhancing contact tracing effectiveness and coverage. To this end, the World Health Organization (WHO) describes distinct categories of digital tools: outbreak response tools, proximity trackers, and symptom tracers (WHO, 2020). Notwithstanding their benefits, the inherent challenges with such digital tools include high infrastructural costs, low overall adherence (participation), and importantly, privacy and data ownership concerns (Kretzschmar et al., 2020; WHO, 2020).

Anglemyer and colleagues (2020) conducted a rapid review on the effectiveness of digital contact tracing versus manual tracing, not limited to COVID-19. In their assessment, they found only low-certainty evidence of success in terms of reduction and prevention of cases. The researchers note the additional risks of privacy breaches, as well as equity concerns for at-risk populations with limited access to resources. Dar et al. (2020) note the benefits of digital contact tracing in light of COVID-19, especially in speeding up the process of identification. However, the researchers raise significant privacy considerations, including “securing the identity of an infected individual from others, stopping the spread of misinformation, … and withholding the countries from establishing a surveillance state” (ibid., p.3). In terms of the latter factor, the authors point to legislation in countries like Israel and South Korea that allows for government tracking of contacts - which involves recording details about occupation, age, travel routes, and importantly, gender.

In Africa, countries like Egypt, Rwanda, South Africa, Democratic Republic of the Congo (DRC), Mozambique and Tanzania have deployed GPS-enabled digital contact tracing, leveraging, inter alia, cell phone tower data, satellite technology, and mobile apps, to fight COVID-19 (Arakpogun et al., 2020). Worryingly, the Ugandan government has sanctioned legal instruments that allow medical officers or health inspectors to enter any premises to search for potential COVID-19 cases, or to inquire about the whereabouts of suspected positive patients (CIPESA, 2021). In the DRC and Tanzania, digital contact tracing may involve unsolicited home visits by community health workers (Nachega et al., 2020).

Ultimately, digital contact tracing poses significant risks to privacy, both in Africa and globally. Governments and health organisations are not necessarily transparent in how data is processed,
shared, or protected (see Angelopoulos et al., 2017). Proximity tracking applications especially may disclose location history, case and contact status, and potentially other personal data (WHO, 2020). Taken together, otherwise well-intentioned digital tools may be exploited in the establishment of widespread surveillance states, for example, in Israel (Amit et al., 2020), South Korea (Park, Choi, & Ko, 2020), and non-democracies like China, Jordan, and Vietnam (Greitens, 2020).

3. PERSECUTION OF LGBTQIA+ GROUPS IN AFRICA

In Africa, the state of LGBTQIA+ rights is dismal. At the time of writing, seven out of 54 countries protect against discrimination based on gender identity and sexual identity; three have legally recognised gender identity; LGBT rights are legal in 21 countries, and South Africa is the only country to recognise adoption and civil unions. Same-sex marriage is banned in nine out of 54 countries. In Uganda, Tanzania, and Sierra Leone, homosexuality is punishable with life-term imprisonment; while in Sudan, Somalia, Somaliland, Mauritania, and northern Nigeria, homosexuality is punishable by death.

South Africa is internationally recognised as a champion of LGBTQIA+ rights. Globally, it was the first country to constitutionally protect people irrespective of sexual orientation, and later the first country in Africa to recognise same-sex unions through the passing of the Civil Union Act. Despite this, many LGBTQIA+ South Africans continue to experience homophobic and transphobic violence (McLean & Mugo, 2015, p.17). This may seem surprising because constitutional protections and the increased visibility of LGBTQIA+ people lead to the belief that homophobia and transphobia are no longer a cause for concern in South Africa (Teal & Conover-Williams, 2016, p.18).

Homophobic and transphobic harassment and violence manifest in several ways. This can range from verbal abuse to physical assault, sexual violence, and even murder. LGBTQIA+ people may be further marginalised by poverty and racism (McLean, 2018, 2020; Thoreson, 2008). Reid (2020) provides an example of discrimination and persecution that LGBTQIA+ people face in Africa, including Kenya, Egypt, Ghana, and South Africa, and how these discriminations are amplified by socio-economic/poverty – whereby LGBTQIA+ individuals do not have financial capital to achieve independence from abusive families, and the like. The significance of this lies in the implications of leaking personal information about LGBTQIA+ people who live in violent communities or with homophobic family members, and who cannot afford to be evicted during a pandemic with job and food security being at an all-time low.

Further, it is important to note the frequent occurrence in some African countries where religious leaders hold significant sway, and often attribute drought, poverty, a pandemic like COVID-19, and any other hardship a community endures as “divine punishment” for harbouring homosexuals (Reid, 2020). This makes LGBTQIA+ people targets of harassment and violence in their communities. Violence against LGBTQIA+ people, and in particular transgender people, has increased worldwide (Human Rights Campaign, 2020; McLean, 2020). The spike in hate crime-related murders is a result of a “culture of violence” that emerges from transphobia and intersecting discrimination on the basis of racism, sexism, and homophobia (Human Rights Campaign, 2020).

The internet and digital technologies are often understood to be safer spaces for LGBTQIA+ people, such as many of those who live on the African continent, where offline spaces may be violent and dangerous to these groups (McLean, 2020; McLean & Mugo, 2015). Digital spaces, as McLean and Mugo (2015) and McLean (2020) have shown, can be negotiated, navigated, and managed – such as through closed groups and secure/encrypted communication. Some members of these online safe spaces may form connections and migrate to text-based messaging applications such as WhatsApp, or into offline spaces. However, sharing of contact data and/or sharing physical space details may not be secure, given privacy controversies with some social media platforms and their relationships with state governments.
As McLean and Mugo (2015, p.99) have written, the internet makes it possible for LGBTQIA+ people to connect with each other and to form safe digital spaces. However, it also provides people, communities, and governments with “tools to monitor” LGBTQIA+ people, especially in various African countries with anti-homosexuality laws (ibid.). One recent example from Egypt is that of the imprisonment of Andrew Medhat for “public debauchery” after police had located him through the gay dating app, Grindr (Nigro, 2019). He had not yet met with the man he was intending to meet, but officials argued that his use of the app was sufficient evidence.

As Nigro (2019) writes, LGBTQIA+ people as a group, “long criminalized and pathologized, is often an afterthought when it comes to user privacy and regulations - which has resulted in a precarious digital landscape”. The reason for this is that the context in which technology is built is a neoliberal one which does not consider how technologies may exacerbate oppressions such as those founded in race, gender, class, and sexuality (Noble, 2018, p.1). Dating apps, for instance, often make use of location data to link users to each other but while useful in finding a match, it can also put users at risk of harassment and violence from those making use of the apps to target LGBTQIA+ people. While this is an example from a dating app, the risk of exposing users’ location data is applicable to the use of tracing and quarantine apps during COVID-19. It is important to protect the data and privacy of users, especially for LGBTQIA+ people who are at risk of discrimination and persecution if their identities are made known to homophobic, transphobic, and queerphobic communities and state governments (Stonewall in Fox, 2019).

4. COVID-19 AND ‘DIGITAL INFRINGEMENT’ ON LGBTQIA+ FREEDOMS

During the first few months of COVID-19, the Association for Progressive Communication (APC) Women's Rights Programme (WRP) (2020) wrote of the adoption of technology and noted the expansion of surveillance and state power. Specifically, they wrote of:

“...reports from many countries, including those in the global South such as Kenya, Uganda and India, that the government is requiring or asking people to install mobile phone apps that use location data for contact tracing. While some measures of surveillance are sophisticated and reliant on tech, others are about marking the bodies of COVID-19 patients with stamps. Routinely, privacy is being compromised and violated, and we are all frightened enough to let this happen”.

Those in the race to adopt and “embrace digital contact tracing” - while a timely response to the pandemic - did not consider “putting laws and policies in place to address the stigma surrounding the epidemic, and to protect the rights of those most marginalized, risks undermining the goal of epidemic control” (Chair, 2020).

As online activity of marginalised groups comes to the attention of state officials, digital security and the protection of personal information becomes a matter of urgent attention. We draw on the work of Trias (2020) and Ranjit (2020) who studied tracing applications in India. Trias (2020) writes of how the app Aarogya Setu, using Bluetooth technology, “can trace the relationships between its users and calculate the infection potentials that each one has. When a new positive case is detected, Aarogya Setu immediately alerts the authorities of all persons who were in contact with that individual. In other words, it grants full authority over the handling of personal data to the state”.

While, to some, this may seem like a concern regarding privacy and access to personal data, for LGBTQIA+ people, this becomes an additional concern around personal safety.

Privacy needs to be understood beyond the notion of sharing information, to also include the various risks to diverse groups. For instance, as Chair (2020) writes, privacy as seen from a feminist lens focuses on the use of our data as a tool of surveillance, one which controls women and LGBTQIA+ people’s “bodies, speech, and activism”. Women and LGBTQIA+ people “experience privacy differently from men because of the social perceptions of how men and women should behave, determining the extent of privacy in patriarchal societies. The discussion on gender in contact tracing,
for example, has left a lot to be desired as the extra risks that women and marginalised communities face are not sufficiently taken into account” (ibid.).

The use of tracing apps is not only an issue of information privacy but also an issue of “autonomy, dignity, bodily integrity, and equality” (Ranjit, 2020). The data being collected on people’s movements may come to be used by governments and corporations “as a means of governance and regulation of what our physical bodies can do” (ibid.). The author provides two examples of tools used in India, that of Quarantine Watch which requires citizens to send hourly selfies to officials to prove that they were in their homes; and the COVA app, which uses geo-fencing and location data to create “a virtual border” (Ranjit, 2020).

The risk of such movement monitoring technologies to LGBTQIA+ people is clear: through confining the body to physical spaces with location data and sharing the data publicly, this group is made even more vulnerable. In India, this resulted in those quarantined being further policed by their neighbours who had access to their personal information through the lists of data that officials had made available (Ranjit, 2020). This is comparable to when Ugandan newspaper Rolling Stone (now defunct) published the names of LGBTQIA+ people in 2010 under the headline “100 Pictures of Uganda’s Top Homos Leak. Hang Them”. The BBC (2010) reported on this in an article titled “Attacks reported on Ugandans newspaper ‘outed’ as gay”. The murder of Ugandan LGBTQIA+ activist David Kato a few months later was attributed to the publication of the names of LGBTQIA+ people (Gettleman, 2011).

The consequences of the public sharing of personal data will not be the same for everyone, and those who are the most vulnerable in society, such as transgender people, may “face greater stigma and discrimination” (Ranjit, 2020). The author provides an explicit example of how in Hyderabad, posters were put up stating that interactions with transgender people would result in contracting the coronavirus. This illustrates the clear danger to vulnerable and marginalised people in the leaking of personal data.

Data recording in the name of a crisis is also problematic in the long term, post COVID-19, as these actions are not reversed once the crisis has passed. Zuboff (2019) provides the example of digital surveillance technologies such as those used during and after the 9/11 moment in the United States, which were justified by the ‘war on terrorism’. However, once the moment had passed, these technologies remained. As Ranjit (2020) writes, “the data now collected by various institutions can be used to re-exert control over our bodies, through ways often unknown, making it hard to question this”. Furthermore, they write that data and privacy legislation has not kept up with the development of technologies such as those introduced in response to COVID-19. The emphasis on data as a resource, with a focus on reducing the risk of infection, fails to bear in mind how giving up personal data may later result in implications for bodily integrity and autonomy.

While, as Nigro (2019) highlights the persecution of gay people using dating apps, the crimes committed against LGBTQIA+ were “unintentional on the parts of the apps themselves”. This brings to attention the need for developers of technology to consider the multiple and intersecting forms of oppression that people may face, and that they should build technology with the “lives and interests of marginalised communities” in mind (Mohanty, 2005, p.511). By building technology in this manner, developers can consider power and its distribution in a way that accounts for the often “unseen, undertheorized, and left out” (ibid.). However, this would require a move away from current modes of Big Tech development, which are primarily driven by for-profit motivations.

5. DATA COLONISATION, PUBLIC HEALTH, AND BIG TECH

While we recognise that many contact tracing apps are not developed by Big Tech, we limit our discussion to the most dominant and valuable companies due their ubiquity. These include the traditional ‘Big Five’, namely Amazon, Apple, Facebook, Google, and Microsoft. Indeed, Big Tech such as Apple and Google were some of the first to respond to the COVID-19 crisis offering up a digital contact tracing API (Sharon, 2020). However, these companies are driven by a for-profit
model and this brings into question the ‘social good’ of their offering of a digital solution during the most recent crisis. Digital technologies, especially those developed by Big Tech being “rooted in political economy dynamics”, may still come to cause harm even if they are “well-intentioned” (Magalhães & Couldry, 2021, p.344). It is important to note here that there is diversity in the approach to digital contact tracing apps. We are therefore mindful of not making sweeping claims about associated privacy and data protection issues. However, the overall point remains that big technology companies are well-positioned to influence individual freedoms through their market dominance.

Considering that many digital solutions and technologies, as well as their data extraction practices, are designed and developed in the Global North and then “deployed in poorer nations” such as in the Global South, colonialism is the most suitable framework to make sense of these data practices (Magalhães & Couldry, 2021, p.345). Like empires who imposed their notion of civilisation on the countries they colonised, Big Tech has swept in with digital solutions for addressing the current public health crisis of COVID-19 relying on desperation for the uptake of technology. Big Tech’s response to the current crisis is also familiar: “[a]s forceful promoters of technological solutionism, prioritizing technological answers to a broad range of social, economic, political and environmental questions facing contemporary society, they marginalize less intensively technological but possibly more appropriate responses” (Barendregt et al., 2021).

Undoubtedly, the speed at which COVID-19 moved required a rapid response, and digital contact tracing “provide[d] speed, scale and accuracy” (Sharon, 2020). However, in times of crisis, some civil liberties may be suspended by governments, and “the sharing of sensitive data like one’s health status and location can contribute to containing the spread of the virus” (ibid.). Digital contact tracing introduces different risks to the recording of data as opposed to recording data on paper, for instance. When the technology is built at speed and rushed to market without the rigorous analysis and testing that may usually be afforded to software, there is a greater risk of vulnerabilities in the software.

In not testing rigorously, room may be left for hacking devices and tracking software. This software, once installed, may be able to open the user’s phone up to commands which may then permit the movement of data, “including all passwords, contacts, reminders, text and voice calls. In addition, the operator could turn on the phone’s camera and microphone, use its GPS to track the target” (Desai, 2020). The sharing of location data “can be used to show who a person associates with and to infer what they were doing together at a given time” (Sharon, 2020). One must simply look to the previous example of the publishing of identities and personal details such as residential addresses of LGBTQIA+ people in Uganda to imagine the risk that such vulnerabilities in software could expose the LGBTQIA+ community to. Unfortunately, the debates around privacy and digital contact tracing “have tended to be framed in terms of a trade-off between individual privacy rights and public health” (ibid.). This is problematic because individuals now face a ‘privacy paradox’: a value dilemma through which they are pressured to sacrifice aspects of their privacy in the (supposed) interest of their health (Rowe, 2020).

Imposing digital solutions on people in a crisis without consideration for their lived experiences is akin to the imposition of values and culture of colonising nations who sought to exploit and extract for profit without concern for the ‘colonised’. An alternative to the imposition of digital solutions would be to adopt a participatory approach, underpinned by an intersubjective ethics, which sees that digital solutions to public health crises are community-led (see Van Zyl & Sabiescu, 2020). We argue that this approach is best informed by a critical intersectional feminist perspective, guided by a feminist ethics of care, because it would be inclusive of multiple lived experiences in the design, while considering the risks that the technology may present to vulnerable groups such as the LGBTQIA+ community.
6. CONCLUSIONS AND RECOMMENDATIONS
In the following section, we contribute both theoretical and practical recommendations to mitigate the risks of digital contact tracing to the LGBTQIA+ community. Namely, we advocate for a critical intersectional feminist approach which accounts for the lived experiences of the most vulnerable, while critically considering the concentration of power over access to personal data.

6.1. A critical intersectional feminist approach to technology
Critical intersectional feminism recognises that systemic oppressions like sexism, racism, classism, ableism, colonialism, and cissexism intersect. Intersectionality shows how discriminations exacerbate each other and that they cannot be separated out (Crenshaw, 1989). A critical intersectional feminist approach to the development of digital solutions will consider the interests and lives of the most marginalised: those who are “unseen, undertheorized, and left out” (Mohanty, 2005, p.511). Such an approach would allow for an analysis of power and exploitation that is not evident in the production of solutions by Big Tech. This is because, at the heart of feminism, is the work of disrupting and destabilizing oppressive power structures and dynamics to create a more equal, inclusive, and socially just world (Cooky, Linabary, & Corple, 2018; hooks, 2000; LaFrance & Wigginton, 2019; Tandon, 2018).

A critical intersectional feminist approach is not without its own challenges. For instance, intersectionality is often critiqued for presenting marginalised groups such as the LGBTQIA+ community as a uniform identity with a single and shared lived experience (Gringeri, Wahab, & Anderson-Nathe, 2010). To counter this, it is important not to essentialise experience and identity but acknowledge “the complexities of multiple, competing, fluid, and intersecting identities” (ibid., p.394). Therefore, designing technology in a participatory manner with people with multiple lived experiences, including vulnerable groups, is so essential to the development of digital solutions which seek to do true ‘social good’ without profiting off a crisis.

An additional recommendation is to employ critical reflexivity into one’s work, to enable individuals to reflect on their positionality, power, and privilege when developing and designing technology. This helps to interrogate not only one’s role in the development and design but also the ways in which power is distributed and plays out (Cooky et al., 2018). Reflexivity acknowledges that people are not separate from their work and that they impose or bring their values to their work, whether they are researchers or software developers. Those developing digital solutions to a crisis are not separate from the design or development process, but their values, politics, personal identities, and assumptions about the world influence and underpin the technology they develop.

In their 2019 report on feminist internet ethical research practices, the APC proposes that a feminist ethics of care should extend to digital security and safety. This includes accounting for digital vulnerabilities such as security breaches or the leaking of personal data. An ethics of care is informed by feminist values and emphasises “care and responsibility rather than outcomes” (Edwards & Mauthner, 2012, p.19). Additional areas of consideration include representation, language, experience, and subjectivity which makes such an approach well-suited to considering the needs of marginalised groups (Blakely, 2007, pp.64-5). In adopting a feminist ethics of care approach to the deployment of digital solutions, the well-being of potential adopters, including LGBTQIA+ people, is at the forefront of the development process.

6.2. Decentralised technology and user-controlled access
A critical intersectional feminist approach disrupts oppressive power structures and favours the decentralization of technology. In this manner, the technology is “under control of independent responsible authorities, would evolve and be open source” (Desai, 2020). Independent responsible authorities would be community-appointed and will include those who are often left out of decision-making processes. Access to a user’s data should only be allowed if the owner of the data “approves it, for each use” (ibid.). Continuing, Desai (2020) writes, “If stored, for backup it should not be
disclosed to third parties and should be deleted when requested. There must be a legal requirement for the length”.

It is not enough for users to opt in voluntarily, but they must also be made fully aware of the implications for handing over access to their data. The length of terms of service documents, wordiness, and the use of jargon often result in users agreeing or consenting to terms “without fully understanding how their safety - their lives - may be at risk” (Nigro, 2019). Consequently, terms of service or terms and conditions need to be made far more accessible to the average person.

Chair (2020) writes on how some national data protection authorities have done well to provide guidance on data protection. These authorities “provided pointers to avoid future misuse of technology such as unwarranted increased surveillance and determine who has authority in collection and processing of data” (ibid.). In Senegal and in Mauritius, for example, data protection authorities ensured and assessed the anonymization of data for “statistical and scientific research purposes to ensure the data may not be de-anonymized” (ibid.), or that those who granted access to their data were duly informed and a time limitation on access to this data was in place.

Ultimately, digital contact tracing, driven by Big Tech as “self-proclaimed” health policymakers, leaves untenable room for exploitation and harm. This is especially the case for LGBTQIA+ persons, who may be in physical danger should their whereabouts, identities, or personal views be exposed. The widespread trade-off between individual privacy (or freedom) and public health is unjust in the broader context of marginalization, and further disenfranchises those at the peripheries of society. A critical intersectional feminist approach can mitigate some of these concerns by proposing solutions that are more equal, inclusive, and socially just. Such an approach, informed by a feminist ethics of care, is transparent, user-centric, and sensitive to volatile political and cultural dynamics.

We encourage future research that seeks to operationalise a critical intersectional feminism in the context of public health.

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FOR BETTER OR FOR WORSE? A FRAMEWORK FOR CRITICAL ANALYSIS OF ICT4D FOR WOMEN

Abhipsa Pal, Indian Institute of Management Kozhikode, abhipsapal@iimk.ac.in
Rahul De’, Indian Institute of Management Bangalore, rahul@iimb.ac.in

Abstract: Diffusion of ICTs provide possibilities for women empowerment by greater participation and enhanced gender-based digital equality. However, a critical analysis reveals that as ICT diffusion widens, there is a persistent threat of widening the gender-based digital divide and exposes women to online sexual abuses, predominantly in developing countries characterized by the gendered nature of the social structure. Instead of accepting ICT as the facilitator to women empowerment, in this paper, we develop a critical research framework for a gender-focused examination of ICT4D studies. Critical research methodology provides the appropriate ontology unveiling social realities through challenging the status quo and exposing the deeper societal inequalities. Using the critical research framework developed, we investigate past ICT4D initiatives and artifacts from literature and draw critical conclusions of its benefits and issues. This study would aid future ICT4D research to investigate areas of gender discrimination and understand the role of ICTs in a critical light.

Keywords: ICT4D; Women empowerment; Gender-based digital divide; Critical research

1. INTRODUCTION
ICTs today hold potential for women empowerment in various ways including easier expression of their feelings through text messages (Barendregt, 2008), spreading awareness about women’s rights on social media (Newsom & Lengel, 2012), and easier access to their finances through mobile banking (Kemal & Yan, 2015). The diffusion of mobile phones and the Internet have dramatically changed the ICT usage landscape for women, with a near equal number of women users, even in certain developing regions in Africa and South America (Gillwald, Milek, & Stork, 2010; Poushter, 2016). On the other hand, the variety of articles highlight the undeniably heroic role of ICTs in enabling women’s voices and increased access to various services, advancing women’s quality of life and social status (Ahmed, Islam, Hasan, & Rahman, 2006). However, on the other hand, a critical view of empowering technology is the dark side of ICT usage by women, the gender-based issues that gain prominence in the digital world. There is an evident threat of gender inequality to widen as ICT diffuses across geographies because even "ICT is not gender blind" (Ibrahim & Adamu, 2016). For instance, the gender divide in terms of smartphone accessibility is dangerously skewed with as low as only 17 percent of women mobile subscribers (Rathee, 2018), in India, with Kenya and Tunisia being close followers (Silver et al., 2019). Sexual abuses and harassment happen predominantly in social media and through mobile phone communications. This evidence shows that the gender-focused studies on ICT usage cannot ignore the deep socio-political issues and historical culture of the economies in question, which leads to persistent gender discrimination. In this paper, we aim to critically examine the role of ICT in empowering women and investigate the persisting gender-based inequality through a review of the past ICT4D literature.

Past literature has focused on the provision of equal access to digital technologies to men and women, thereby establishing how ICT4D aids in reducing the gaping divide (Akubue, 2000; Danjuma, Onimode, & Onche, 2015). However, field studies reveal gender-related challenges in terms of operationalization of ICT4D projects due to the present inequality of access (Potnis, 2014). Though
gender-focused ICT studies largely identify ICTs in positive roles (Roberts, 2016; Seth et al., 2020), a rising number of studies now have raised the question of continued bias towards women even in the use and participation of ICTs (Moitra, Hassan, Mandal, Bhuiyan, & Ahmed, 2020; Potnis, 2014). Developing countries are often characterized by historic traditions that give rise to systematic gender bias, reinforced in the ICT usage scenario (Ibtasam et al., 2019). The gendered nature of societal problems of bias and abuse are often prominent in regions influenced by postcolonialism. Therefore, we argue that the ICT4Ds role should be critically analyzed since there is evidence of gender discrimination, in terms of ICT and social structures in these developing economies.

Critical research methodology aims to critically view and examine the status quo, the existing environment in which ICT is implemented, examining the orthodox traditions, historical social injustices, and deeply ingrained inequalities (De’, Pal, Sethi, Reddy, & Chitre, 2017). In this paper, we first develop a framework for critical research for gender studies and then analyze ICT4D initiatives using data from past literature. We aim to undergo a literature review to analyze the state of gender-focused studies in ICT4D literature and analyze the articles critically to identify the missing context of discriminatory roles of ICT. Based on the findings, we suggest a framework for the reference of future studies that reveals the various dominating themes of gender studies within the ICT4D domain, and how critical research methodology can be beneficial.

The following part of the paper includes the motivation, followed by the theoretical background, and the methodology. The preliminary results are given with discussion concluding the paper.

2. MOTIVATION: ICT4D FOR WOMEN

“Feminism is a social movement whose basic goal is equality between women and men. In many times and places in the past, people have insisted that women and men have similar capabilities and have tried to better the social position of all women…” (Lorber, 2001)

ICT4D promises eradication of gender inequality with greater freedom of expression and increased participation (Roberts, 2016). Interesting studies have reported that women spend more time on their mobile phones than men (Lemish & Cohen, 2005) and social media helped women protesters act at par with men (Newsom & Lengel, 2012). The variety of articles highlights the undeniably heroic role of ICTs in enabling women’s voices and increased access to various services, advancing women’s quality of life and social status (Ahmed et al., 2006).

In contrast, historically, information technology has reinforced gender discrimination, reported as early as the 1900s. Fewer women have exposure and literacy to computer usage due to distinctive absence of encouragement and support as their male counterparts, and face barriers to entry to Internet access just as a result of male dominance (Reisman, 1990; Spender, 1997). A critical view of empowering technology is the dark side of the ICT usage by women, the gender-based issues that gain prominence in the digital world. For instance, social media and mobile devices, while enabling women’s rights activists and women protesters to express their opinions, give rise to a disturbing phenomenon of sexual harassment and gender-based abuses (Andalibi, Haimson, De Choudhury, & Forte, 2016; Delisle et al., 2019; Global Fund for Women, 2015). Across online platforms, women are regular victims of digital sexual crimes like private surveillance, online stalking, threats and abuses, and exposure to offensive media content (Buni & Chemaly, 2014). Studies reported that almost half of the women using online dating face abuses (Odongo & Rono, 2017). Mobile devices have also acted as a rising medium for sexual harassment towards women (Hassan, Unwin, & Gardezi, 2018). Issues can often become as critical as leading to gender-based violence through ICTs (Thakur, 2018). The problems take a critical turn in conservative developing countries like India, Pakistan, Israel, and Indonesia, where women identity is defined by the conservative cultural structure of the societies (Barendregt, 2008; Dalal, 2008; Hassan et al., 2018; Lemish & Cohen, 2005; Thakur, 2018). This leads us to suggest a critical lens for the analysis of gender roles of ICT4D.
3. LITERATURE

The broader information systems (IS) literature has acknowledged the influence of gender on technology usage (Jackson et al., 2008; Trauth, 2013). The lack of female users and low women participation has dominated the concerns of IS researchers (Dholakia, Dholakia, & Kshetri, 2004). The gender bias extends to the under-representation of women in IT professions and education (Drury, 2011; Major, Morganson, & Bolen, 2013; McGee, 2018). The IT studies with gender focus are not limited to IS literature but extend to gender studies. The examination of such studies shows that there is a persistent influence of IT in widening the gender bias.

ICT4D literature, in general, has highlighted the power of ICTs in the elimination of gender biases, by bridging the divide (Obayelu & Ogunlade, 2006). Several ICT4Ds are specifically designed for the benefit of women beneficiaries (Seth et al., 2020). Community radio has been recognized as a communicative tool for local women through local appropriation, leading to effective participation (Asiedu, 2012). ICTs such as mobile phones and the Internet have been considered as instruments for advancing socioeconomic development, with implications for women concerning empowerment and employment (Danjuma et al., 2015).

Despite these benefits, the prominent gender digital divide constrains the inclusion of women and girls in participation in the ICT4D projects. ICT4D projects often fail to reach the women beneficiaries, though designed to include women empowerment, due to gender-based challenges including the non-usage of mobile phones by women (Potnis, 2014). The freedom to use ICTs become gender-biased significantly when observing the patterns through lenses of culture, religion, and traditions, particularly to the non-Western countries (Ibtasam et al., 2019). Further, ICTs have acted as empowerment only for the elite women, continuing to bar participation of the under-represented, as observed in the #MeToo movement on social media confined to the privileged class of women protesting against sexual harassment (Moitra, Ahmed, & Chandra, 2021; Moitra et al., 2020). These are indications of the gendered nature of ICT (Danjuma et al., 2015; Ibrahim & Adamu, 2016), but the field needs further examination through critical research to examine ICT4D adoption and the barriers for women in terms of low access, social bias, and misuse by sexual abusers (Hassan et al., 2018).

Keeping in mind that the mere introduction of ICT4D projects cannot eradicate the deep social structures of gender bias, we suggest that ICT4D needs a more significant critical stance to analyze its role using a gender-focused lens.

4. THEORETICAL BACKGROUND: CRITICAL RESEARCH

The critical research paradigm evaluates and critically analyses the social world and its structures (De’ et al., 2017). It deals with “…critiquing existing social systems and revealing any contradictions and conflicts that may inhere within their structures” (Orlikowski & Baroudi, 1991, p. 19). “For more than thirty years of critical research in information systems (IS) has challenged the assumption that technology innovation is inherently desirable and hence to the benefit of all” (McGrath, 2005). With unequal benefits for individuals across gender-based categories as our underlying assumption, critical research provides the appropriate ontology for data analysis (Brooke, 2002). Therefore, in this study, as we aim to examine the gendered nature of ICT4D, critical theory would serve as a tool to challenge the status quo of ‘ICT reducing gender divide’ and using social theories to reveal the underlying biases or challenges if any. The methodological phases of analysis for critical research in IS have been elaborated by Myers & Klein (2011), which we have followed for the analysis.

<table>
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<tr>
<th>Principle</th>
<th>Principles for Critical Analysis (De’ et al., 2017; Myers &amp; Klein, 2011)</th>
<th>Critical Analysis Principles for ICT usage by Women</th>
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sentangle the gender issues submerged in... a darker side of IT (Masiero, 2020).

A critical analysis would reveal both the positive and the darker sides of ICTs and women, bringing out the socio-political issues that give rise to certain disturbing results from an empowering technology (Andalibi et al., 2016; Munyua, Mureithi, & Githaiga, 2010). There has been evidence of gender implications for technostress as a darker side of IT (D’Arcy, Gupta, Tarafdar, & Turel, 2014). Critical research paradigm in information system research suggests six principles that encapsulate the involvement of concepts by social theorists, encourages evaluators to take a value position, and challenge pre-existing societal beliefs for further improvement of the society, through individual emancipation (Myers & Klein, 2011). Additionally, the principle of ‘provenience’ or the investigating of the local history, and the principle of ‘representation’ of how the lives of the (women) users are affected by the ICT, offers a deeper and stronger critical lens for the understanding of ICT4D (De’ et al., 2017). Additionally, there should be subaltern theoretical considerations, since most influential theories in the previous literature, originating predominantly in the West, often miss out on the nuances of the ‘Global South’(Masiero, 2020). Therefore, in this paper, we develop a framework for the evaluation of existing ICTs with the lenses of critical IS research for the

| Principle-1 | Using core concepts from critical social theorists | Gender Theories like Gender Essentialism, Feminism Theory, Critical Feminism, and Gender schema theory (See the list of Gender theories used in IS studies by Trauth, 2013), (Sen, 2001; Spivak, 1988) |
| Principle-2 | Taking of value position | Strong stand for equal rights of men and women through ICT; Gender-based biases need to be addressed |
| Principle-3 | Challenging prevailing beliefs and social practices | Challenge the notion that ICT empowers women and is free from gender discrimination |
| Principle-4 | Individual emancipation | How is the ICT providing scope of emancipation for women users |
| Principle-5 | Provenience or local history that gives rise to certain social conditions | Understanding the local history and gender-based culture of the society; What is the history of gender inequality in society? |
| Principle-6 | Representation of how ICT shapes the society | Has the diffusion of ICT reduced/enhanced the predominant gender divide in society? Does ICT hold special meaning to women and expression? |
| Principle-7 | Improvements in society | How the socio-political issues that give rise to dark concerns for women using ICTs can be addressed. |

Table 1. Framework for Critical Analysis of ICT Usage by Women

4.1. Framework for Critical Analysis

The framework for critical analysis of gender studies (Table-1) has been developed using the core principles of IS critical research by (Myers & Klein, 2011) for the stepwise guideline for analysis, with the inclusion of provenience and the structures of the social world (De’ et al., 2017). The first principle suggested by Myers & Klein, the identification of concepts by critical social theorists, will require the selection of feminist and gender theories for our framework. The existing theories often have a Western origin while missing the cultural and social issues characteristic of the post-colonial subaltrern world (Masiero, 2020). Therefore, we include the seminal theory by Spivak (1988) on the citizens of the postcolonial world and Sen’s capability approach (Sen, 2001) to understand freedoms and empowerment of women of the global south embedded in the deep social structures of years of systematic gender-based oppression. When the particular theory has been chosen for the analysis of specific ICTs, the next principles of ‘challenging prevailing beliefs’ and ‘individual emancipation’ will be directed by the theoretical stances. Individual emancipation can be established through deep analysis of the participation of women in terms of usage and individual benefits through the ICT. The examination of provenience becomes essential to disentangle the gender issues submerged in traditional layers of oppression, as the local history would reveal the gender-based culture and traditions. The final steps would reveal the impact of the ICT in terms of usage by women beneficiaries and greater societal development.

A critical analysis would reveal both the positive and the darker sides of ICTs and women, bringing out the socio-political issues that give rise to certain disturbing results from an empowering technology (Andalibi et al., 2016; Munyua, Mureithi, & Githaiga, 2010). There has been evidence of gender implications for technostress as a darker side of IT (D’Arcy, Gupta, Tarafdar, & Turel, 2014). Critical research paradigm in information system research suggests six principles that encapsulate the involvement of concepts by social theorists, encourages evaluators to take a value position, and challenge pre-existing societal beliefs for further improvement of the society, through individual emancipation (Myers & Klein, 2011). Additionally, the principle of ‘provenience’ or the investigating of the local history, and the principle of ‘representation’ of how the lives of the (women) users are affected by the ICT, offers a deeper and stronger critical lens for the understanding of ICT4D (De’ et al., 2017). Additionally, there should be subaltern theoretical considerations, since most influential theories in the previous literature, originating predominantly in the West, often miss out on the nuances of the ‘Global South’(Masiero, 2020). Therefore, in this paper, we develop a framework for the evaluation of existing ICTs with the lenses of critical IS research for the
developing countries (See Table-1). Reviewing past ICT4D literature and examining the ICTs across the global south, like social media, mobile phones, digital banking, etc., we critically examine its role in women empowerment and the reasons behind the negative concerns from these technologies.

5. METHODOLOGY
We conduct a systematic literature review of the past ICT4D studies, but do not confine our search to ICT4D or IS literature. We shortlist papers from various social and psychological domains, with the keyword search with variations of the phrases, 'gender and information technology', 'gender and ICT4D', 'women empowerment and information technology, and 'ICT4D and women'. The purpose is to select the various sub-domains of gender roles of ICT4D and examine them critically using the developed framework.

6. PRELIMINARY RESULTS OF CRITICAL ANALYSIS
The following six sub-domains emerged from the preliminary literature review of gender-based ICT4D studies.

(1) Social Media
Social media has played a significant role in enabling freedom of expression for women across the globe, including the developing countries (Newsom & Lengel, 2012). We will critically analyze social media usage by women, using the framework developed above. In the evaluation, we would investigate how social media has helped women express their views at par with men, but also made them vulnerable to women-focused crimes like online stalking and abuses (Buni & Chemaly, 2014; Newsom & Lengel, 2012). For instance, social media usage failed in the individual emancipation (principle-3) of the underprivileged women who did not raise their voices in the #MeToo movement (Moitra et al., 2020).

(2) Mobile Phones
Mobile phones are considered one of the most empowering ICTs for the marginalized sectors (Abraham, 2006). Mobile phones have enabled women to convey their romantic expressions through texts in conservative societies (Barendregt, 2008). However, at the same time, mobile phones take the form of an easy weapon for sexual harassment by men (Hassan et al., 2018). The investigation of mobile devices using the framework for critical analysis would reveal the deeper societal issues that give rise to such dark concerns. Mobile phones have also offered freedom to women (Sen, 2001) (Principle-1), and allowed them to express themselves, which is otherwise difficult in the society (Barendregt, 2008) (individual emancipation, principle-4), but also led to sexual abuses causing a similar fear of participation as in the existing conservative society (principle-6 and principle-7).

(3) Digital Banking
Digital and mobile banking offer socioeconomic development through greater financial inclusion(Donner & Tellez, 2008). The question of inclusion of women in the digital banking ecosystem, in countries like India and Kenya, with a wide gender gap for mobile phone users, is still unanswered. A deeper evaluation of the ICT through critical analysis would show where women stand in terms of financial inclusion and access to various financial services, including digital payment services. When analyzing through critical lenses, mobile banking offers financial freedom (Sen, 2001) (principle-1) to women, but a thorough examination of the literature would reveal the society-level reshaping and improvement (principle-6 and principle-7).

(4) Telecenters
Although telecenters are installed in countries in less-developed rural locations in Asia, Africa, and Latin America, some reports suggest gender inequality in the usage pattern of these ICTs, that stems from cultural norms and low decision-making power of women (Jorge, 2000; Kumar & Best, 2006;
Lwoga & Lwoga, 2017). A critical lens for analysis of various telecenter projects in developing economies will not only reveal the barriers and constraints faced by potential women users, impacting individual emancipation (principle-4), but also help in understanding the provenience of the culture and its effect on women participation (principle-5).

(5) **Healthcare Information Systems**

Women frequently seek health information from online healthcare systems (Warner & Procaccino, 2004). These systems help in both spreading awareness of female-specific ailments and offer online diagnostic support, as well (Bidmon & Terlutter, 2015). It would be interesting to critically evaluate the vast gender differences in the usage patterns of these systems, with women being the more regular users. Social issues like the difficulty of women visiting hospitals and difficulty in traveling could be underlying causes of this phenomenon.

(6) **Internet**

A critical analysis of the Internet using the framework would reveal the mass empowerment provided to women. The significant disparity in Internet adoption by the two genders (Dholakia et al., 2004) reveals the rising concerns due to the pre-existing social structures.

In summary, the various ICT4D artifacts that enable socioeconomic development including equality, when examined critically, may expose the dark side of ICT and its prevailing gender-based inadequacies. This paper aims to examine these various sub-domains within ICT4D through the critical theory framework developed.

7. **CONCLUSION**

A critical analysis of the various ICTs and their usage patterns by women helps in understanding the deeper social issues that give effect to the disparity across the genders. While ICTs offer empowerment to women through greater expression and easier access to various services, the wide gender gap and the gender-based offenses on digital platforms, expose the dark side of ICTs. How these issues can be addressed at the grassroots level is understood from the evaluation of the provenience and representation of women in the society through lenses of gender theories, as prescribed by critical theorists.

The critical examination of the ICT4D initiatives and women empowerment are examined through feminism and theoretical lenses that include the nuances of the global south. Often ICTs such as, social media and mobile phones offer freedom to women to express their thoughts and concerns (Sen, 2001), and result in individual emancipation, but may not transform into social improvement due to reinforcement of gender biases already in the historical traditions of the region. As we analyze the various ICTs through a critical framework developed based on De’ et al. (2017), Masiero (2020), and Myers & Klein, 2011), we reveal the power and underlying barriers to gender empowerment through ICT4D.

**REFERENCES**


Abstract: Premised on the logic that more, high-quality information on majority world women’s lives will improve the effectiveness of interventions addressing gender inequality, mainstream development institutions have invested heavily in gender data initiatives of late. However, critical empirical and theoretical investigations into gender data for development policy and practice are lacking. Postcolonial feminist theory has long provided a critical lens through which to analyse international development projects that target women in the majority world. However, postcolonial feminism remains underutilised for critically investigating data for development projects. This paper addresses these gaps through presenting the findings from a participatory action research project with young women involved in a gender data for development project in Bangladesh. Echoing postcolonial feminist concerns with development, the ‘DataGirls’ had some concerns that data was being extracted from their communities, representing the priorities of external NGOs to a greater extent than their own. However, through collaborating to develop and deliver community events on child marriage with the ‘DataGirls’, this research demonstrates that participatory approaches can address some postcolonial feminist criticisms of (data for) development, by ensuring that gender data is enacted by and for majority world women rather than Western development institutions.

Keywords: Data, gender, international development, postcolonial feminism, participatory action research

1. INTRODUCTION

Over the last ten years, mainstream development actors such as the UN, Gates Foundation and the World Bank, have all launched gender data for development initiatives. The argument made by these proponents of the ‘gender data revolution’ (Fuentes and Cookson, 2020) is, in the words of Melinda Gates (2016), that “we cannot close the gender gap without first closing the data gap”. This treatise is based on the belief that a “paucity of data hampers effective policy-making” in the first instance, and “hinders effective monitoring and accountability” in the second (Chattopadhyay, 2016: p.4). In other words, having the right data on women and girls’ lives should mean that development organisations can design projects that address gender inequality more effectively and evaluate these initiatives more accurately.

Yet despite the fact that numerous “powerful international development institutions have called for a ‘gender data revolution’” and the implications that this has for women and girls’ lives, as of yet there has been little critical academic study of this phenomenon, with Fuentes and Cookson’s (2019: p.881) paper the notable exception. In particular, empirical studies of development projects claiming specifically to collect digital data in order to close the ‘gender data gap’ and the ‘gender gap’ are lacking. Critical data for development (D4D) studies is an emerging field (Taylor and Broeders,
2015), as is data feminism (D’Ignazio and Klein, 2020). The former draws on critical development theory and concepts to analyse data for development projects, and the latter draws on critical feminist theoretical concepts to deepen our understanding of how data projects perpetuate intersectional gendered inequalities. Yet there is little overlap between the two nascent fields, with data for development projects specifically seeking to address gendered power relations receiving negligible critical attention. Postcolonial feminist theorists have been providing critical insight into the intersectional power relations inherent in development projects that target women in the majority world for decades. However, as of yet no academic research has been carried out taking a postcolonial feminist theoretical approach to the ‘gender data revolution’ in international development.

This paper addresses these gaps by presenting findings from a participatory action research study that collaborated with young women engaged in a gender data for development project in Bangladesh. The young women involved in the ‘DataGirls’ project felt that the data they were collecting should be shared with the community rather than extracted for use by external NGOs. However, whilst exploring ways to make the ‘DataGirls’ findings accessible to the community, it also emerged that the young women wanted to share different information than that which they had been tasked to gather by the ‘DataGirls’ project. These findings echo postcolonial feminist critique of mainstream international development interventions as perpetuating misrepresentations of majority world women and being aligned to the interests of development actors, thus furthering neocolonial and patriarchal power relations (Kothari, 2002; Syed and Ali, 2011). Through working in participation with some of the ‘DataGirls’ to share information on child marriage with their communities, the gendered subject they felt was most vital to address, the research detailed in this paper demonstrates that participatory approaches can enable gender data for development projects to be enacted by and for majority world women, thus responding to postcolonial feminist concerns, albeit within structural constraints.

2. POSTCOLONIAL FEMINISM AND DEVELOPMENT

Postcolonial feminists have addressed weaknesses in both postcolonial and feminist theory. Postcolonial theory has often neglected the ways in which “gender and sexuality are necessarily imbricated in colonialism and its legacies” (Chambers and Watkins, 2012: p.297). In response to this oversight, some postcolonial feminists have sought to bring women’s experiences of colonialism to the fore (Chaudhuri and Strobel, 1992, Jayawardena, 1992), whilst others have deconstructed the ways in which notions of femininity and masculinity in the colonial era shaped, and were shaped by, imperialism (McClintock, 1995; Sinha, 1995; Stoler, 2002).

As well as extending postcolonial studies, postcolonial feminist theorists have also highlighted the limitations of Western liberal feminism. For example, Spivak (1985: p.243) demonstrated how through upholding the notion of a transhistorical, singular ‘womanhood’ Western “feminist criticism reproduces the axioms of imperialism”. When white second-wave feminists proclaimed ‘sisterhood is global’ they negated the ways in which racism intersects with gendered oppression (Combahee River Collective, 1978; Lorde, 1979; Moraga and Anzaldua, 1983; Smith, 1983). Furthermore, Mohanty (1984: p.353) argued that where white Western feminists did try to represent women in the majority world, they often did so by collapsing their diverse experiences into a sole oppressed and vulnerable “third world woman”, a trope that through juxtaposition props up the equally untrue stereotype of Western women as “secular, liberated and having control over their own lives”.

These postcolonial feminist ideas have been very influential in critical development studies. Kothari (2002: p.48) notes that development studies is “replete with texts that present as homogenous diverse groups of people and practices, such as books on … gender relations in Sub-Saharan Africa”. Syed and Ali (2011) argue that present-day gender and development research and projects are the continuation of the colonial trope of the ‘white woman’s burden’, in which white Western feminists play the role of expert and ‘saviour’ to the majority world female ‘victim’, whilst ignoring indigenous women’s subject position and sense of agency. In Abu-Lughod’s (2002: p.789) words,
“projects of saving other women depend on and reinforce a sense of superiority by Westerners, a form of arrogance that deserves to be challenged”. After all, as Trinh (1989) notes, the power that women in the West have to study and intervene in the majority world is not often possible the other way around. Sardar (1999) agrees that it is in the ability to define, represent and theorise about the majority world that neo-colonial power truly lies.

In response to these postcolonial feminist critiques, some academics working in the majority world on international development related issues have sought to find other ways of knowing and being beyond Eurocentric narratives, for example through making space for majority world women to speak and represent themselves, so that the “material complexity, reality and agency of Third World women’s bodies and lives” can be re-established (Mohanty, 2003: p.510). For some, such as Miles and Crush (1993), this has meant engaging in life history research with women in the majority world “as a way of recovering hidden histories, contesting academic androcentrism, and reinstating the marginalised and disposed as makers of their own past”. They have also tried to develop new ways to ‘speak with’ rather than ‘to’ or ‘for’ the people with whom one is engaged in research”, leading to the rise in popularity of participatory development approaches (McEwan, 2001: p. 102). For example, Segebart adopted a participatory approach in her research into the monitoring of municipal development plans in the Brazilian Amazon as a way to “respond to feminist (and) postcolonial claims of decolonising and breaking down hierarchies of knowledge production” (Schurr and Segebart, 2012: p. 148).

It is this last point, that engaging in participatory development work can respond to postcolonial feminist criticisms of international development, that this paper builds upon. As Asiedu (2012: p.1200) argues, postcolonial feminist theory and critique is largely absent from ICT4D scholarship, despite the fact that it can “offer important ideas to address gender and ICT issues facing the global south”. More recently, Narayanaswamy (2016) has utilised postcolonial theory to critically examine the Knowledge for Development (K4D) paradigm, including the way that the discourse constructs women in the majority world as possessing a ‘knowledge deficit’ that requires training and access to ICTs led by Northern-based development experts. De et al. (2018) also draw from the work of postcolonial feminist Gayatri Spivak’s ideas about the subaltern voice to advocate for using local languages rather than defaulting to English as the main operating language in ICT4D. However, there remains a wide scope for new work on ICTs and development that draws upon the wider postcolonial feminist canon. For example, just as there is little scholarship on ‘gender data for development’ projects in general, as “feminist and postcolonial scholarship and data studies remain as largely unconnected fields with little cross-fertilisation” (Leurs (2017: p.134), there is also an absence of work analysing the rise of gender data for development from a postcolonial feminist perspective.

Therefore, what follows is a postcolonial feminist analysis of a participatory action research intervention into a gender data for development project with young women in Bangladesh. This paper provides a detailed account of the participatory process that was undertaken, the findings of this process and also reflections upon the extent to which taking a participatory approach to gender data for development addressed postcolonial feminist concerns about development.

3. METHODOLOGY

The empirical data drawn upon for this paper was collected and analysed as part of the author’s PhD. The methods utilised included six months of participant observation of an NGO project in Bangladesh, as well as 77 interviews, two participatory workshops and three community events with some of the stakeholders engaged in the project. This research was carried out from April to June, and September to December 2019. The interview and participatory workshop data were translated and transcribed with the help of two research assistants. These transcripts, as well as the participant observation research diary, were analysed in line with Carney’s (1990 in Miles and Huberman, 1994: p.2) ‘ladder of analytical abstraction’, moving from summarising and packaging the data through In Vivo and evaluative coding, through to repackaging and aggregating the data by collating and
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synthesising emerging themes, before constructing an explanatory framework through mapping these themes against the literature to draw conclusions.

‘DataGirls’ - the project on which this research was carried out - was an international government funded intervention designed by a UK head-quartered multinational NGO and delivered in partnership with an implementing Bangladeshi partner NGO. Commencing in 2018, and lasting for two years, this project entailed recruiting and training 48 young women (aged 16 – 19) from four different regions of Bangladesh to become smartphone-based digital data collectors. These young women were given smartphones with a research application uploaded onto them, through which they were set various data collection tasks. These data collection tasks were carried out for five other multinational NGOs engaged in work with girls in Bangladesh, and the topics were decided by these organisations in discussion with the ‘DataGirls’ NGO staff based in the UK and Bangladesh. The ‘DataGirls’ were paid for their data collection work, and were awarded with a Market Research Society qualification in digital research.

4. FINDINGS

This paper presents the findings of a participatory action research collaboration with 10 of the ‘DataGirls’ in Bangladesh. We collaborated to address one of the concerns that the young women had raised regarding ‘DataGirls’: the fact that the gender data they gathered on behalf of external NGOs was not shared with the community from whom it was extracted. Through working together to try to address this and ‘close the loop’ of the gender data, it also emerged that the young women felt there were other topics that they would prefer to share information on with their communities rather than those that they had been assigned to collect. Engaging in this participatory process with the ‘DataGirls’ therefore brought two key critical questions to the fore: 1) Who is gender data for?, and 2) Who is gender data by?. If gender data for development projects are not by and for majority world women, but are instead by and for international NGOs, then this perpetuates the colonial and patriarchal power relationships that postcolonial feminists have criticised international development for furthering. As such, this paper provides empirical evidence that strengthens the argument that participatory approaches can go some way towards responding to postcolonial feminist concerns about (data for) development. However, as the discussion section will argue, participatory development practices can go some way towards responding to postcolonial feminist critique but cannot alone dismantle the structural global power relations which continue to oppress majority world women and create the conditions for data-led ‘development’ in the first place.

4.1 Gender data for whom?

A concern that many of the ‘DataGirls’ raised was the fact that the data that they gathered on behalf of the NGOs was not fed back to them or the wider community:

Me: “Do you know about the results of the [project] research?”

Lamia: “No, all the information goes straight to the office”

Me: “Do you want to know?”

Lamia: “It would be good, because I would know how well I had done through them … how much all of the things are improving”

As this interview excerpt with Lamia, one of the ‘DataGirls’, demonstrates, the young women involved in this gender data for development project wanted to know the results of the research that they had carried out. In part they wanted to see the data so that they could ‘know how well’ they had done and therefore assess their own performance as a digital data collector. However, they also wanted to know the findings so that they could know ‘how much all of the things are improving’ – i.e. so that they too could understand what topics people in their community felt positively about, as well as issues that needed attention. As one of the other ‘DataGirls’, Rakiba told me:

2 Pseudonyms have been used for all participant names for anonymity purposes

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“Sister, we cannot get the right idea about the problem without research. Suppose there is shortage of drinking water in the community but after research we can know that the main problem is food scarcity - so research is best”

Whilst Lamia, Rakiba and many of the other ‘DataGirls’ were interested in having the findings of the data that they had gathered returned to them, they did not only want this data to be shared with themselves alone. The ‘DataGirls’ also felt that it was important for the wider community to have access to the information gathered during the data collection, so they too could have their ‘awareness raised’. The ‘DataGirls’ told me that one of the main positive outcomes of the ‘DataGirl’ project for the wider community was that those that they collected data from had gained useful information whilst being interviewed:

“We talk to them regarding the things we were trained on. We explain the topic to them. For instance, there were two topics called Food and Nutrition 1 and Food and Nutrition 2. So, girls in our locality didn’t know much about food and nutrition. When we were made to research on it, we spoke to the girls about these things, and so they got to know these things from us. And then we found out information about them that we hadn’t known. Added together, the whole of it was great. When we sent the recordings to our seniors, they understood the whole picture” (Fahima)

However, as the ‘DataGirls’ only gathered data from a few people from their local community, selected by the project staff in line with their sampling criteria, they told me that they also wanted the ‘DataGirls’ research topics to be shared more widely with those living in their local area:

“The main purpose of TEGA is to raise awareness and help the girls. So, in this case if the parents and elderly people are given training on this context then I think it would be helpful” (Anika)

“If a meeting was held with the parents in the village and topics like child marriage, eve teasing or other such topics were discussed, they would also realise that girls just don’t sit at home anymore they are able to go forward. They can study and then get jobs. Through these kind of meetings awareness will grow amongst the parents and they’ll encourage their daughters to study” (Razia)

This call from the ‘DataGirls’ to have the data that they had gathered on behalf of NGOs about girls and gender equality issues fed back to them and their communities, rather than remaining solely in the hands of these external organisations for their organisational uses, is in line with debates taking place within the data for development literature (e.g. Thatcher et al. 2016; Albornoz et al. 2019; Mann, 2017). As Narayanaswamy (2016) asks in her postcolonial feminist critique of extractive ‘knowledge for development’ practices, if knowledge is power then “why should only the Northern technical expert hold knowledge?”.

Building on this, I decided to organise a participatory action workshop with the young women in one of the four ‘DataGirls’ networks to explore further, and hopefully develop some solutions to, this issue of ‘closing the gender data’ loop. My research assistant and I travelled to Northern Bangladesh in October 2019 to meet with 10 of the ‘DataGirls’. Originally there had been 12 in this network, but one (Tasnina) had given birth recently, and another had married and left the project earlier in the year. The location for the workshop was a local government hall equidistant from the three villages where the 10 ‘DataGirls’ lived. The reason that this network was selected, instead of the other three networks, was due to the fact that this concern about the need to share the findings of the data collection with themselves and the wider community had been raised most often by the young women in this network. The workshop lasted from 9.30 am to 4 pm.
In line with the aim of participatory research, which is that the participants rather than the researchers should take the lead (Manzo and Brightbill, 2007), the workshop consisted of various different participatory activities designed so that the young women could take centre stage whilst myself and my research assistant played the role of “conduits, channelling perspectives and voices which would otherwise remain silent” (Gillies and Alldred, 2012: p.49). One of these activities involved making posters on the ‘DataGirls’ research topics. The ‘DataGirls’ in this network had collected data on three different topics (girls’ access to economic opportunity, knowledge of digital financial services, and pregnant adolescents’ nutritional knowledge) for three different NGOs. Prior to the workshop my research assistant had translated the final reports, written by the NGO for the NGO clients whom the data was gathered for, from English to Bangla. A copy of these was given to each of the ‘DataGirls’ for them to read and keep. In three groups the ‘DataGirls’ created colourful posters exploring these findings, before presenting them to the rest of the group. In the group discussion following the presentations the young women said that the findings in the final reports matched well with what they had remembered from their interviews with the research participants. They also felt strongly that these results should be shared with the rest of the community.

This further confirmation that the ‘DataGirls’ wanted to share the findings of the data they had gathered back with their communities from whom it was gathered then progressed to the next stage of the participatory action workshop – the ‘DataGirls’ deciding what data they would like to share.

4.2 Gender data by whom?

The next part of the participatory workshop focused on this question – what information did the ‘DataGirls’ most want to share with their communities? The young women all wrote on a post-it note the one topic that they would most like to share with their community. They stuck their post-it notes to a big piece of paper and this was held up so that everyone could see. ‘Child marriage’ was voted for the most times, followed by ‘Girls Education’. One young woman put ‘Child labour’ and one put ‘Dowry’. What stood out from this exercise was that the topics which the ‘DataGirls’ had chosen were not those that they had been collecting data on for the external NGOs, but were other topics that they felt were more important to share:

Tasnia: We all want [the project] to improve even more … if some more work could be done on child marriages …

Me: What sort of work?

Tasnia: I mean also awareness like parents and everyone becoming a little more aware - I think it would be improved.

Me: What sort of work on awareness?

Tasnia: Awareness that girls should not be married off at a young age, that they should study, help their parents, they should work and gain independence. So that they can lead their lives independently … explaining it to them and, like, maybe conducting a training for the parents or through a meeting, explaining it to them.

The fact that the young women had chosen different subjects, such as child marriage, rather than the ones that the NGO had tasked them to collect data on reflects postcolonial feminist critiques of the misrepresentation of women in the majority world. Postcolonial feminist scholar Chandra Talpade Mohanty (1988:334) in her seminal piece ‘Under Western Eyes’ rails against the way that Western feminist texts have “discursively colonize[d] the material and historical heterogeneities of the lives of women in the third world, thereby producing/re-presenting a composite, singular "Third World Woman". As geographer Joni Seager (2016) points out:

“women in poor countries seem to be asked about 6 times a day what contraception they use …. But they are not asked about whether they have access to abortion. They are not asked about what sports they like to play”
Rather than be (mis)represented by more powerful others, however, the ‘DataGirls’ were able to choose collaboratively the information about girls that they wanted shared with their communities during this participatory process. Through a group discussion the ‘DataGirls’ decided that they would all like to work on one topic together, and that they would select the most voted for topic – child marriage. They also chose community events as the method to disseminate information by, to which the local people and also the chairpersons of each area would be invited. Crucially, the young women wanted these events to take place three times, once in each village so that each community could benefit equally. The workshop ended with us agreeing that we would all meet again to decide on and prepare the content of these community events.

This second participatory workshop took place in November 2019. The day began with participatory diagramming, with the ‘DataGirls’ writing down what they wanted their communities to know about child marriage, including their own personal views and experiences, or those of people that they knew. Two of the ‘DataGirls’ present had been married before the age of 18, and shared their own experiences with the rest of the group:

“I married into a good family so I didn’t face too many difficulties. I think it’s good that I got married because I was experiencing a lot of eve teasing, but that stopped after I got married. And because I married into an educated family I was able to stay in school, but that’s not possible for most girls when they get married” (Moriam)

“I am still studying too so I am happy … but I have more responsibilities now, like looking after my in-laws” (Farida)

Tansina, the ‘DataGirl’ who had recently had a baby and so had not been able to attend, had also married before she was 18. As the discussion continued, the rest of the group said that this was a more typical case of child marriage – she had been having an ‘affair’ with her now husband, so her father had insisted that she married him. However, after the marriage her husband and in-laws began treating her badly, including restricting her freedom of movement, and they did not want her to participate in ‘DataGirls’ anymore, or continue her education. The group concluded that early marriage is different for different young women, but that these issues were common in most cases they had seen in their communities. They agreed that they wanted to share some of these experiences in their community events, highlighting the challenges young women in their villages faced. We worked together to create a powerpoint on the project laptop that the District Officer of the ‘DataGirls’ programme had brought to the session. This would be projected onto a screen for the community engagement. The ‘DataGirls’ selected key information to share, and included a 4 minute World Bank video from YouTube called ‘Our Daughters’ which tells the story of a young woman in Bangladesh being forced to marry and drop-out of school against her will. In their village groups the ‘DataGirls’ also chose one of them to present a speech written together during the session. They also asked if the ‘DataGirls’ District Officer, me, and whichever local officials who attended would also give short speeches.

The ‘DataGirls’ concluded that the community events turned out to be a success. They were happy with the turnout (55, 65 and 25 attendees respectively) and that the attendees were a mixture of ages and gender identities. In two of the villages this was the first community event there had ever been on child marriage. In the village where there had been workshops on child marriage before, the ‘DataGirls’ said that they had not been well received in comparison to their own sessions. When I asked why they felt this to be the case they said that this was because the previous events had been one-way lectures, that had no room for open discussions. By comparison, their events had had time for questions and debate following their presentations and speeches. Other aspects that the ‘DataGirls’ said had made their events a success was the use of digital technology, which they felt engaged people to a greater extent, the inclusion of male as well as female community members, the fact that they had shared good quality information in a personal and engaging way and that they had given participants a chance to share their views and opinions, rather than just being spoken to. Only one of the three village chairmen attended, but the ‘DataGirls’ said that there were positives
and negatives to this. On the positive side, the chairman’s attendance meant that he had heard local people’s views, and had made a speech against child marriage which the ‘DataGirls’ felt would have a big influence on child marriage rates. On the other hand, the two events without the presence of the local chairman had livelier, more extensive community debates, which the ‘DataGirls’ felt were very important, and meant the events had a “good hype” and would be talked about for days to come.

5. DISCUSSION AND CONCLUSIONS

This paper has provided empirical evidence that suggests that taking a participatory approach to gender data for development can address some longstanding postcolonial feminist critiques of international development. Participatory research emerged out of the desire to “break the monopoly on who holds knowledge and for whom social research should be undertaken” (Fine, 2008: p.215), aiming to do research ‘with’ rather than ‘on’ people, producing findings that not only directly benefit the participants but also fairly represent them (Cahill, 2007). Resonating with postcolonial feminist concerns about international development interventions being led by and for development actors, thus perpetuating misrepresentations of majority world women as well as neo-colonial and patriarchal power relations, the ‘DataGirls’ also felt that the project did not gather the gender data they felt was most important to them and their lives, and that it extracted information from their communities rather than sharing knowledge equitably. Engaging in the participatory action research process together not only enabled these issues to be discussed and brought to the fore – it also meant that the ‘DataGirls’ could work together to gather information on child marriage, the subject they felt was most critical to them and their lives, and to develop and deliver community events to share this ‘gender data’ with those in their local area. As such, based on these findings, it can be concluded that as a participatory approach shifts gender data for development so that it becomes led by and for majority world women, rather than by and for Western development actors, it can address some postcolonial feminist critiques of (data for) development.

Yet it would be naïve to claim that a short-term, small scope participatory action project such as this provides the simple, instrumental resolution to neocolonial and patriarchal power relations. As Cahill (2007: p. 299) writes “we need to be wary of broad applications of the term ‘participation’ because it often masks tokenism and the illusion of consultation that may, in fact, advance dominant interests”. Whilst I facilitated this participatory research with the ‘DataGirls’ with the best of postcolonial feminist intentions, in practice it cannot be denied that it replicated some of the problematic aspects of mainstream international development that we sought to disrupt. For example, the participatory process not only provided space for the ‘DataGirls’ to enact their agency to address some of their concerns with the programme – it also provided findings for my PhD, thus arguably furthering the long history of Westerners profiting from the testimonies of majority world women (Trinh, 1989). As Heeks (2017: p.5) has argued data justice is unavoidably structural. It is impossible for postcolonial feminist data for development, no matter how participatory, to exist in a neocolonial, patriarchal world. However, despite these limitations this paper has provided an empirically substantiated critique of mainstream gender data for development practices, and demonstrated the extent, however limited, to which participatory gender data that is by and for majority world women can address these concerns. These findings therefore contribute to the ongoing debates regarding the role of data and development in bringing about a gender equitable and just world, with implications for future development research and practice.

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KEY LESSONS LEARNED FROM WORKING DURING COVID-19 ON A PROJECT IN THE WORLD'S BIGGEST REFUGEE CAMP

Faheem Hussain, Arizona State University, USA, faheem.hussain@asu.edu
Suzana Brown, SUNY Korea, South Korea, suzana.brown@sunykorea.ac.kr

Abstract: Using a case study structure, this research-in-progress paper elaborates the struggles of working on a humanitarian project during the Covid-19 period. The authors identify six specific challenges and propose innovations to address each of these challenges. The challenges are the following: supply chain, design of solutions, human resource development, connectivity, and user data collection. This unprecedented situation has been a testing ground for new innovative solutions for work in conflict zones.

Keywords: refugee, Covid-19, conflict zones

1. INTRODUCTION

This "research-in-progress" paper is based on the findings from ongoing humanitarian technology research in the world's biggest refugee camp for Rohingyas, on the border between Myanmar and Bangladesh.

2. BACKGROUND

Rohingyas are arguably the most persecuted people at present with the majority of them living as refugees in Bangladesh, after fleeing the systematic ethnic cleansing in their native country Myanmar. Out of the 1.3 million Rohingya refugees in Bangladesh, many are facing challenges with physical mobility. The main cause behind such disabilities among Rohingya refugees is little or no health services in their native villages in Myanmar and long-term injuries sustained while fleeing the conflict.

Rohingya camps are located in the second poorest district in the country, Cox’s Bazar (Vince, 2019). The refugees live on a deforested hillside, densely packed, sleeping on mats in shacks made from plastic woven walls and roofed with plastic sheets. The refugee “city” has very few latrines and freshwater standpipes (Vince, 2020).

In addition, the standard request during Covid-19 to socially distance is nearly impossible in those camps (Raju, & Ayeb-Karlsson, 2020). Refugee camps and slums are constructed as temporary places with very little extra space. Refugees already make up a vulnerable segment of society and people residing in refugee camps have a higher risk to be affected by an outbreak of Covid-19 (Vonen et al., 2020).

In such an environment and during the current pandemic, a research group from SUNY Korea, Hellenic Mediterranean University, and Arizona State University are working in collaboration with a partner NGO of Bangladesh, Young Power in Social Action (YPSA) to address this accessibility issue. The team is currently developing and testing an alternative design for the rubber shoe of mobility aids such as crutches and canes. This cost-effective design would function better in challenging environments such as unprepared and unpaved surfaces. The team estimates this new design will allow users to navigate with increased stability and thus result in an improved quality of life.
3. METHODOLOGY
Using a case study structure, this research-in-progress paper elaborates these aforementioned struggles and innovations to address each of these challenges. Beyond this specific project, this paper aims to contribute to the ongoing conversation on conducting international field research during the time of COVID-19. This research recommends a set of action items to overcome some of the major obstacles against humanitarian technology field research in #NewNormal.

3.1. Supply chain
This project was based on the use of 3D printers which are novel for the Bangladeshi location. In relatively normal times this issue would have been overcome with an import from either China or India. During Covid-19 not only travel but also distribution of goods has been disrupted with essential supplies having priority. After several months of intense negotiation, one 3D printer was imported from China during a period when the government relaxed restrictions on imports.

3.2. Solution design
Engineers and designers were not able to go to the field as planned and furthermore, they were physically distributed between 3 countries with variable travel restrictions. Quarantine made it impossible for them to travel even if allowed by the local authorities. Even within the country travel was difficult which limited local partner movement to and from the camp areas.

3.3 Human resource development
The initial plan was to have face-to-face training which had to be redesigning to online training. Because of the different time zones many of the sessions had to be asynchronous.

3.4 Connectivity
Bangladesh has relatively poor connectivity but the refugee camps have zero connectivity. Research team members had to employ some novel approaches in communication that could later be used in some other conflict zones with zero connectivity.

3.5 User data collection
Data collection and user feedback had to be reinvented and low-end smartphones have been used to record videos from the field for researchers to be able to evaluate their product.

3.6 Unpredictable policy changes
Finally, constant policy changes in almost every country made it impossible to make longer-term plans. Those include regulations regarding access to the camp areas; who is allowed to visit the host communities; regulation regarding shipment during COVID-19, etc.

4. CONCLUSIONS
Research centered on a humanitarian project poses its own challenges. However, during a health pandemic, all the attenuating circumstances are becoming more complicated. In this short "research-in-progress" paper we inform readers about a number of issues arising while conducting international field research during the time of COVID-19 in the world's largest refugee camp in Cox’s Bazar, Bangladesh. We group those issues as follows: supply chain, connectivity, human development, unpredictable policy changes, user data collection, and solution design. In our future work, we will present insights on if and how such issues have been resolved.
REFERENCES AND CITATIONS


Abstract: Information and communication technologies (ICTs) have increasingly become vital for people on the move including the nearly 80 million displaced due to conflict, violence, and human right violations globally. However, existing research on ICTs and migrants, which almost entirely focused on migrants’ ICT use ‘en route’ or within developed economies principally in the perspectives of researchers from these regions, is very fragmented posing a difficulty in understanding the key objects of research. Moreover, ICTs are often celebrated as liberating and exploitable at migrants’ rational discretion even though they are ‘double-edged swords’ with significant risks, burdens, pressures and inequality challenges particularly for vulnerable migrants including those forcefully displaced and trafficked. Towards addressing these limitations and illuminating future directions, this paper, first, scrutinises the existing research vis-à-vis ICTs’ liberating and authoritarian role particularly for vulnerable migrants whereby explicating key issues in the research domain. Second, it identifies key gaps and opportunities for future research. Using a tailored methodology, broad literature relating to ICTs and migration/development published in the period 1990-2020 was surveyed resulting in 157 selected publications which were critically appraised vis-à-vis the key themes, major technologies dealt with, and methodologies and theories/concepts adopted. Furthermore, key insights, trends, gaps, and future research opportunities pertaining to both the existing and missing objects of research in ICTs and migration/development are spotlighted.

Keywords: ICTs and migration; information and communication technologies and migration; digital technology and migration; ICT4D and migration; technology, vulnerable migrants, risks, burdens, pressures, and inequality; technology and migration literature review; ICTs and migration literature review; ICTs and refugee literature review

1. INTRODUCTION

Despite a 27 per cent slowdown precipitated by COVID-19, as of 2020, over 281 million people including around 80 million displaced due to conflict, violence and human right violations—of which around 34 million are border crossing refugees and “asylum seekers”—are on the move (UN DESA, 2020; UNHCR, 2020). Meanwhile, information and communication technologies (ICTs) or ‘digital technologies’ are increasingly becoming an integral part of the dynamics. ICTs, primarily mobile phones and the internet, are significantly affecting contemporary human mobility and migration, labour and resource flows, globalised economy and information sharing. As such, these technologies have become essential components in the lives of people on the move especially vulnerable migrants such as the displaced, trafficked or exploited, as well as their families and networks in all stages of migration—pre-migration, migratory journeys, (re)settlement/“integration” and return migration (Hamel, 2009; Massey, 2009; Surak, 2017). Descriptions such as the “connected migrants” (Diminescu, 2008), “digital migrants/diaspora/refugee” (Everett, 2009;
Jumbert, 2018), “mediatized migrant” (Hepp et al., 2012) and “connected presence” (Licoppe, 2004) all reflect the entwinement of these technologies with migrants. Advances in these technologies have increasingly complicated people’s movements and connections to more circulatory, complex, dynamic, fluid and unpredictable patterns (Castells, 2011). The distinction between mobility and migration as well as other related concepts such as migrant, foreigner, immigrant, diaspora, nomad, refugee, asylum migrant, (internally) displaced person (IDP), irregular migrant, economic migrant and even sedentary (Douglas et al., 2019) has become more fuzzy and problematic (Crawley & Skleparis, 2018).

Recently, interest in this entwinement of ICTs and migration/development has enormously increased among academics, civil society organisations, international agencies, and governments. Although explicit research on migrants’ use of new ICTs can be traced back to at least the 1990s, the area still remains young demanding more research (Andersson, 2019). This could be attributed to the ever-changing complexity and dynamism in the way people move, interact, and connect amidst the rapid shifts and changes in technology and innovation. Existing research in ICTs and migrants—which is almost entirely focused on migrants’ use of technology ‘en route’ or within countries with developed economies (“Global North”) principally in the perspectives of researchers from these regions—remains very fragmented. Furthermore, the increasingly used phrases such as “migrant tech” and “refugee tech” are so rosy celebrating ICTs as liberating and utilisable at migrants’ discretion and rational choice despite the reality that they are ‘double-edged swords’ with significant risks, burdens, pressures and inequality challenges particularly for vulnerable migrants.

This paper attempts not least a twofold contribution to ICTs and migrants’ research towards addressing the aforementioned limitations. First, it scrutinises the status quo of such research vis-à-vis the liberating and authoritarian power of ICTs particularly for vulnerable migrants whereby explicating key research objects for future theorisation. Second, it identifies key gaps and opportunities for future research. To this end, broad literature relating to ICTs and migration/development published between 1990 and 2020 was surveyed producing 157 selected publications—not all are cited in-text for brevity and space/word limitation but they are outlined in Table 1. The selected literature was critically appraised vis-à-vis the key themes, major technologies dealt with, and methodologies and theories/concepts adopted. Key insights and trends were also gleaned.

Traditionally, mobility has been understood as a transitory movement of people (also capital, goods and services) in the course of their everyday life including livelihood mobility (Benz, 2014; Steel et al., 2017) and residential mobility (Cooke & Shuttleworth, 2018); and migration as a permanent change of location often between countries or urban-rural areas (Gmelch, 1980). Various parties adopt their version of migration-related concepts for their purpose (such as legal, administrative, academic and statistical) informed by spatial, temporal, methodological, legal, cultural and political factors (IOM, 2007; 2019). Attributes such as places of birth and residence, legal rights and citizenship and length of stay influence the way these concepts are defined and used. As Sironi et al. (2019) affirm, such definitions are sometimes ‘inclusivist’ and other times ‘residualist’ (exclude some parties such as those who flee war or persecution). For example, the UN agency, IOM defines migration as:

A process of moving, either across an international border, or within a State. It is a population movement, encompassing any kind of movement of people, whatever its length, composition and causes; it includes migration of refugees, displaced persons, uprooted people, and economic migrants (IOM, 2004, p. 41).

Similarly, according to the 1951 Geneva convention, ‘refugee’ is defined as:

A person who, owing to a well-founded fear of persecution for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his [sic] nationality and
is unable or, owing to such fear, is unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it (IOM, 2021).

This paper primarily focuses on vulnerable migrants such as those displaced, trafficked, and exploited notwithstanding the problems associated with labelling and attempting a clear-cut distinction between different “types” of migrants noted earlier. The author believes that this work is the first overarching rigorous analysis of ICTs and migrants; notwithstanding some related work—for example, Brown et al. (2019) reviewed 35 papers on refugees’ ICT use; Collin et al. (2015) identified three research areas in migrants’ ICT use—to prepare for migration, to maintain link and variation in use; Chonka & Haile (2020) reviewed literature relating to the role of ICTs in mobility and migration pertinent to the Horn of Africa; and Andersson (2019) overviewed “diaspora” and new media use. This analysis has the potential to substantially inform future research and policy; and shed light on the importance of ICTs, mobility, and migration for ICTs for Development (ICT4D) research.

Following this introduction, Section 2 presents the methodology devised and used. Sections 3 and 4 respectively elucidate empirical evidence, methods, trends, and insights on the liberating and constraining power of ICTs for migrants based on the existing literature; followed by Section 5 which denotes the gaps and future research opportunities. The paper ends with a short concluding remark in Section 6.

2. METHODOLOGY

This section presents a short discussion of the methodology adopted (See ‘Appendix I’ for the detailed methodology). To add rigour, a literature review strategy that draws mainly on Fink (2019), Gall et al. (1996), Geldof et al. (2011), Iden & Eikebrokk (2013), Labaree (2020), Okoli (2015), and Okoli & Schabram (2010) was devised to identify, collect, evaluate, select and analyse the literature. The selected literature was pooled from diverse areas related to ICTs, migration and development. These include media and communication, information systems, information and communication technologies, information and communication technologies for development (ICT4D), migration/mobility, diaspora, transnationalism, development studies, law, geography, economics, sociology, anthropology and history.

A mix of material accessed through searching catalogues, electronic databases, academic journals, conferences, and search engines principally Google (Scholar) was analysed. While the review mostly focused on peer-reviewed published academic work (mainly from 20 journals), other relevant grey literature such as practitioner reports, policy documents, working papers, theses as well as books were also considered. While this review may be considered as primarily integrative with historical, theoretical, methodological, systematic and argumentative features (Labaree, 2020; Okoli, 2015), I purposely avoided using the commonly used adjective “systematic” to describe it. This is due to the inherent limitations of the so called “systematic” literature review particularly in the context of multidisciplinary social science reviews conducted by limited reviewers within a constrained timeframe which may lead to exacerbated generalisations. While this analysis was conducted by a single reviewer as part of doctoral research, to minimize ‘reviewer bias’, a stringent review procedure was followed, extended time (around 18 months) was allowed, and the work has gone through several iterations based on feedback from four experienced academics. However, while the approach adopted here resonates with the “systematic” literature review techniques, I, by no means, claim the review to be exhaustive to generate definitive generalisations and bias free.

Generic themes and topics were identified using a hybrid of manual and software-assisted automated inductive coding. The first set of themes and topics were manually identified by reviewing 117
papers selected from the initial relevant literature retrieved by searching databases using the combination of keywords that represent all key concepts, i.e., digital technology/ICT, migration, and inequality/development. However, as the keyword search strategy was expanded and the themes started to recur, inspected automatic coding was considered for the additional literature. Consequently, all of the selected publications including those manually thematised were imported to ‘NVivo 12 plus’ content management and analysis software package and coded inductively. After a careful manual review and validation of the automated coding to address limitations associated with algorithmic evaluation, themes emerged from the manual analysis and from the automated coding were compared, collated, merged, and refined resulting the key themes. The main themes emerged are organised and examined vis-à-vis ICTs’ liberating and tyrannical role for migrants as follows.

3. THE LIBERALITIES OF ICTS FOR MIGRANTS

In most literature, ICTs are viewed as liberating for migrants with little or no consideration to their negative aspects. This section scrutinises such literature with respect to four themes which emerged in the analysis; the facilitating role of ICTs for: “diasporic”, transnational, and familial connections; planning and execution of migration; migrants’ “integration”; and migration-related livelihoods.

3.1. ICTs for facilitating “diasporic”, transnational, and familial connections

While concentrated in the contexts and perspectives of the “Global North”, a relatively large and relatively established body of literature explores how the “diaspora” or transnational community often settled in “Western” countries are connected. It underlines how ICTs have provided a platform for migrants to stay connected with their family and community whereby maintaining their culture and identities and transnational ties; although ICTs are mostly implicit (Hall, 1990; Levitt and Jaworsky, 2007). Such literature examines how ICTs enable the broader multifaceted connection between migrants, their network and environment, and how familial relationships, intimacies and responsibilities have been facilitated (See Table 1).

For example, researchers such as Diminescu (2008), Hamel (2009) and Lim et al. (2016) emphasise how ICTs enable migrants to “circulate” while creating and maintaining near and distant connections. Sayad (2004) highlighted how ICTs are increasingly transforming the “twofold absence” of migrants to a dual and concurrent presence of ‘here and there’. Be it simple “conversational” to substitute absence or “connected” to ensure a continuous virtual presence (Diminescu, 2008), this literature reflects migrants’ continuous exploration and utilisation of ICT including for familial relationships and intimacy.

Familial solidarities, shared commitments and familyhood have been manifested differently including by proxy—representational objects or persons compensating for the absent person, physically, or through imagined co-presence (Nedelcu and Wyss, 2016). These are extended and become more and more realistic amid advances in ICTs whereby emotions, care and support are being exchanged at a distance such as via live video calls. Some scholars have explored how ICTs are increasingly being used to “do” and connect to family, give care at a distance, and share resource, emotion, and responsibility.

For example, based on ethnographic research on Filipino women migrants in the UK, Madianou (2016a, 2016b) demonstrated how new ICTs—“polymedia”—enabled the “ambient co-presence” of families across multiple locations, and enhanced the “low-level emotional reassurance” for those with strong relationships. Similarly, qualitative research with Romanian migrants in Switzerland by Nedelcu and Wyss (2016) demonstrated how ICTs have shaped the “ritual”, “omnipresent” and “reinforced” communications and their “ambivalent” effects such as feelings, emotions, and
solidarity; and how ICTs enabled the “cosmopolitanization” of everyday life by enabling the capacity and feeling of “being and doing things together” at a distance (See Table 1 for more examples). Generally, ICTs offer tremendous benefits for migrants’ multifaceted communications, and this has been demonstrated in a relatively large body of literature concentrated in the contexts and perspectives of the “Global North”.

3.2. ICTs for facilitating the planning and execution of migratory journeys

Besides facilitating transnational and familial connections ICTs, primarily mobile phones, have also been praised for being essential “toolkits” particularly for “irregular” migrants during their often fragmented and dangerous migratory journeys. Some researchers have elucidated this interaction.

For instance, Gillespie et al. (2018), Dekker et al. (2018), Dekker & Engbersen (2014), Gough & Gough (2019) and Kang et al. (2018) denoted how ICTs enabled migrants to plan, navigate and document their journeys and to access services en route. Mobile phones have been used to calculate distances, learn about terrains, weather conditions and currencies, learn and translate languages, navigate places and services—refuelling points, money transfer and temporary shelters, illuminate dark footpath, connect to friends and family, humanitarian actors and smugglers. They served as “life savers” by providing a platform to signal and communicate dangers (Dekker et al., 2018; Mancini et al., 2019). They also provided digital alternatives to store and transport personal memories and crucial documents, maps, dictionaries, books, and cash which can make an immense difference for the migrants during difficult journeys. In sum, despite the associated challenges and risks (Section 4), as several researchers demonstrated (See Table 1) ICTs have become critical navigation, networking and “life-saver” tools for migrants during their often dangerous and fragmented migratory journeys.

3.3. ICTs for facilitating “integration”

This section overviews ICTs’ role in migrant “integration”. “Integration” is a hugely contested concept but is mostly construed as a dynamic, multidimensional, and a two-way adaptation in a “host” society (Ager & Strang, 2008; Fortunati et al., 2011a). Although limited to the “Global North” contexts and perspectives, there is significant emerging research on ICTs’ role in migrant “integration”/inclusion which draws on the earlier “diaspora” literature. This can be classified in two overlapping categories.

The first category emphasises migrants’ ICT-facilitated information practices pertaining to their information needs and enhancement of social capital for “integration”. Although impact studies are generally lacking, this category explores migrants’ ICT use—mainly mobile phones, internet, and social media—apropos different dimensions of integration like income and employment, language and culture, education and skills, and social capital.

However, views on the way ICTs influence “integration” are contradictory. One view foregrounds ICTs’ positive role. For example, based on their analysis of resettled refugees’ ICT practices in New Zealand, Andrade and Doolin (2018) identified eight ICT use patterns vis-à-vis well-being enhancement and “affective participation” including communication, online transaction and expressing cultural identity. Based on a qualitative analysis of Syrian refugees, AbuJarour and Krasnova (2017) indicated mobile phone use can enable the social inclusion of refugee migrants. Qualitative research by Alencar (2018) with 18 Syrian, Eritrean and Afghan refugees in The Netherlands highlighted the vitality of social media networking sites for language and cultural literacy and social capital development. Kaufmann (2018, p. 882) concluded “smartphones hold an untapped potential for integration processes” based on their analysis of Syrian refugees’ ICTs practices using interviews, “WhatsApp” chats, and participant research. Aretxabala and Riezu
(2013) concluded that ICTs increase social capital of migrants. “Mixed” method research by Felton (2015) with “non-English speaking migrants” in Australia revealed how mobile internet has been widely used for seeking accommodation and job-related location information.

The contrasting view highlights ICTs’ negative role in “integration”. For example, Suh and Hsieh (2019) in their interview-based research with Korean migrants in the USA revealed that while ICT-enabled information allowed the migrants to build and maintain “local” and “global” identity, the “intraethnic” communication slowed down their “integration”. Komito & Bates's (2009) research revealed Polish migrants’ use of social media and social networking technology reduces their “integration” in Ireland although it enables them to become “media rich and resilient”. In their interviews and observation-based research with Turkish migrants in the United Kingdom, Aydemir (2018) posited that while ICT-enabled communication enhances bridging—connecting with members of different groups, it also “trivialises” the pre-emigration social ties, and increases “individualism and particularism”. Wilding's (2009) analysis highlighted the unintended consequences of ICT-based projects aimed for the social inclusion of youth with refugee backgrounds in Australia—misuse of personal data and protraction of obligations and responsibility.

The second category relates to the development, implementation, and outcomes of ICT-based projects apropos “integration”/inclusion. For instance, Codagnone & Kluzer (2011) synthesised five studies that examined ICT-based initiatives relating to immigrants and ethnic minorities (IEM) in 27 European countries and 11 case studies from France, Germany, Spain and the UK using survey, case analysis and workshops. The findings highlight a user-driven and bottom-up ICT uptake by IEM and the importance of third sector entities and IEM associations to enable ICT use for inclusion. The study also highlights the hindrances of digital inequality for socio-economic inclusion of IEM as a result of factors such as socio-economic status, gender, language, infrastructure and inadequate digital content. Brown and Grinter (2016) reported a “human-in-the-loop” interpretation messaging platform that mediates the communication between two groups with different languages. Almohamed et al. (2018) illustrated a promising participatory approach to designing ICT solutions for refugee “integration” which involved NGOs, volunteers, refugees and ICT designers to inform the design concept. Muñoz et al. (2018) explored the potentials of free digital learning (FDL) tools and initiatives for migrants’ language learning, civic integration, employment, and higher education. Overall, despite the lack of impact research and the varying views on ICTs’ actual role in migrants’ “integration”, there is significant emerging research in this domain (See also Table 1).

3.4. ICTs for enabling livelihoods

Livelihoods is another area affected by ICTs. The livelihoods of migrants and their families are highly enmeshed with aspects of migration/development including remittances and investments (Duffield, 2006; Sørensen et al., 2002) which are increasingly entangled with ICTs (Hackl, 2018; Steel et al., 2017). However, very little is known about the contemporary interplay between ICTs, livelihoods and migration/(im)mobility/development particularly in the “Global South” context (Scoones, 2009; Steel et al., 2017). Existing studies tended to overlook ICTs’ role; concentrate on rural households with a narrowed view of “naïve localism” (Scoones, 2009); and view livelihood enhancement only as income increment (Czaika and De Haas, 2014). The disregard of ICTs’ role has been contradicting people’s increasing use of these technologies in their daily livelihood-related activities. In fact, as Heeks (2006) underlined, this issue is prevalent in the wider ICTs and development—“there has been a bias to action, not a bias to knowledge. We are changing the world without interpreting or understanding it” (p. 1).

However, some broadly related limited work in ICTs and migration-related livelihoods—income, employment, and skills; remittances; and livelihoods amid environmentally-related displacement are worth mentioning. Regarding the former, for example, Steel et al. (2017) in their case studies in
Cameroon, Rwanda and Sudan found that digital connections and the flow of people, goods, services and information are improving livelihoods. However, some are affected by digital inequality and the politics of mobility (Cresswell, 2010)—unable to move or access new technologies due to social inequalities—“trapped populations” (Boas, 2017). Those without access to mobile phones become more and more dependent on traditional intermediaries for job opportunities and market information. Some grey literature also featured digital labour case studies relating to refugees and IDPs like “Samasource” \(^1\) (Hatayama, 2018; Samasource, 2019). Hackl (2018, p. 158) states “(…) ‘digital livelihoods’ are already becoming a new development mantra […] refugees should tap into digital economies by becoming data cleaners and crowd workers, thereby building a brighter future from cash for food to tech for food”. Nevertheless, such optimism appear to be misplaced as the premise represents only limited groups—young technology savvy and relatively wealthy Syrian refugees (Borkert et al., 2018; Kaufmann, 2018) as denoted in Mansour’s (2018) qualitative study which shows that two-thirds of the Syrian refugees who crossed to Egypt have high digital literacy skills.

Hatayama (2018) reported how internet, mobile phones, applications, and platforms enabled some refugees and IDPs to enhance income and financial resources—including by delivering online language training, crowdfunding, peer-to-peer lending, e-commerce, and entrepreneurship; and also, to access and share information and to develop skills—including information about local employment opportunities and regulations, and to access content and teachers from higher education institutions remotely. There is also a growing trend of delivering computer coding and other IT skills to refugees and IDPs in refugee camps (Hatayama, 2018). Fintech and biometric solutions such as blockchains and biometric identity cards are also portrayed as assisting refugees and IDPs to access financial and essential services. However, it unclear whether and how the notorious privacy and ethical issues related to the use of such technologies in the context of vulnerability (Madianou, 2019; Maitland, 2018; Thomas, 2005) have been addressed. Hatayama’s (2018) report appears to represent only limited cases since such applications are largely absent in many contexts including vast refugee camps in the Horn of Africa. Mobile money systems such as M-PESA in Kenya have been reported to facilitate payments and financial transactions to the poor including “asylum seekers” and refugees in camps who mostly are deprived of traditional financial services (Miao et al., 2018; Suri & Jack, 2016).

 Regarding remittances and livelihoods amid environmentally-related displacement, research on remittances tended to focus on households in migrant sending countries, and ICTs’ role has been largely ignored. Although specific research on ICTs’ role in livelihoods during environmentally-related displacement is generally lacking (Boas, 2017), some researchers have highlighted the importance of ICTs in such situations. For example, Lu et al.’s (2016) analysis of the mobility of people affected by Cyclone Mahasen in Bangladesh using mobile phone data indicates the usefulness of mobile phones to understand fast-changing human mobility which can offer crucial information on people’s livelihood and safety in the time of disaster. Hiremath and Misra (2006) presented how ICT-enabled migration information intervention in Gujarat, India addressed critical local livelihood problems. They stated a simple migrant information centre enabled by wireless in local loop (WLL) telephony enormously supported the social and economic security of the vulnerable migrants by reducing migration costs, enhancing communication and networking.

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\(^1\) “Samasource”, a digital microwork service by a San Francisco based company, is reported to secure large and labour-intensive data and artificial intelligence (AI) related digital work contracts such as web search and evaluation, image tagging and transcription from corporate companies in developed countries such as Google, CISCO and Yahoo. The company then decomposes, encapsulates and distributes the micro digital work using online platforms to people in poverty including refugees and IDPs in camps in Kenya, Uganda, India, Haiti and Costa Rica (Borokhovich et al., 2015; Gino & Staats, 2012a; Hatayama, 2018). It has been stated that the business model connects the cheap labour in developing countries to the high labour demand in countries with advanced economies and to use microwork to benefit marginalised people to earn a living wage instead of receiving aid (Borokhovich et al., 2015).

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improving employment opportunities, protecting labour rights, improving perception towards migrants, and enhancing emotional, food and financial security. If the project delivered as claimed, the success appears to rest on its identification of local needs and participatory appraisal.

In summary, apart from the broadly related studies cited earlier (See also Table 1), research targeting ICTs’ role in the contemporary migration-related livelihoods is rare. This is despite the strong entanglement of migration, livelihoods, and ICTs.

<table>
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<tr>
<th>Research area in ICTs and migration</th>
<th>Example relevant literature</th>
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<tr>
<td>ICTs in “diasporic” and transnational connection</td>
<td>Andrade &amp; Doolin, 2018; Awad &amp; Tossell, 2019; Boas, 2020; Collin et al., 2015; Dekker et al., 2016; Diminescu, 2008; Fortunati et al., 2011b; Georgiou, 2006; Gifford &amp; Wilding, 2013; Hall, 1990; Hamel, 2009; Komito &amp; Bates, 2011; Larsen et al., 2006; Levitt, 1998; Levitt &amp; Jaworsky, 2007; Lim et al., 2016; Marlowe, 2019; Oiarzabal, 2012; Oiarzabal &amp; Reips, 2012; Pearce et al., 2013; Thompson, 2009; Vincent, 2014; Wilding, 2006; Wyche &amp; Chetty, 2013</td>
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<td>ICTs in migrants’ “integration”</td>
<td>AbuJarour et al., 2019; AbuJarour &amp; Krasnova, 2017; Alam &amp; Imran, 2015; Alencar, 2018; Alencar &amp; Tsagkroni, 2019b; Almohamed et al., 2018; Andrade &amp; Doolin, 2018; Aretxabala &amp; Riezu, 2013; Aydemir, 2018; D. Brown &amp; Grinter, 2016; Codagnone &amp; Kluzer, 2011; Collin &amp; Karsenti, 2012; Felton, 2015; Garrido et al., 2010; Kaufmann, 2018; Komito &amp; Bates, 2009, 2011; Muñoz et al., 2018; Siddiquee &amp; Kagan, 2006; Suh &amp; Hsieh, 2019; Wilding, 2009</td>
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<td>ICTs in behaviours and processes of migration</td>
<td>Alampay, 2018; Andrade &amp; Doolin, 2018; Boas, 2017; Borkert et al., 2018; Cooke &amp; Shuttleworth, 2018; Czaika &amp; De Haas, 2014; Czaika &amp; Parsons, 2017; Dekker et al., 2018; Dekker &amp; Engbersen, 2014; Elbadawy, 2011; Frouws et al., 2016; Haug, 2008; Kotyro, 2019; Latonero, 2012; Leurs &amp; Smet, 2018; Madianou, 2012a; Mancini et al., 2019; Molony, 2012; Morrison &amp; Clark, 2016; Onitsuka &amp; Hidayat, 2019; Poot, 1996; Smet, 2018; Spaan &amp; van Naerssen, 2018; Thulin &amp; Vilhelmsen, 2014; Vilhelmsen &amp; Thulin, 2013</td>
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<td>Key research areas</td>
<td>Relevant literature</td>
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<tr>
<td>ICTs and migration-related livelihoods</td>
<td>Borkert et al., 2018; Borokhovich et al., 2015; Gino &amp; Staats, 2012b, 2012a; Hackl, 2018; Hiremath &amp; Misra, 2006; Kaufmann, 2018; Latonero &amp; Kift, 2018; Lu et al., 2016; Miao et al., 2018; Patil, 2019; Steel, 2017; Steel et al., 2017; Suri &amp; Jack, 2016; Yafi et al., 2018</td>
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<td>Migrants and digital visibility, surveillance, and border control</td>
<td>Alencar et al., 2019; Beduschi, 2017; Chouliaraki &amp; Musarò, 2017; Frouws et al., 2016; Gillespie et al., 2018; Hugman et al., 2011; Jumbert, 2018; Jumbert et al., 2018; Kingston, 2014; Latonero &amp; Kift, 2018; Madianou, 2019; Maitland, 2018; Mancini et al., 2019; Newell et al., 2016; Thomas, 2005; Vannini et al., 2019; Vukov &amp; Sheller, 2013; Wall et al., 2017</td>
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<td>ICTs, human trafficking, and extortion</td>
<td>Borkert et al., 2018; Dekker et al., 2018; Beşer &amp; Elfeitori, 2018; Harney, 2013; Latonero, 2011; Latonero &amp; Kift, 2018; Maitland, 2018; Newell et al., 2016; Mirjam Van Reisen &amp; Mawere, 2017; Van Essevel, 2019; Vukov &amp; Sheller, 2013; Wall et al., 2017</td>
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<td>ICT-enabled communication, burdens, and pressures on migrants</td>
<td>Akuei, 2005; Awad &amp; Tossell, 2019; Horst, 2006; Madianou, 2016b; Nedelcu &amp; Wyss, 2016</td>
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<td>Migrants and “digital divide”</td>
<td>Alam &amp; Imran, 2015; Benítez, 2006, 2010; Caïdi et al., 2010; Chatman, 1996; Clark &amp; Sywyj, 2012; Frouws et al., 2016; Fuchs, 2009; Goodall et al., 2010; Harney, 2013; Katz et al., 2017; Leung, 2018; Platt et al., 2016; Robertson et al., 2016; Salman &amp; Rahim, 2012; Vertovec, 2009; Wilding, 2009; Yu et al., 2018</td>
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<tr>
<td>Digital migration study</td>
<td>Dekker &amp; Engbersen, 2014; Kotyrlo, 2019; Leurs &amp; Prabhakar, 2018; Leurs &amp; Smets, 2018; Lu et al., 2016; Messias et al., 2016; Sánchez-Querubín &amp; Rogers, 2018; Schrooten, 2012; Zagheni et al., 2014</td>
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Table 1: Key research areas and relevant literature in ICTs and migration
4. THE TYRANNY OF ICTS FOR MIGRANTS

As noted earlier, ICTs are often viewed as liberating and utilised at migrants’ discretion. As such, most existing literature emphasises their benefits. However, besides their benefits, these technologies also pose critical risks, burdens, pressures, and inequality. Although specific research on the tyrannical aspects of ICTs is extremely rare, this section sheds light on this important area by drawing on reflections from the wider related literature. Three key areas are particularly emphasised and discussed in turn: digital risks; ICTs-related burdens and pressure; and digital inequality.

4.1. Migrants and digital risks

Apart from risks that they share with all other ICT users such as computer-induced health risks, digital risks associated with migrants can be viewed in two major lenses. They are digital visibility, surveillance, and border control on the one hand, and human trafficking and extortion on the other as elucidated below.

4.1.1. Migrants and digital visibility, surveillance, and border control

There are increasing risks associated with ICT-enabled visibility and surveillance of migrants primarily when they flee home and travel within and across borders in pursuit of safer places (Mancini et al., 2019; Wall et al., 2017). These include surveillance by source and destination nation states, smugglers, traffickers and criminal gangs (Latonero & Kift, 2018; Vukov & Sheller, 2013), risks linked to the use of digital data such as digital biometric identifications which may expose migrants’ identities (Maitland, 2018), and data generated as a result of migrants’ use of ICTs such as mobile phone and social media usage data—often quoted as “big-data”.

The post 9/11 widespread use of surveillance technologies, “technologies of control”, at borders and beyond has been exacerbated amidst the ICT-assisted “irregular” migration notably since the 2015/16 “refugee crisis”. Some researchers have highlighted the increasing sophistications of these technologies and how their use is increasingly deterring the rights of protection and privacy of vulnerable migrants (Jumbert, 2018; Madianou, 2019; Vannini et al., 2019). Digital borders have extended beyond physical borders whereby large amounts of migrants’ data—often racially profiled—are collected and stored in large, distributed databases and shared among several actors.

In addition, many European immigration and border authorities have sought and gained legal impunity to search (and even to hack) migrants’ phones (Frouws et al., 2016; Jumbert et al., 2018). While such activity may inform some elements of the intended purposes—such as verifying and identifying migrants from other security threats, overreliance on such technologies may also lead to erroneous and risky outcomes—for example, migrants may self-censor; mobile phone use may have been shared among many users; and migrants’ online identity may be hacked and faked by others.

Some studies highlighted different forms of these risks. For example, Beduschi (2017) highlighted migrants’ risk of being tracked and discovered by traffickers, smugglers, border guards and common criminals via global positioning system (GPS) applications. Chouliaraki and Musarò (2017) observed how authorities in Greece and Italy used ICTs to intercept migrants before they reach borders. In their study of Syrian and Iraqi refugees’ journey to France, Gillespie et al.(2018) highlighted the tension between the importance of mobile phones as “lifelines, as important as water and food” and mobile phones being new sources of exploitation, abuse and surveillance for migrants as migration has been criminalised by European policy and financialised by smugglers. Mobile phones have sometimes been a source of torture and even death such as when migrants’ possession of sensitive information is discovered by perpetrators.
Other studies stressed concerns regarding the growing use of biometric identification systems in relation to vulnerable migrants by various parties including governments, and humanitarian and private organisations (Kingston, 2014). Biometric identifications can easily expose individuals as they involve physiological and behavioural patterns of a person such as fingerprint, DNA, iris, face, voice, ear shape, body odour, hand-written signature, keystroke and gait (Kingston, 2014; Thomas, 2005). Jumbert et al. (2018, p. 4) stressed that:

*Of particular concern are the implications of a hybrid form of governance, where private companies, state authorities, NGOs and international organizations fail to understand the surveillance capabilities of digital devices or fail to set high standards of digital safeguards.*

Furthermore, migrants’ increased use of ICTs has produced abundant digital data that can characterise migrants’ online behaviour as well as their identities. While ethical, cautious and responsible use of such data could be beneficial in many ways such as “for the protection of migrants’ human rights by enhancing both decision-making and measures to prevent unnecessary deaths at sea, ill-treatment and human trafficking of migrants” (Beduschi, 2017, p. 981), inappropriate use of such data could also risk migrants’ life and privacy. However, research examining the extent of risk posed or exhibited on migrants and their networks as a result of inappropriate use of migrants’ digital data is lacking.

Nevertheless, it should be noted that migrants are not always passive victims of surveillance as they sometimes appropriate their use of ICTs. For example, Gillespie et al. (2018) documented how Syrian refugees used ICTs creatively to avoid surveillance such as by protecting their digital identities, using encrypted mobile applications, closed groups, pseudo-names and avatars in social media to share sensitive information. In short, the increasing use of “technologies of control” and migrants’ digital traces by various actors poses a serious risk for vulnerable migrants despite this important issue is raised only in passing in most of the existing literature (See Table 1).

### 4.1.2. ICTs, human trafficking, and extortion

Digital visibility and “technologies of control” are not the only digital risks for migrants. Some researchers reflected on how ICTs primarily mobile phones and social media have been used by smugglers, traffickers and gangs to misinform, enslave, extort and torture migrants for ransom (Latonero, 2011; Van Esseveld, 2019) as well as how migrants may consume misleading and fake information from social media which sometimes may lead to deadly consequences (Borkert et al., 2018). Van Esseveld (2019) and Reisen and Mawere (2017) shed light on how mobile phones are being used by traffickers and armed groups in transit countries such as Libya to abuse and extort migrants. As highlighted in “Tortured on Camera: The Use of ICTs in Trafficking for Ransom” (Van Esseveld, 2019), traffickers have used live calls while migrants are being tortured and screaming, recorded images and videos of torture to collect ransom from distant families and friends.

Beşer & Elfeitori (2018) underline how European partnership with Libya to prevent migrants from coming to Europe has encouraged violations including arbitrary detention, enslavement, malnutrition, the lack of hygiene, torture, and sexual abuse in Libya. Newell et al. (2016) in their study of information practices of undocumented migrants at the USA-Mexico border highlighted how possessing contacts of friends and family subjected migrants to risks of extortion and abuse by drug and human traffickers, thieves, and corrupt officers; and how migrants mistrusted and rejected ICT-based assistance including from humanitarian actors in fear of surveillance. Further, migrants’ reliance on locals for basic services such as mobile cellular subscription due to lack of essential documents and legal rights subjected them to fraud, blackmailing and exploitation (Dekker et al., 2018; Newell et al., 2016; Vannini et al., 2019). In sum, although specific research is rare, emerging
evidence shows the increasing use of ICTs for human trafficking and migrant extortion (See Table 1).

4.2. ICT-enabled communication, burdens, and pressures on migrants

Migrants’ increased ICT-enabled communication and connectedness come with costs of burden and pressure like social surveillance, obligation and commitments (Awad & Tossell, 2019). For instance, Horst’s (2006) field study in Jamaica highlighted how increased access and use of mobile phones leads to unforeseen burdens and social obligations whereby distant migrants are “burdened by love and the compunction to give” and increased gendered surveillance and involvement in each other’s everyday life. Akuei’s (2005) study on Sudanese resettled refugees in the USA shows how remittances as social obligations pose unforeseen pressure on resettled refugees. “Knowing what their kin are facing in Cairo and other asylum locales, resettled refugees expressed feeling a deep responsibility to honour these obligations. […] with their mounting remittances and meagre resources to improve their own lives, it is the resettled refugees who now feel the poorer” (p. 13). Nedelcu and Wyss (2016) denoted how ICT-facilitated co-presence not only supplements the wellbeing and quality of family relationships, but also its “ambivalent” effect adds extra pressure and commitments primarily on distant migrants to respond to calls at any instant. ICTs also enabled increased cultural surveillance whereby those with weak relationships experienced increased conflict (Horst, 2006; Madianou, 2016b). Therefore, alongside the benefits, ICT-enabled communication and connectedness bring costs of burden and pressure on migrants.

4.3. Migrants and digital inequality

Digital inequality is another key challenge for vulnerable migrants. Digital inequality can be understood as differences in accessing, using, and benefiting from ICTs among various groups due to factors such as power and economic status, rights, age, sex, and geographical location. Earlier studies focused on a “digital-divide” which emphasised variations in economic participation and physical access to technology such as personal computers (Duncombe & Heeks, 2002; Warschauer, 2002). While still mainly concentrated on “sociodemographic and socioeconomic determinants” (Scheerder et al., 2017, p. 1607), the contemporary notion of “digital-divide” is beyond mere access to technological equipment (DiMaggio & Hargittai, 2001; Warschauer, 2004). Here, ‘digital inequality’ instead of “digital-divide” is used to reflect the multidimensional inequalities driving and driven by the uneven distributions of not only the technologies but also the motivation, resources, structures and capabilities to use them (Fuchs, 2009). Besides the technology, other dimensions—for example, behavioural (motivation and skills) and usage-related (e.g., bandwidth and frequency of use)—are critical (van Deursen & van Dijk, 2019). In fact, digital inequality may exist where physical access is universal (van Deursen & van Dijk, 2019). Belloni’s (2020) ethnographic study with Eritrean refugees in Italy and Eritrea showed that despite having access to technology refugees have been avoiding communication with home in response to the overwhelming expectations and responsibility until they reach their aspired upward destinations and settle. Thus, as Norris (2001, p.32) emphasised, digital inequality should be analysed in all three levels – micro (resources and motivations at individual level), meso (political and institutional contexts) and macro (economic and technological contexts).

While digital inequality is not limited to migrants, it needs a contextual analysis given migrants’ heightened information needs. The purpose and use of ICTs by migrants such as asylum-related migrants is significantly different from the rest of the society; and migrants have specific information needs often characterised as information poverty (Chatman, 1996) and challenged by structural and social barriers (Caidi et al., 2010; Maitland, 2018). Due to their particular situations, asylum-related migrants are often very information precarious which could lead them to misinformation and vulnerability (Harney, 2013). Leung’s (2018) study in Australia, for example,
shows that while refugees and “asylum seekers” use the internet mainly to access information relevant to their challenging circumstances and to connect to their families and fellow migrants, “netizens” (mainstream users in the general society) use internet mainly for online presence. The author also revealed the legitimacy to use ICTs is dually questioned (by origin and destination countries) for refugees/asylum seekers (like most social, legal and economic resources) whilst it is authorised for “netizens”—as long as the authority of the nation-state is not challenged. Merisalo & Jauhiainen's (2019) research on the ICT use of migrants from 37 countries in Africa, Asia, and Middle East in their journeys from origin country to transits and destinations demonstrated how the circumstances of asylum-related migrants forced them to use ICTs although they had not had prior habit, interest, and skills.

While specific and impact research on migrants’ digital inequality is rare, some studies have considered variations in access and use of ICTs by migrants and families with migration backgrounds vis-à-vis factors such as age, gender, income and education either with respect to origin country (Benítez, 2006; Merisalo & Jauhiainen, 2019) or recipient society (Leung, 2018; Yu et al., 2018) (See also Table 1). Leung (2018) highlighted how English-only internet content and affordability exacerbated the “digital-divide” among refugee background users in Australia. Katz et al. (2017) highlighted how low digital access and use affected the learning and development of “immigrant” children and “low-income” families in the USA. Benítez (2006) highlighted the importance of skills, education, family, and cultural capital for the successful use of ICTs; and how ICTs are more vital for those migrants constrained to travel by legal, economic, and social factors. Some studies explicated the role of social relations in digital inequality. For instance, Platt et al. (2016) highlighted how Indonesian domestic workers’ ICT-enabled communication in Singapore is contingent on the “always ongoing” negotiation with their employers as their communication can be deterred by way of surveillance and obscuring “WiFi” passwords. In sum, multilevel and multifaceted digital inequalities are increasingly affecting vulnerable migrants. However, although some studies conveyed variations in migrants’ access and use of ICTs explicitly or implicitly, they did not adequately problematise the subject and its consequences as important areas of research.

5. GAPS AND OPPORTUNITIES

Sections 3 and 4 examined the status quo of literature relating to ICTs and migration apropos the liberalities and tyrannies of ICTs for vulnerable migrants. This section highlights eight insights, gaps and opportunities relating to both the existing and missing objects of research in ICTs and migration/development.

First, existing research on ICTs and migrants is almost entirely limited to migrants’ ICT use ‘en route’ or within the “Global North” and perspectives from these regions. Thus, it needs decolonising and reimagining vis-à-vis the “Global South” as not least the socio-economic, cultural, technological, and political contexts of the “Global South” are significantly different from the “Global North”, and over 80 per cent of internal and international migration takes place within regions in the “Global South”.

Second, despite some existing research on migration- and mobility-related livelihoods—seasonal and local migration/mobility, remittances, refugees’ self-reliance, etc., there are several gaps. Notably, most existing studies are place-deterministic—failing to consider the multilocality of livelihoods particularly in transnational contexts and overlooking livelihood’s multidimensionality—they tend to focus merely on income. They also ignore ICTs’ role despite the increasing entwinement of people’s movements and ICT use apropos diversifying and securing
livelihoods often across multiple locations. Despite some challenges\(^2\), ICTs can extend corporeal movements to imaginative, virtual, and communicative ones whereby enabling the physically immobile—those bound by socio-economic constraints, family responsibility, age, cultural norms, etc., to access livelihood opportunities at a distance. However, research that recognises ICTs’ role vis-à-vis the diversity and multilocality of contemporary livelihoods and the peculiar circumstances of migrants particularly in the “Global South” context are exceptionally scarce. This can be seen as important opportunity for future research.

Third, while ICTs have become migrants’ critical navigation, networking and ‘life-saver’ toolkits; and enabled migration management for several actors, they also pose risks primarily for vulnerable migrants. Misuse of migrants’ online and usage data and biometric identification systems poses serious risks for these migrants. Research investigating the extent of such risks in different contexts particularly from the perspective of migrants and exploring a balanced way of developing and using these technologies by putting migrants’ lives and their participation at the centre is needed.

Fourth, literature indicates that ICTs are increasingly enabling the realisation of a virtual relationship and intimacy nearly typical of in-person interactions particularly for those constrained by distance. Nevertheless, they also pose pressure and burdens particularly on distant migrants laden with multiple socio-economic obligations and commitments. However, existing studies tend to view ICTs only optimistically; and critical research cogitating both the ‘bright’ and ‘dark’ consequences of ICTs particularly on vulnerable migrants is generally lacking. This is one important gap to be addressed by future research.

Fifth, there is sufficient evidence confirming the increasing influence of ICTs on migration behaviours, patterns and processes including (potential) migrants’ aspirations and decisions (See Table 1). However, existing evidence is inadequate to answer very important questions including ‘how increase in access and use of ICTs relate to inward/outward migration?’ necessitating contextual and focused research particularly vis-à-vis the growing informal, fragmented and often dangerous migration apropos both the source and destination countries at micro, meso and macro level. Future research in this area can benefit from drawing on existing migration theories such as new economic migration theory\(^3\) to understand the role of ICTs in migration. However, such theories need to consider the role of power and gender in collective decision making.

Sixth, while several researchers have attempted to explore the facilitating role of ICTs in migrants’ “integration”, existing studies not least focused only on ICTs’ positive role often only in the perspective of the isolated contexts in the “Global North”. Critical research on ICTs’ role in and impact on migrants’ multidimensional inclusion especially in relation to the digital and the wider multidimensional inequality is needed.

Seventh, migrants are increasingly affected by digital inequality which has broader implications to other types of multilevel and multidimensional inequality. Although some researchers have

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\(^2\) Those who lack the means and capability to move either physically or virtually are unable to leverage the potentials of mobility and migration for their livelihood advantages. These immobility traps and their consequences can be caused by deficiencies associated with both physical and virtual mobility. In addition to constraints of physical mobility such as financial resources, those who are in the remote side of the digital-inequality – those constrained by factors associated with physical access, motivation and capability to use ICTs are often excluded from the benefits of virtual mobility. However, less mobility does not always infer more immobility and sometimes mobility also promotes immobility. For example, immobility can be reinforced by the mobility of others such as households of migrants due to domestic and caretaking responsibility (Kothari, 2003; Steel et al., 2011). Other times immobility may be strengthened by social obligation of migrants such as responsibility for remittances (Akuei, 2005; Bailey et al., 2002; Hunter, 2015).

\(^3\) New economic theory of migration argues that decision to migrate is not a result of a decisions of isolated individual actors to maximise wage and income; but it might be a collective decision not only to maximise income and wage but also to minimise or disperse risks (de Haas, 2010; Stark, 1985; Taylor, 1999). This theory also holds that migration can lead to a relative deprivation where income inequality in a community as a result of migration and remittance might lead to further migration (J. E. Taylor, 1999); and increase in local employment, production and wages does not necessarily stop migration. The older neoclassical economic theory of migration assumes geographical labour market and wage differentials, and individuals’ rational choice to maximise utility determne migration motives and decisions both at micro and macro level (Harris & Todaro, 1970; King, 2012; Massey et al., 1993; Sjaastad, 1962; Todaro, 1969).
conveyed variations in migrants’ ICT access and use explicitly or implicitly, they have failed to adequately problematise the subject and its consequences as important areas of research signalling future attention.

Finally, ICTs are increasingly influencing migration research. They are reshaping data collection and analysis methodology with important implications for migration theorisation (See ‘Appendix II’ and Table 1). Rigorous research on the ethical use of digital methods for migration studies is another important opportunity for future research.

6. CONCLUSION

In a bid to assess the current status quo and illuminate future directions in ICTs and migrants research, this paper has attempted to outline contemporary knowledge and pinpoint the key gaps and future opportunities particularly vis-à-vis ICTs’ liberating and tyrannical role especially for vulnerable migrants like the displaced and trafficked. This was done by drawing on 157 published materials relating to ICTs and migration/development. Against the dominant view on ICTs’ empowering role, the analysis elucidates the “double-edged sword” consequences of digital technologies by expounding how these technologies not only offer opportunities but also pose risks, burdens, pressures, and inequality predominantly on vulnerable migrants. It establishes how ICTs, particularly mobile phones and the internet, are increasingly reconfiguring all aspects of migration including migrants’ networking and connections, behaviours and processes of migration, migrants’ integration and social capital, and migration-related livelihoods. In doing so, however, these technologies not only empower these migrants such as by facilitating dangerous migratory journeys and social connections but also subject them to risks including ICT-facilitated trafficking, torture, extortion, and surveillance as well as burdens and pressure including protracted responsibility and commitments and multifaceted socio-economic inequality created or amplified by ICTs. Overall, the analysis provides ‘food for thought’ particularly on the need to thoroughly consider both the contextual ‘bright’ and ‘dark’ role and consequences of ICTs for a more realistic and nuanced ICTs and migration research and practice.

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APPENDIX I: LITERATURE SELECTION AND THEMATIZATION APPROACH

1. Data source and collection
   1.1. Source of data

The review process began with searching databases, academic journals, and conferences with mixed combinations of keywords (See the ‘Keyword and searching strategy’ section) from fields of new media and communication, information systems, information and communication technologies (digital technology), information and communication technologies for development (ICT4D), migration, development studies, law, geography, economics, sociology, anthropology and history. The literature search and identification process primarily focused on a peer-reviewed published academic research. However, other relevant publications such as practitioner reports, policy documents, working papers from authoritative sources and thesis have been also included in the review process.
Search engines, databases, and journals including Google Scholar, ABI/Inform collection via ProQuest, Scopus, Web of Science, ACM Digital Library, ScienceDirect, JSTOR, and relevant sources in the list of 79 ICT4D-related publication resources collated by (ICTworks, 2012) were used to search and retrieve electronic materials. In addition, peer-reviewed published works which emerged from the analyses of forward and backward cross-referencing have been included in the review. The University of London’s multi-institution online catalogue, the Senate House library and the Royal Holloway University of London’s library collections have been used as primary sources for the location and retrieval of relevant paper-printed publications such as books for which digital copies were not available or inaccessible. In some cases when very relevant full text publications were not accessible, authors are directly approached for a copy via academic networking platforms such as ResearchGate and Academia. Due to the multidimensional and interconnected nature of the constructs of digital technology, migration, inequality/development, this review is by no means considered to be exhaustive.

The keyword search (See the next section) returned tens of thousands of search results which mostly originated from migration, diaspora, transnationalism, mobility, sociology, ICTs for Development (ICT4D), development studies and media and communication studies. The publications were sourced from the following journals and publication sources: Information Technology and people, Global Networks, Social Media and Society, Information Communication and Society, Popular Communication, Journal of Computer-Mediated Communication, Ethnic and Migration Studies, Information Technology and Society, Media, Culture and Society, MIS Quarterly, Critical Sociology, Gender and Society, Migration and Development, Family Issues, New Media and Society, Mobile Communication, Information Technologies and International Development, Information Systems Journal, conferences and publications from the Association of Computing Machinery.

1.2. Keywords and searching strategy

To achieve the searching strategy, combinations of terms representing concepts of digital technology, migration and inequality/development were searched using search engine friendly Boolean operators. The initial attempt was to retrieve publications named by the combination of at least three concepts in the nexus of digital technology, migration, inequality, and development such as ‘ICT and migration and inequality or development’. However, this was not sufficient to capture all related literature. Consequently, a range of combination of keywords representing at least two concepts simultaneously in the nexus, for example, ‘ICT and migration’, ‘digital technology and inequality’, ‘ICT and inequality’, ‘migration and development’, ‘migration and inequality’, ‘digital inequality’ were added to the search strategy. The list of keywords used in the search to represent the relevant concepts are summarised in ‘Table a’.

<table>
<thead>
<tr>
<th>Concept aimed</th>
<th>Keyword used</th>
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<tbody>
<tr>
<td>ICTs</td>
<td>(digital) technology/technologies, ICT, social media, mobile phone, internet, (new) media, (new) technology/technologies, information and communication technology/technologies, ICT4D, information system</td>
</tr>
<tr>
<td>Migration, migrants and mobility</td>
<td>migration, migrations, migrant, migrants, mobility, refugee, global south migration, south-south migration, displacement, transnational, diaspora, forced migrants/migration, mobility</td>
</tr>
<tr>
<td>Inequality</td>
<td>inequality, marginality, exclusion, inclusion, discrimination, digital divide, digital inequality, e-inequality, e-exclusion, e-inclusion, digital inclusion</td>
</tr>
<tr>
<td>Development</td>
<td>international development, human development, global development, development</td>
</tr>
</tbody>
</table>
Table a: Keyword searched in the literature

1.3. Selection of publications

The selection process of the identified literature underwent three stages. In the first stage, 1314 publications were identified and their citation information and digital full text whenever available and accessible was downloaded and recorded to Mendeley reference manager. The choice of Mendeley over other competing reference manager software such as Zotero, RefWorks, CiteULike and EndNote for this research was mainly due to a personal preference as well as its features such as PDF format friendliness, generous free cloud storage (currently 2GB), desktop and web versions of the application, good synching feature allowing work from multiple locations and devices (Parabhoi et al., 2017). At this stage, publications were considered based on search engine indexing information such as title, source link, reasonable number of citations in accordance with publication year. Publications that were older than 30 years but had no evidence of any citation in the database that listed the publication or Google Scholar were not considered. In the second stage, 870 publications were selected based on a review of the abstract or executive summary whenever available or a quick skimming of headings and content pages for relevance. In the third stage, 157 publications were selected based on a further review of the papers for perceived quality by reviewing the combination of the abstract or executive summary, full or part of the introduction page based on the length of the publication, chapter and topic headings, full or part of the methodology and conclusion sections.

2. Scope and in/exclusion criteria
2.1. Publication year

Due to the rapid changing nature of ICTs and their resulting implications for migration, inequality, and development, only materials published after 1990 were considered in this review.

2.2. Publication language

For this review, only publications in English were considered. This is due to limitation to translate publications in all other languages to English within the limited time and resource available and a deliberate reluctance to use automatic translators due to quality concerns.

2.3. Interdisciplinary nexus

The choice of publications for inclusion based on their coverage of any of the dimensions in the digital technology, migration and inequality/development nexus was shaped by two major constraints. On one hand, the concepts of digital technology, migration and inequality/development are very broad and complex by nature and considering publications from all of these disciplines per se for review was unfeasible and challenging for analysis. On the other hand, studies that span over the intersection of all these disciplines are limited in the literature. Consequently, literature that intersects across at least two dimensions in ICTs, migration and inequality/development nexus were considered in the review to reconcile the situation. These intersections were ICT-migration-inequality/development, ICT-migration, ICT-inequality/development, migration-inequality/development.
2.4. Type of migrant/migration

For the purpose of this review, although there may be overlap in rare cases, only literature that engages with international migration (migration across national borders) rather than internal migration or displacement within a country has been considered. In considering the literature, no distinction has been made between various aspects of migration such as pre-migration, journey, settlement and return and types of migrants such as labour or economic migrants, forced migrants such as refugees and “asylum seekers” and other migrants such as student migrants. In addition, no type or aspect of inequality and development was predefined for the purpose of the literature search.

2.5. Geographical coverage

As the research informed by this review primarily aims to investigate the link between ICTs, migration, and inequality/development within countries of developing economies, initially, the review was piloted merely on the context of the developing economies or the “Global South”. However, unfortunately, this generated very few materials. Hence, since the primary purpose of this review is exploration of the theories, methods, and empirical evidence in the existing literature to understand the status quo rather than drawing statistical generalisation, publications, and studies of various nature from a range of geographies and contexts have been considered.

2.6. Publication quality

For the in/exclusion of the literature for analysis, most aspects of the ‘concept hierarchy of research quality’ framework proposed by Mårtensson et al. (2016, p.599) was used vis-à-vis all the theoretical, methodological and the findings/empirical aspects of the sources. The framework sets out 32 research quality evaluation concepts hierarchically interconnected in three tiers through 4 branches, i.e., credibility, contribution, communicability, and conformity. The papers were evaluated against the 23 evaluation concepts at the tail of the concept tree in the framework (See ‘Table b’). Since the framework has been developed for the evaluation of research quality including research approach and process in general rather than research output in particular, not all constructing concepts of the framework were strictly applied for this review. The parameters highlighted in Table b were used as a main in/exclusion criteria. In addition, given the literature review was done by one person, attempts were made to reduce subjectivity as much as possible (Kolbe & Burnett, 1991) by relying on the pre-set evaluation criteria to avoid the influence of personal connection or prior knowledge of authors, personal emotions and imaginations.

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<th>Credible</th>
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<td>Original result</td>
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Table b: Literature quality evaluation criteria (adapted from Mårtensson et al., 2016)

3. Coding and analysis

The next stage of the review process following literature selection was coding and thematic analysis. Prior to abductive review of each paper under each theme (Reichertz, 2007) as per the questions set out in ‘Table c’, generic themes and topics were identified using a hybrid of manual and software-assisted automated inductive coding. The first set of themes and topics were manually identified by reviewing 117 papers. These papers were selected from the initial relevant literature retrieved by searching databases using the combination of keywords that represent all key concepts, i.e., digital technology/ICT, migration, inequality, and development simultaneously. As elaborated above, however, the keyword search strategy was expanded further and additional literature was retrieved. As the themes started to recur, inspected automatic coding was considered for the additional literature. Consequently, all of the selected publications including those manually thematised were imported to ‘NVivo 12 plus’ content management and analysis software package and coded inductively. After a careful manual review and validation of the automated coding to address limitations associated with algorithmic evaluation, themes emerged from the manual analysis and from the automated coding were compared, collated, merged, and refined resulting the initial broad themes (See Section 3 and 4 of the main paper). Although incapable of accomplishing thematic analysis by itself, ‘NVivo 12 plus’ software package has supported the process by offering features that enhance organisation, consistency and automatic coding (Braun & Clarke, 2006). Following the initial thematic analysis, all the selected publications were moved to a separate folder in Mendeley reference manager and tagged according to the themes identified and additional themes were incorporated as they emerged. For consistency and smooth referencing in the future, terms and phrases used for tagging were progressively recorded in a separate document.

What aspect of Digital technology, migration, inequality and development the publication primarily focusses on?

What are the outstanding concepts and themes in relation to Digital technology, migration, inequality and development discussed in the publication?

What is the main theory or argument put forward?
What analytical framework if used?
What is the key finding?
How the argument or finding confirms or contradicts with others?
What uniqueness is observed in the study?
What methodological or theoretical strength is reflected in the study?
Are there any issues or concerns to be noted in the study?
What future research gap is identified by the publication?

Table c: Guiding question for reviewing publications in various themes

4. Challenges and limitations
   4.1. Theoretical challenge

The broad, multidimensional, and fluid nature of the concepts of ICTs, migration, and inequality/development has posed theoretical complexity in marrying theories emerged from different dimensions of the literature. Due to the novelty of the study of digital technology in the context of migration, and inequality/development as a nexus, matured and tested analytical frameworks are hardly available notwithstanding this might be considered not only as a challenge but also as an opportunity. Furthermore, use of different nomenclature of concepts such as ICTs and different types of migrants in different publication outlets made it difficult to readily locate relevant publications.

4.2. Methodological challenge

The review has been confronted with some methodological challenges. For example, reconciling contents of publication in hard copy format such as paper printed books with the digitally-available publication content has been a challenge. In addition, due to a relatively large number and word count of a range of publications and the availability of only one reviewer, the evaluation, classification, and coding process has been extremely tedious and time consuming. The inclusion of publications written only in English language in the review process can also create a loophole in the review outcome. The review might be also prone to bias as publications were reviewed by one person for in/exclusion decisions.
APPENDIX II: DIGITAL MIGRATION STUDY

Literature shows that digital methods for migration study are becoming popular (e.g., Leurs & Prabhakar, 2018; Leurs & Smets, 2018; Lu et al., 2016; Messias et al., 2016; Sánchez-Querubín & Rogers, 2018; Schrooten, 2012; Zagheni et al., 2014). Mainly influenced by the postcolonial digital humanities and media and migration studies (Risam, 2019), literature in this arena can be viewed in two broad lenses; digital influence in theorisation—ICTs’ influence in re-engineering theories and concepts of migration; and digital influence in methodology—ICTs’ influence in the way migration study is conducted.

Regarding the former, literature suggests that the academic community recognises that theorising migration has been messy and problematic. One of the major problems of theorising migration has been the failure to recognise or to adequately reflect the fact that the migration world is a circulatory, dynamic, and complex system rather than organised and stable structure that can be studied with stable methods and theories (Castles, 2010; Diminescu, 2008; Urry, 2012). Most migration theories tend to suffer from separating mobilities of migrants from that of sedentary populations, migration routes from metropolitan journeys, cross-country circulations from vicinity movements, regional policies and culture from global influences, etc (Diminescu, 2008). However, there is increasing recognition of the flaws of early migration theories primarily those of the pre-1980s which tended to conceptualise migration in a simple pull-push model by emphasising merely individuals; and lacking synthesis of ethnographic descriptions of migration linking the macro level models of economics, geography and demography (Bakewell, 2008; Castles, 2010; Diminescu, 2008; Faulkner et al., 2019; Nieuwenhuys & Pecoud, 2007). Such conceptualisation of migration in terms of a simplistic push and pull model has been challenged and attracted responses such as Appadurai’s (1990) multidimensional model of disjuncture theory (Faulkner et al., 2019).

As Castles (2010) argues, to fit its purpose, the contemporary digital technology-mediated migration needs to be theorised vis-à-vis the “social transformative” perspective at various social, temporal and spatial levels (p. 1583). Local, regional or global migration phenomenon cannot be fully understood without thoughtful consideration of the connectivity among various localities and mediations at different levels. As Messias et al., (2016) agree, despite the increasing expansion of digital technologies, linking theory with data remains a challenge in migration study. Although modern technological developments have improved the collection and use of migration data, matters such as lack of data and limitations related to the production, harmonisation and use of cross-country data particularly from the “Global South” continues to constrain not only the empirical evidence but also the development and testing of migration theories (Messias et al., 2016). For example, the lack and insufficiency of empirical evidence on “South-South” migration remains a challenge. This has posed a limitation both in understanding the contextual dynamics of migration in the region, and in informing the overarching migration theories that can enhance the development of migration theories by delivering evidence for theoretical continuity across “South-North” (Nawyn, 2016). ICTs’ increasing entwinement with migration warrants reimagining migration theorisation for a more nuanced understanding of the contemporary ICT-influenced migration.

Regarding methods, the literature indicates that digital technology and online communications highly influence the methodology of the contemporary migration study (e.g., see Dekker & Engbersen, 2014; Kotyrlo, 2019; Leurs & Smets, 2018; Table 1 in the main text). Consequently, various scholars suggest a range of approaches to studying migration in the age of digital technology. However, there is tension between different scholars’ approaches which appear to focus on the way the interplay between ‘continuity’ and ‘rupture’ associated with migrants and their relationship with their environment across different space and time is explained. For example, in early 1990s, researchers such as Tarrius (1989) cited in (Diminescu, 2008) suggested a simultaneous three layers of analysis to understand the time- and space-based relationships of migrants within their networks.
and their environment—the “mobility paradigm”, namely: movement of proximity, movement within the host space, and large-scale international migrations (Diminescu, 2008). By adding the fourth layer reflecting the role of digital technology in the migration dynamics to Tarrius’s (1989) model, Diminescu (2008) suggests that the contemporary digital technology-influenced migration can be better explained by understanding mobility in all its physical, imaginary, and virtual modes, and perceiving the continuum in space and time associated with the multiple movements that are accumulated and articulated in the practices of people.

One application of digital technology in migration research is the use of online data and communication traces. For example, with its limitations, Messias et al. (2016) used “places lived” data from Google+ online data to study migration flows among clusters of countries. As the authors already acknowledged, such application of online data to study complex migration phenomenon such as demography or migration flow can be delicate. The obvious drawback is that such data is not representative of the broader migratory population but the thin slice of it—those who access and use technology. As elucidated in Section 6, the availability and use of a vast amount of online data—often termed as “big data”—as a result of intensive use of ICTs by migrants raises important ethical issues; and rigorous research on this delicate area is deficient (Taylor, 2016).

Generally, ICTs are increasingly influencing the way migration is conceptualised and migration studies are conducted. However, focused, and rigorous research investigating the safe use of digital methods for migration studies is rare.
INFORMATION SOURCES AND ANXIETY AMONG REFUGEES IN KENYA DURING COVID-19

Matthew A. McGee, Pennsylvania State University, mam8223@psu.edu
Carleen Maitland, Pennsylvania State University, cmaitland@ist.psu.edu
Dorothy Njoroge, United States International University-Africa, dwanjiku.n@gmail.com

Abstract: In the COVID-19 pandemic, refugees’ access to information has become increasingly important given the rapid change in the scientific and public health knowledge-base. However, this access is complicated by social distancing requirements that disrupt traditional in-person communication. Many refugees must then rely on alternative information sources to stay informed. Differences in media types and information sources in turn may be related to anxieties arising from the virus and perceptions of others’ adherence to recommended protective behaviors. We examine these relationships with survey data from 1,000 refugees living in both camps and non-camp settings in Kenya. Using logit models, we test relationships between information source and anxiety and the effect of these variables on refugees’ expected behaviors of community members. Our primary contributions include the finding that information sources consistently exacerbate (e.g., Facebook) or ameliorate (e.g., news from the internet) different anxieties, or can have mixed effects (e.g., radio). We also find that anxiety and information have significant impacts on refugees’ expectations of compliance by others and that, whether between camps or between camps and non-camp locales, findings vary by location. Our results have implications for refugee media and infectious disease anxiety scholarship as well as for managing infectious disease response.

Keywords: Refugees, COVID-19, Information, Anxiety, Social Perception

1. INTRODUCTION

The COVID-19 pandemic has affected people across the globe, including refugees. It has disrupted traditional inter-personal communication channels, making information on COVID-19 more difficult to obtain. This lack of information may exacerbate refugees’ pre-existing anxieties. However, a variety of media, from national and local radio, to mobile-phone-based sources (SMS/WhatsApp) may fill the gap, and help assuage pandemic fears. In general, it has been found that during pandemics, people’s adherence to recommended behaviors is influenced by individual factors, such as self-efficacy, and social factors (Farooq et al., 2020), including perceptions of others’ adherence (Desclaux et al., 2017). In turn, media and information sources may influence these perceptions (Allington et al., 2020). These media sources may play an even greater role in refugee camps where access to information is more limited due to their typically rural locations and smaller personal networks. We investigate these relationships among refugee populations, which may have locationally determined media and information sources.

To study these relationships, we analyze the COVID-19 related information sources, anxiety sources, and perceptions of other’s adherence to virus mitigation strategies reflected in data from the United Nations High Commissioner for Refugees’ (UNHCR) Kenya COVID-19 Rapid Response Survey. The data set includes 16 information sources and 10 distinct sources of Covid-19 anxiety. We analyze relationships between information sources and anxiety through logistic regression models for specific locales. Next, using logistic regression, we examine the combined
impact of information sources and anxiety on perceptions of others’ compliance with recommended behaviors.

The paper is structured as follows. First is the review of the literature on refugees and infectious disease outbreaks, including their media and information environments, disease-related anxiety, and the behavioral intentions and social perceptions related to recommended behaviors. Second is background information on the media and information environment in Kenya as well as a descriptive analysis of the dataset. This is followed by presentation of the findings. Finally, is a discussion of the implications of this study.

2. LITERATURE REVIEW

In the following sections we present the aforementioned three-part literature review. Along with describing how media, anxiety, and expectations of others play a role in the normal lives of refugees, we analyze how they may differ under pandemic settings and consider the interactive relationships between them.

2.1. Media and Information Environment

Two established media theories, the knowledge gap and media repertoires, inform our analysis of the media environment of refugees. The knowledge gap theory provides the rationale for media use in accessing Covid-19 information, while media repertoires emphasizes the multi-media environment of refugees. In the past, the knowledge gap theory has been used to describe the inequality in information acquisition from mass media due to socioeconomic factors (Tichenor, Donohue, & Olien, 1970). However, research on information attainment related to infectious diseases suggests more nuanced analyses are required (Ho, 2012; Bekalu and Eggermont, 2014). Ho (2012) found that the knowledge gap hypothesis was not supported in her study of public knowledge of the H1N1 flu pandemic in Singapore. However, differences were found in the knowledge gap size within her sample based on the type of media used. Bekalu and Eggermont (2014) show that mass media usage widens the regional gap of HIV/AIDS knowledge between urban and rural communities in northwestern Ethiopia. This importance of location in infectious disease knowledge was corroborated by Agegnehu and Tesema (2020) in their study of HIV/AIDS in Ethiopia. The results from these studies show that, while socioeconomic status and media usage are not predictive of infectious disease knowledge, gaps in knowledge of infectious diseases tend to have other underlying influences, like community location and media type.

The media repertoires framework recognizes diverse media use behaviors and underpins our analysis of the relationships between media. Kim (2016), in a study of Korean media use, identified five different media repertoires (e.g., news on traditional media, internet only) and explains these differences with both individual and structural factors. Similarly, Jang and Park (2016) examine complementarity and substitutability between media. Their analysis of Korean users and the role of devices investigates substitutability between paper and computers in consuming news, and computers and telephones in consuming informative content. Peters and Schroder (2018) combine media repertoires with news repertoires, integrating a socio-spatial component. However, the spatial component is on a micro-scale, referring to local situations of media use, such as within a household or on a bus.

Spatial elements are important in the context of refugee communities, as many reside in camps or urban centers. These dense collections of individuals can increase the likelihood of heterogeneity in media sources. Both within camps and between camp-based and urban refugees, differences in wealth, education, literacy, and multilingualism can all affect access to Covid-19 information. As noted by Kumpel (2020), simple heterogeneity in interest levels can affect people’s access to news, particularly via social media networks where algorithms use past behaviors to serve up personalized
content. This heterogeneity in demographic factors can lead to differences between groups in the usage of media to gain information on and cope with anxiety caused by COVID-19 (Pahayahay and Khalili-Mahani, 2020).

2.2. Anxiety

The stresses of forced displacement prior to, during, and post-migration contribute heavily to an increased risk of anxiety among refugees (Hameed et al., 2018). For example, Karenni refugees residing along the Burmese-Thai border see anxiety rates as high as 42% (Vonnahme et al., 2015). Hameed et al. write in their 2018 review article that this increased prevalence of anxiety is due to trauma from violence and political oppression, the resulting lack of basic necessities, and lasting concerns of safety and uncertainty for the future.

Infectious diseases like COVID-19 can exacerbate anxieties by triggering pre-existing traumas, hindering the flow of information, and furthering social isolation. The natural concerns that many people have surrounding illness and death are compounded for refugees, who in many cases are limited in their ability to check on the health of their friends and family in their home countries (Rees and Fisher, 2020). Anxieties surrounding one’s health during an infectious disease outbreak are made worse in refugee camps where medicine and healthcare are already strained due to overcrowding, poor hygiene, and lack of resources (Hermans et al., 2017). Further, the necessary diversion of health resources towards fighting an infectious disease can then limit access to healthcare services for refugees with preexisting mental illnesses (El-Khatib et al., 2020).

An additional source of anxiety for refugees during infectious disease outbreaks is the lack of information due to communication barriers (Bukuluki et al., 2020). Many refugees face communications barriers due to language differences between their home and hosting countries. This barrier can prevent them from receiving public health and educational messages from governmental sources. Language barriers can also expose refugees to public health misinformation from their peers and informal social networks (Bukuluki et al., 2020). This stress-inducing lack of information and confusing misinformation serve as additional sources of anxiety.

COVID-19 has contributed to refugees’ anxiety through social distancing policies, which have the potential to exacerbate the already common social isolation of refugees. Social support and connectedness are important for refugee recovery following trauma, but their inability to make new connections due to social distancing inhibits this (Rees and Fisher, 2020). A lack of social support and connectedness, along with financial hardships due to social distancing, can contribute to increased feelings of loneliness and anxiety (El-Khatib et al., 2020). The isolation effects of social distancing may be even more exaggerated for refugees, who tend to be seen as transmitters of the virus due to their migratory status (Bukuluki et al., 2020).

Quarantining policies can be especially traumatic for refugees as well, some of whom have previously experienced forced detainment and restricted freedom of movement (Rees and Fisher, 2020). Properly explained reasoning for the importance of quarantining could alleviate this anxiety, but the aforementioned communication barriers do not always make this possible. This same issue often results in a fear of the uncertainty related to quarantining policies (El-Khatib et al., 2020). In some situations, stringent movement restrictions can even prevent refugees from accessing resources like communal sources of water (Bukuluki et al., 2020). Disruptions to refugees’ rights and daily routines like these act as additional sources of anxiety.

2.3. Behavioral Intentions and Social Perceptions

Adherence to quarantining and other social distancing policies is influenced in part by social and cultural norms (Webster et al., 2020). During the 2003 SARS outbreak in Toronto, individuals reported that they felt social pressures to adhere to quarantining (Cava et al., 2005). These pressures
are dual sided, though, in that when it is known that some individuals have broken quarantine, others are more likely to break protocols as well (Braunack-Mayer et al., 2013). Desclaux et al. (2017) find that cultural pressures to quarantine during the 2014-2016 West Africa Ebola epidemic existed on both the household and the community level. They write that study participants recognized the collective commitment to protecting their community, and that failure to comply was seen as disrespectful.

Along with social perceptions, one of the greatest motivating factors for adherence to virus-mitigating behavioral changes is fear of the virus. In their international sample on COVID-19 behavioral changes, Harper et al. (2020) found that fear of the virus and anxiety related to it were predictors of health-compliant behavioral changes. Other factors like moral or political orientation were not nearly as significant in determining behavioral intentions. Clark et al. (2020) saw similar results in their international study on COVID-19 compliance behaviors. They found that those who wanted to prioritize their own health and believed that behavioral changes would have an effect were the most likely to comply.

Media was also found to influence health-protective behavioral intentions. Specifically, Allington et al. (2020) saw that COVID-19 conspiracy theories resulting from misinformation on social media were a contributing factor to non-compliance with health-protective behaviors. On the other hand, usage of traditional forms of broadcast media had a positive relationship with health-protective behaviors. The authors posit that the reason for these trends observed in their UK sample is that broadcast media is regulated, whereas social media is not.

The above discussion highlights the role of location and media type on infectious disease knowledge of refugees, as well as the types and combinations of media use. It also examines refugee anxiety and the exacerbating role of the pandemic. Of note are the informational aspects, such as the relationship between anxiety and lack of information, as well as the effect of social distancing on information. Finally, the literature review highlights the role of fear of the virus, a form of anxiety, as well as media, on intentions to comply with behavioral recommendations.

While these findings suggest a relationship between information sources, anxiety, and Covid-19 expectations of compliance, comprehensive quantitative evidence is lacking. Specifically, the relationship between information sources and particular sources of Covid-19 anxiety require further investigation. Similarly, while logically media and fear of the virus are likely to impact expectations of others’ compliance, little evidence of this relationship among refugees exists. In the following, we examine these associations, specifically investigating:

RQ1: How are refugees’ information sources and specific Covid-19 anxieties related? What role does location play?

RQ2: How are refugees’ information sources and specific Covid-19 anxieties related to expectations of others’ compliance to recommended behaviors? What role does location play?

3. BACKGROUND AND METHODS

Our research is influenced by the Kenyan refugee and media context. UNHCR Kenya (2020) reports the majority of refugees originate from Somalia (54%) and South Sudan (24.6%). Refugees primarily reside in camps, with 44% living in Dadaab, 40% in Kakuma/Kalobeyei, and 16% in urban areas (UNHCR, 2021).

Kenya’s media environment is highly-competitive, with one of the most vibrant and well-produced media in the African continent (BBC, 2019). With a literacy rate of 82% (World Bank, 2018), Kenyans consume a wide array of media in English, Kiswahili, and local languages. Currently, Kenya has six dailies, regional publications and various kinds of magazines. While newspapers are mainly concentrated in urban areas, they have a pass along rate of 10-14, greatly increasing their
reach (Obuya and Ong’ondo, 2019). Furthermore, digital editions also extend the reach. This is alongside more than seventy television stations and over 160 radio stations according to the Media Council of Kenya website.

Kenya’s Internet penetration is one of the highest in Africa at 87.2% (Internet World Stats), occurring primarily through mobile phones (83%) (Namunwa, 2019). However, due to high data costs only 13 million of the 43.3 million Kenyans with access to a phone are active users.

Unsurprisingly, radio remains the most popular medium, followed by television. Media concentration and cross-ownership is an area of concern with 5 privately owned media networks dominating media ownership in the country (Obuya and Ong’ondo, 2019). However, the government-owned media, Kenya Broadcasting Corporation has extensive reach across the country and runs several radio stations and a couple of television outlets.

To study how the consumption of COVID-19 information from these sources impacts refugee anxiety and social perceptions, we utilize public survey data from the World Bank. We first provide descriptive statistics of COVID-19 information sources, anxieties, and social perceptions of others among refugees on a regional level for contextual understanding. After conducting ANOVA and Tukey tests for differences in means among social perceptions, we construct a series of logit models in an attempt to explain why. We first test whether individuals’ COVID-19 information sources are predictors for their related anxieties and then for whether their information sources and anxieties predict their perceptions of others adherence to protective guidelines. We chose to use logistic regression models for these tests because of the binary nature of our survey data and the utility of testing significance of both the overall model and the individual predictors as well as the availability of metrics on model fit.


Our data comes from a publicly available survey by the World Bank, together with Kenyan National Bureau of Statistics, UNHCR, and the University of California, Berkeley, from May to August of 2020. The group conducted a high frequency phone survey in Kenya to monitor the socioeconomic impact of COVID-19 on households throughout the country. Survey participants came from three different sources: randomly drawn from a subset of the 2015/2016 Kenya Integrated Household Budget Survey, randomly generated phone numbers, and UNHCR’s list of registered camp-based and non-camp-based refugees. Limiting the sample to those self-reporting to be refugees produced a sample of 948 respondents.

While the broader survey’s primary focus was the economic impact of COVID-19, sections also addressed subjective health and well-being, knowledge of COVID-19, household and social relations, media and information sources used for Covid-19 information, anxieties related to the pandemic, and perceptions of the adherence of other households to recommended behaviors (e.g., social distancing). Questions employed an open response format, where responses were coded by the survey team. For instance, participants were asked: “What sources have provided you with information about Covid-19?” with the choice to name a medium or a source. Results identified 16 Covid-19 information sources/media and 10 Covid-19 anxiety variables.

Our dependent variable ‘expectations of others’ compliance’ was measured as the number of households out of 10. This measure is appropriate due to social desirability concerns biasing responses to direct questions about individuals’ intentions to comply.

3.2 Descriptive Statistics

Table 1 shows the demographics of the four sample locations (Dadaab, Kakuma, and Kalobeyei camps, and other areas) as well as for the overall sample. While the original survey collected data on refugees’ county of residence, the anonymized data set released by UNHCR designates location
only as a specific camp or ‘other.’ While UNHCR often interprets ‘other’ as ‘urban,’ since it is strictly unknown, here we maintain the dataset label of ‘other.’ However, in our analysis, following UNHCR, we often imply ‘other’ as associated with urban locale. Values represented in parentheses show the proportion relative to the locales’ sample size. ‘No formal’ indicates no education and pre-primary education; ‘primary’ indicates primary education and vocational schools; ‘college’ indicates middle level college, university undergraduate, and university postgraduate schooling; and ‘other’ indicates all other forms of education including Madrassa and Duksi.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dadaab</th>
<th>Kakuma</th>
<th>Kalobeyei</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>218,730</td>
<td>196,666</td>
<td>38,546</td>
<td>80,750</td>
<td>494,289</td>
</tr>
<tr>
<td>N</td>
<td>119 (0.0005)</td>
<td>384 (0.0019)</td>
<td>223 (0.0058)</td>
<td>258 (0.0032)</td>
<td>948 (0.002)</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>64 (0.54)</td>
<td>183 (0.53)</td>
<td>142 (0.64)</td>
<td>156 (0.60)</td>
<td>545 (0.57)</td>
</tr>
<tr>
<td>Female</td>
<td>55 (0.46)</td>
<td>165 (0.47)</td>
<td>81 (0.36)</td>
<td>102 (0.40)</td>
<td>403 (0.43)</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-23</td>
<td>15 (0.13)</td>
<td>72 (0.21)</td>
<td>11 (0.14)</td>
<td>45 (0.17)</td>
<td>164 (0.17)</td>
</tr>
<tr>
<td>23-28</td>
<td>22 (0.18)</td>
<td>65 (0.19)</td>
<td>32 (0.24)</td>
<td>53 (0.21)</td>
<td>193 (0.20)</td>
</tr>
<tr>
<td>28-33</td>
<td>20 (0.17)</td>
<td>51 (0.15)</td>
<td>53 (0.16)</td>
<td>45 (0.17)</td>
<td>141 (0.16)</td>
</tr>
<tr>
<td>33-38</td>
<td>13 (0.11)</td>
<td>49 (0.14)</td>
<td>35 (0.20)</td>
<td>34 (0.13)</td>
<td>142 (0.15)</td>
</tr>
<tr>
<td>38-43</td>
<td>9 (0.08)</td>
<td>42 (0.12)</td>
<td>46 (0.11)</td>
<td>25 (0.097)</td>
<td>100 (0.11)</td>
</tr>
<tr>
<td>43-48</td>
<td>12 (0.10)</td>
<td>31 (0.09)</td>
<td>24 (0.045)</td>
<td>23 (0.09)</td>
<td>76 (0.08)</td>
</tr>
<tr>
<td>48-53</td>
<td>12 (0.10)</td>
<td>16 (0.05)</td>
<td>10 (0.04)</td>
<td>13 (0.05)</td>
<td>50 (0.05)</td>
</tr>
<tr>
<td>53-58</td>
<td>7 (0.06)</td>
<td>12 (0.03)</td>
<td>9 (0.005)</td>
<td>9 (0.04)</td>
<td>29 (0.03)</td>
</tr>
<tr>
<td>58-63</td>
<td>5 (0.04)</td>
<td>5 (0.01)</td>
<td>1 (0.01)</td>
<td>5 (0.02)</td>
<td>17 (0.018)</td>
</tr>
<tr>
<td>63</td>
<td>4 (0.03)</td>
<td>5 (0.01)</td>
<td>0 (0.00)</td>
<td>6 (0.023)</td>
<td>15 (0.015)</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No formal</td>
<td>38 (0.32)</td>
<td>66 (0.19)</td>
<td>39 (0.17)</td>
<td>27 (0.10)</td>
<td>170 (0.18)</td>
</tr>
<tr>
<td>Primary</td>
<td>35 (0.29)</td>
<td>99 (0.28)</td>
<td>66 (0.30)</td>
<td>72 (0.28)</td>
<td>272 (0.29)</td>
</tr>
<tr>
<td>Secondary</td>
<td>27 (0.22)</td>
<td>129 (0.37)</td>
<td>84 (0.38)</td>
<td>98 (0.38)</td>
<td>338 (0.35)</td>
</tr>
<tr>
<td>College</td>
<td>4 (0.03)</td>
<td>28 (0.08)</td>
<td>23 (0.10)</td>
<td>47 (0.18)</td>
<td>102 (0.11)</td>
</tr>
<tr>
<td>Other</td>
<td>15 (0.13)</td>
<td>26 (0.08)</td>
<td>11 (0.05)</td>
<td>14 (0.06)</td>
<td>66 (0.07)</td>
</tr>
</tbody>
</table>

Table 1. Sample Demographics by Location (%)

In each of the locations the sample consists of more men than women, with the greatest difference being in the Kalobeyei Settlement where 64% of the respondents are male. For privacy, participants ages are partitioned into 5-year intervals. Participants ages ranged from 18 to 63 and above, with over 50% falling in the age range of 18 to 38, both in the total sample and in each location. Some variation exists between locations with regards to educational attainment, but in all cases the majority of individuals have attained either primary or secondary education. The Dadaab camp has lower educational attainment rates, but higher forms of other education including madrassa. In the non-camp locations, refugees have higher educational attainment levels.

In Tables 2 and 3 below, values represent the number of participants in each location mentioning the information source or anxiety respectively, with the relative proportion to the sample in parentheses. Since these values come from multiple response questions, proportions will not sum to 1 for any location.

As indicated in Table 2, information sources ranged from traditional mass media (newspapers, radio, TV) and newer forms (internet news, Facebook) as well as traditional interpersonal sources such as friends and family. In between these broadcast and inter-personal modes, are a variety that could enable sharing of information with small groups or communities (e.g., SMS/WhatsApp) and focus...
on the source rather than the medium (religious leaders, local medical professionals, etc.). In the combined sample, the most common information sources, in order, are national radio, TV, news on the internet, international or government agencies, and WhatsApp or SMS. It’s interesting to note that four of the top five identified are in fact the medium rather than the source.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Dadaab (0.13)</th>
<th>Kakuma (0.21)</th>
<th>Kalobeyei (0.18)</th>
<th>Other (0.59)</th>
<th>Total (0.29)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV</td>
<td>15</td>
<td>72</td>
<td>39</td>
<td>153</td>
<td>279</td>
</tr>
<tr>
<td>Newspaper</td>
<td>2 (0.20)</td>
<td>18 (0.052)</td>
<td>10 (0.045)</td>
<td>20 (0.078)</td>
<td>50 (0.053)</td>
</tr>
<tr>
<td>National Radio</td>
<td>25 (0.20)</td>
<td>99 (0.28)</td>
<td>84 (0.38)</td>
<td>112 (0.43)</td>
<td>320 (0.34)</td>
</tr>
<tr>
<td>Local Radio</td>
<td>63 (0.53)</td>
<td>50 (0.14)</td>
<td>16 (0.072)</td>
<td>26 (0.10)</td>
<td>155 (0.16)</td>
</tr>
<tr>
<td>Billboards or Posters</td>
<td>2 (0.017)</td>
<td>11 (0.032)</td>
<td>10 (0.045)</td>
<td>5 (0.019)</td>
<td>28 (0.03)</td>
</tr>
<tr>
<td>International or Government Agencies</td>
<td>33 (0.28)</td>
<td>104 (0.30)</td>
<td>72 (0.32)</td>
<td>52 (0.20)</td>
<td>261 (0.28)</td>
</tr>
<tr>
<td>NGOs or CBOs</td>
<td>12 (0.10)</td>
<td>74 (0.21)</td>
<td>62 (0.28)</td>
<td>6 (0.023)</td>
<td>154 (0.16)</td>
</tr>
<tr>
<td>News on the Internet</td>
<td>17 (0.14)</td>
<td>84 (0.24)</td>
<td>50 (0.22)</td>
<td>115 (0.45)</td>
<td>266 (0.28)</td>
</tr>
<tr>
<td>Facebook</td>
<td>4 (0.034)</td>
<td>45 (0.13)</td>
<td>11 (0.049)</td>
<td>33 (0.13)</td>
<td>93 (0.098)</td>
</tr>
<tr>
<td>Twitter</td>
<td>2 (0.017)</td>
<td>12 (0.034)</td>
<td>5 (0.022)</td>
<td>7 (0.027)</td>
<td>26 (0.027)</td>
</tr>
<tr>
<td>WhatsApp or SMS</td>
<td>10 (0.084)</td>
<td>75 (0.22)</td>
<td>42 (0.19)</td>
<td>79 (0.30)</td>
<td>206 (0.22)</td>
</tr>
<tr>
<td>Friends, family, or colleagues</td>
<td>32 (0.27)</td>
<td>69 (0.20)</td>
<td>54 (0.24)</td>
<td>55 (0.21)</td>
<td>210 (0.22)</td>
</tr>
<tr>
<td>Local medical professional</td>
<td>1 (0.008)</td>
<td>16 (0.046)</td>
<td>20 (0.09)</td>
<td>7 (0.027)</td>
<td>44 (0.046)</td>
</tr>
<tr>
<td>Other medical professional</td>
<td>1 (0.008)</td>
<td>13 (0.037)</td>
<td>5 (0.022)</td>
<td>4 (0.016)</td>
<td>23 (0.024)</td>
</tr>
<tr>
<td>Political leaders</td>
<td>1 (0.008)</td>
<td>3 (0.009)</td>
<td>1 (0.004)</td>
<td>1 (0.004)</td>
<td>6 (0.006)</td>
</tr>
<tr>
<td>Religious leaders</td>
<td>7 (0.059)</td>
<td>15 (0.043)</td>
<td>12 (0.054)</td>
<td>3 (0.012)</td>
<td>37 (0.039)</td>
</tr>
</tbody>
</table>

Table 2. Information Variables by Location (%)

For most information sources, significant variation exists between locations. In ‘other’ locations the traditional mass media of TV and national radio were the most popular. The most evident location-specific differentiation is the usage of local radio in Dadaab, where over 50% of survey participants reported using the medium as a COVID-19 information source, while less than 15% of participants in all other locations did. This is most likely due to the local Somali-language radio station built and operated in Dadaab. Notable differences also exist between camps in use of news on the internet and WhatsApp/SMS, which are hardly mentioned in Dadaab but account for roughly 20% of mentions in the other two camps.

In a similar fashion, the frequencies of anxiety sources for each location and the total sample are available in Table 3. While a significant factor structure was not identified, subjects identified anxiety sources that roughly fall into three categories: individual and community health, social welfare systems, and broader economic concerns and uncertainty. Anxiety related to the two specific variables death and infection are by far the greatest reported, both overall and consistently in each location. Over 65% of all participants cite them as a source of anxiety.

Like the information source variables, some variation exists between locations for each anxiety source, however it is less pronounced. The greatest difference between locations is in anxiety related to food security, with the Dadaab camp again being the stand out case, where 32% of surveyed individuals reported this anxiety, as opposed to the 20% average in the other three locations. Also, with the lowest proportions of anxieties concerning food, healthcare, and education, refugees living outside of camps have the highest proportion of reported anxieties related to employment and the economy, and 14% cite ‘uncertain ends’ as an anxiety source.
McGee et al. 
Refugee Covid-19 Information Sources

<table>
<thead>
<tr>
<th>Anxiety Source</th>
<th>Dadaab</th>
<th>Kakuma</th>
<th>Kalobeyei</th>
<th>Other</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infection</td>
<td>81 (0.68)</td>
<td>247 (0.64)</td>
<td>164 (0.74)</td>
<td>177 (0.69)</td>
<td>669 (0.71)</td>
</tr>
<tr>
<td>Death</td>
<td>70 (0.59)</td>
<td>232 (0.60)</td>
<td>147 (0.66)</td>
<td>171 (0.66)</td>
<td>620 (0.65)</td>
</tr>
<tr>
<td>Infecting Others</td>
<td>42 (0.35)</td>
<td>129 (0.34)</td>
<td>67 (0.30)</td>
<td>58 (0.13)</td>
<td>296 (0.31)</td>
</tr>
<tr>
<td>Employment</td>
<td>7 (0.059)</td>
<td>48 (0.125)</td>
<td>24 (0.11)</td>
<td>50 (0.19)</td>
<td>129 (0.14)</td>
</tr>
<tr>
<td>Economy and Mobility</td>
<td>11 (0.092)</td>
<td>46 (0.12)</td>
<td>29 (0.13)</td>
<td>47 (0.18)</td>
<td>133 (0.14)</td>
</tr>
<tr>
<td>Education</td>
<td>10 (0.084)</td>
<td>57 (0.15)</td>
<td>26 (0.12)</td>
<td>18 (0.07)</td>
<td>111 (0.12)</td>
</tr>
<tr>
<td>Healthcare</td>
<td>24 (0.20)</td>
<td>71 (0.19)</td>
<td>26 (0.12)</td>
<td>18 (0.07)</td>
<td>139 (0.15)</td>
</tr>
<tr>
<td>Food Insecurity</td>
<td>38 (0.32)</td>
<td>99 (0.26)</td>
<td>41 (0.18)</td>
<td>43 (0.17)</td>
<td>221 (0.23)</td>
</tr>
<tr>
<td>Uncertain End</td>
<td>2 (0.017)</td>
<td>29 (0.076)</td>
<td>14 (0.063)</td>
<td>37 (0.14)</td>
<td>82 (0.086)</td>
</tr>
<tr>
<td>Other</td>
<td>1 (0.008)</td>
<td>9 (0.023)</td>
<td>8 (0.036)</td>
<td>3 (0.012)</td>
<td>21 (0.022)</td>
</tr>
</tbody>
</table>

Table 3. Anxiety Variables by Location (%)

Next, is the data reflecting refugees’ perceptions of the number of households following COVID-19 preventative measures. Summary data are depicted in Figure 1 with each panel representing the location in its title. Most respondents believe that all other households (10/10) in their community are adhering to preventative measures. Variation does exist, however, with 21% believing that 5 or fewer households out of 10 are following these practices.

![Figure 1. Perception of Adherence](image)

Overall, on average, respondents believed roughly 8 out of 10 households in their community were compliant, but a one-way analysis of variance test shows statistically significant differences across locations. The location with the highest average is ‘other’ locations (8.80), followed by Dadaab Camp (8.68), then Kalobeyei (8.00) and Kakuma (7.49), in last. A follow up Tukey multiple pairwise-comparison confirms a statistically significant difference between the means of Kakuma.
and Dadaab, Kakuma and other locations, and Kalobeyei and other locations. These analyses are shown in full in Tables 4 and 5, with ** indicating p<0.05 and *** indicating p<0.01. With this knowledge that perceptions of others vary by location, we have reason to investigate if this is due to differing information sources and related anxieties.

<table>
<thead>
<tr>
<th>Location</th>
<th>Df</th>
<th>Sum Sq</th>
<th>Mean Sq</th>
<th>F value</th>
<th>Pr(&gt;F)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td>3</td>
<td>315</td>
<td>105.16</td>
<td>13.99</td>
<td>6.34e-9***</td>
</tr>
<tr>
<td>Residuals</td>
<td>928</td>
<td>6977</td>
<td>7.52</td>
<td></td>
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</tr>
</tbody>
</table>

**Table 4. One-way ANOVA Table for Perception of Adherence**

<table>
<thead>
<tr>
<th>Difference</th>
<th>Lower</th>
<th>Upper</th>
<th>Adjusted p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kakuma-Dadaab</td>
<td>-1.1767</td>
<td>-1.933</td>
<td>0.0003887***</td>
</tr>
<tr>
<td>Kalobeyei-Dadaab</td>
<td>-0.6707</td>
<td>-1.478</td>
<td>0.1362</td>
</tr>
<tr>
<td>Other-Dadaab</td>
<td>0.2023</td>
<td>-0.5867</td>
<td>0.9912</td>
</tr>
<tr>
<td>Kalobeyei-Kakuma</td>
<td>0.5060</td>
<td>-0.1034</td>
<td>0.1422</td>
</tr>
<tr>
<td>Other-Kakuma</td>
<td>1.379</td>
<td>0.7934</td>
<td>&lt;0.0001***</td>
</tr>
<tr>
<td>Other-Kalobeyei</td>
<td>0.8729</td>
<td>0.2232</td>
<td>0.003190**</td>
</tr>
</tbody>
</table>

**Table 5. Tukey HSD for Perception of Adherence**

4. FINDINGS

Next, we examine our research questions using logistic regression models. For a first look at the effect of information sources on anxieties, a logistic regression model for each anxiety source was created. In each model (see Table 6), the anxiety source serves as the dependent variable and the information sources act as independent variables. Each column in the table represents a logistic regression model for the corresponding anxiety source. Values in each row are the model coefficients. The first row displays the Nagelkerke pseudo-R² value for each model. Each of these models is significant, but adjusted R² values range from 0.031 to 0.369.

Facebook is the most frequently significant variable (8 out of 9 models) and National Radio and NGOs or CBOs follow closely behind (7 out of 9 models each). Some media source variables tend to have similar coefficient signs across all anxiety models, suggesting these sources systematically exacerbate or ameliorate anxiety. Others have mixed effects.

Assessing information sources and numbers of different anxiety sources affected, the ‘consistently exacerbates anxiety’ category includes TV (3), newspapers (2), and Facebook (8). Conversely, the information sources in the ‘consistently ameliorates anxiety’ category are ‘News on the Internet’ (6 significant anxiety sources), WhatsApp/SMS (3), and ‘Friends, family, or colleagues’ (5). In the mixed-effects category (negative/positive effects on anxiety sources) are national radio (4/3), local radio (4/2), international/government agencies (2/2), and NGOs/CBOs (6/1). Also, no anxiety source had a consistent relationship with each information source. Instead, it appears that each anxiety source had both positive and negative significant relationships among the information sources. This further emphasizes the influence of the information source on anxiety.

Also of note are the models with the lowest and highest adjusted R² values. The models predicting anxiety related to getting infected and dying have the lowest adjusted R² values, suggesting that consumption of Covid-19 information does not increase refugee anxiety related to personal wellbeing. However, the three models with the highest adjusted R² values are those predicting anxiety related to healthcare, food, and infecting others. In contrast to the previous models, Covid-19 information consumption plays a relatively more influential role on refugees’ anxiety related to communal wellbeing.
Table 6. Information and Anxiety Logistic Regression Models

Finally, we conducted logistic regression analyses of expectations of compliance to assess the joint impact of information and anxiety (see Table 7). Variables that had low correlation levels were left out to reduce dimensionality. Preliminary analyses included age and gender, but found they were not significant and did little to improve the overall adjusted R² value. Education is the only significant demographic variable, and only for refugees living outside of camps.

Information sources’ associations with expected behaviors in the combined sample include significant positive effects (national and local radio), as well as significant negative effects (Facebook and newspapers). In contrast, the location-specific effects of information sources were difficult to discern. Between camp comparisons are hindered by differences in camps’ information sources. Nevertheless, in the non-camp (‘other’) locations, TV has a significant positive effect on expectations. In both Dadaab and Kakuma, local radio had a significant positive effect. Hence, the consistent and mixed relationships between information and anxiety discussed above are not evident for information and expectations.

Similarly, the relationship between anxiety and expectations of compliance are mixed. In the combined sample, worries related to infection, infecting others, and education are all negatively related to expectations, whereas fears over the economy had a positive relationship. Yet in Dadaab and Kakuma, anxiety related to death had a positive relationship with expectations. Finally, for those outside camps, anxiety had mixed effects. Similar to the combined sample, worries over infecting others and education had a negative impact on expectations, while fears about the economy had a positive relationship.

Assessing the models and predictors overall, each logistic regression model is significant under Chi-square goodness of fit tests and each has an adjusted R² value of 0.38 or greater. Across locations, the model’s explanatory power is greatest for Dadaab and least effective for non-camp locations. Systematic assessment of information and anxiety effects show some consistency in effect. For example, local radio was a significant predictor in Dadaab and Kakuma. Similarly, death anxiety had a positive effect on expectations in both Dadaab and Kakuma. Consequently, it can be concluded that while information sources and anxieties have differing effects, both positive and negative, and their significance varies by location, consistent effects do exist.
Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021

Overall, this research finds refugees’ anxiety sources fall into three general categories: individual and community health, social welfare systems, and broader economic concerns and uncertainty. Between camps and other locales, the nature of anxieties differed. In camps, COVID-19 anxieties were related to community health and social welfare, such as food security and healthcare, while

<table>
<thead>
<tr>
<th>Table 7. Perception of Adherence Logistic Regression Models (p value)</th>
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</table>
Refugees living outside of camps were more concerned with broader economic trends. Further, between-camp comparisons highlighted differences, such as the concern over food security in Dadaab, which is less evident in Kakuma and Kalobeyei. These findings extend the research on refugees’ anxiety related to infectious disease (Hermans et al., 2017; El-Khatib et al., 2020) by analyzing locational differences in the sources of anxiety.

Critically, this study provides unique insights into the relationships between anxiety sources and media types through regression models. These models help delineate media’s relationship with specific sources of anxiety. Media have the lowest impact on anxiety related to personal wellbeing (getting infected and dying) and the highest impact on communal wellbeing (infecting others, healthcare, and food). The analysis also identified media that consistently ameliorate or exacerbate different anxieties such as Facebook (exacerbating) and news on the Internet (ameliorating).

A further unique contribution is insights into the the joint impact of information sources and anxiety on expectations of others’ adherence to recommended Covid-19 behaviors. As media are expected to play a role in shaping individuals’ perceptions of others’ adherence to recommended behaviors (Allington et al., 2020), such expectations can, in turn, influence individual compliance. Of particular note in the analysis is the systematic lack of effect of age and gender, and only a location-specific effect of education. These results deviate from findings related to the role of demographics in general in refugee media use (Pahayahay and Khalili-Mahani, 2020), and gender in particular as relates to refugees’ mobile phone use (Canevez et al. 2021). The limited effect of demographics suggests programs promoting compliance can have broad but locationally-specific effects.

This combined analysis builds bridges between the disparate media effects and anxiety research in the specific domain of infectious disease behavioral compliance. Whereas Harper et al. (2020) and Clark et al. (2020) find fear of the virus promotes compliance, Allington et al. (2020) point to media. The results showing fear of death as related to expectations of others in Dadaab and Kakuma lend further support to the notion that fear of the virus is associated with compliance. In addition is the positive relationship between fear of economic impact and compliance expectations. Conversely, this work identifies anxieties that may hinder compliance, namely fear of infecting others and anxiety about education. Similarly, these findings of the positive relationship between national and local radio as well as TV on perceptions of compliance lend further support to Allington et al.’s (2020) findings, but add the caveat that in Kenyan context, these results will vary by locale.

As such, a key contribution of our overall study is the importance of location in not only assessing anxiety and sources of information but on crafting effective responses to reduce anxieties and promote behavioral compliance. This study has highlighted the locational differences not only between urban and rural locales, but between different rural locales – a finding that may be related to unique sociocultural context of refugee camps, which in the Kenyan context tends to host refugees from different nations. Nevertheless, we do find some consistency in effects of information sources on various anxieties, with some that consistently exacerbate (e.g., Facebook) others ameliorate (e.g., news from the internet), while still others having mixed effects (e.g., radio).

In summary, this study is the first of its kind to examine the relationship between Covid-19 media use and anxiety, with further implications for community expectations concerning compliance with recommended behaviors. It demonstrates significant differences in Covid-19 media use between camps and other locations, as well as between camps themselves. Locational differences in sources of anxiety were also found, although less notable than those in media use. These findings have implications for scholarship on infectious disease management in refugee hosting nations, as well as practical implications for designing information campaigns to reduce anxiety and encourage compliance with recommended behaviors.
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THE QUEST FOR DEVELOPMENT: WHEN SOCIAL MEDIA-BROKERED POLITICAL POWER ENCOUNTERS POLITICAL ‘FLAK JACKETS’

Boluwatife Ajibola, London School of Economics and Political Science (LSE), ajibola.boluwatife50@gmail.com

Abstract: Social media provides an extended space for collective action, as netizens leverage it as a tool for claim-making and for demanding the dividends of governance. However, political regimes often greet expanding use of social media with censorship, which netizens often have to contend with, particularly in the quest for development outcomes. While existing studies having expansively explored multiple uses of social media, the specific features that signal their massive uptake and how this intersects with the quest for political power has not been substantially documented. This paper argues that social media is characterized by social buttons that expedite the multiplication of ‘digital bullets’ – in forms of tweets and perceived detestable comments – which compromise the defense lines of political regimes, hence, their uptake of censorship as metaphorical ‘flak jackets’. This research is conducted on the basis of key informant interviews with voices against social media censorship in Nigeria since the inception of Nigeria’s ruling government in 2015, particularly following the proposed ‘Protection from Internet Falsehood and Manipulations Bill’ in 2019.

Keywords: ICTs, democracy, ICT4D, internet regulation, social media, political power

1. INTRODUCTION

Social media has not only metamorphosed communication lines between and among the peoples of the world, easing interactions and redefining the complexities of human association, but its uptake in civic engagement has also expanded in the last two decades. Pre-existing mediums of information exchange and communication has shifted, to adapt to the presence of social media. As a source for news about public matters (Newman et al. 2014), and conduit for citizens’ political engagement (Boulianne, 2019), social media has connected the world and eliminated boundaries (Van Dijk, 2006). The meagre cost of content exchange among connected audiences, particularly in creating public awareness partly explains its popularity as a tool for political engagement. Importantly, some social networks possess unique features through which audiences gain access to contents.

The instrumentality of social media, and the internet in general, in social networking have undoubtedly transformed the political landscape as people have moved largely from being passive audiences to political messages (Evans, 2010). Political office holders often leverage social media networks in projecting their manifestos, personal and party ideologies; in gaining visibility; reporting periodical achievements; and some in seeking public or sectional approval. However, some, through their social media accounts, are often criticized by aggrieved citizens. Some regimes present themselves as democratic, having pledged their commitment to the promotion of its tenets, however, at some point the feedback lines, or the norm of engagement becomes unacceptable to them, causing them to act in ways contrary to democratic principles.

Vareba et al (2018) notes that internet regulation has become an indispensable tool today for the perpetration of varied forms of vices, and governmental regimes in both democratic and autocratic settings have implemented some of these to restore some forms of ‘sanity’. However, it is found that social media regulations in Africa have been more of threat to freedom than a panacea to checking online vices. African governments have frequently deployed internet regulation as an instrument of
political intimidation and violation of human rights, and as a means to undermining the acquisition and expression of political power by the citizens. While several researchers have investigated the positive and negative uses of the social media, as well as the varied forms of its censorship, inviting further investigation are new research into how political censorship of social media, as a result of its affordances, threaten political power and consequent socio-economic development. So far, also, there has been little discussion about the democracy-development nexus, in the context of evolving privileges of social media to citizens, especially in Africa.

Acemoglu and Robinson (2008) theorize that for economic institutions and policies to be changed in a credible way, people need to acquire political power. They distinguish between two components of political power – de jure (institutional) and de facto political power. De jure, political power originates from political institutions in the society, while de facto political power originates from outside the sphere of political institutions, whereby, people through revolts or collective action pursue and impose their development objectives. With de jure political power originating from political institutions, one of which is democracy – “a set of political institutions” (Acemoglu and Robinson, 2008), and de facto leveraging collective action, it is imperative to understand how socio-economic development can be hindered through the repression of digital tools or contraction of spaces through which people acquire and demonstrate political power. Ultimately, this paper argues that social media enhances the acquisition of political power requisite for securing desired socio-economic development objectives including those not prioritized by political regimes. It goes further to conclude that netizens leverage ‘digital bullets’ of social media in acquiring political power – actions which are in-turn greeted by repression by political regimes, especially when their ‘defense lines’ are perceived to have been compromised.

This paper has been divided into four main sections. The first section reviews literature on social media uses, their censorship, and political power. This is followed by the section outlining the methodology of primary research, then the presentation of findings on anti-social media legislation popular under the President Muhammadu Buhari administration in Nigeria. These are followed by the discussion section and the conclusion. The findings of this study will contribute a robust and nuanced knowledge to that existing on the development-democracy nexus, and social media censorship in the global South, while it will provide more contextualized depth to those of the North.

2. SOCIAL MEDIA USES, CENSORSHIP AND POLITICAL POWER

Social media has largely diffused content creation processes. As opposed to mainstream media which has to pay journalists for distributable contents, social media platforms such as Facebook, Twitter, YouTube and Instagram provide ‘spaces’ where contents can be uploaded by the general public and citizenry (de Zwart, 2018). It has also brought the world to an era of more “interactive communication indicated by the emergence of new media”, whereby anyone can be a producer of information (McQuail, 2005:40); causing a shift to a more social environment, where users are not just passive receivers, but are also content creators (Bruns, 2008; Jha & Bhardwaj, 2012). This extends from the viewpoints of Bryer & Zavatarro (2001) who revealed that social media facilitates social interaction, makes collaboration possible, and enables stakeholder-deliberation.

Studies have found a positive correlation between online political expression and political participation. The privilege social media grants to freedom of political expression have largely escalated online and offline political engagement (Bode et al, 2014; Hsieh & Li, 2014; Holt et al, 2013; Tang & Lee, 2013), thereby liberalizing democratic spaces. Further, the extent to which people are empowered to participate in political practices, determine the extent of democratic acceptance. Participation here includes voting, representing, deliberating, resisting, and contributing to self and collective rule (Warren 2017). Corroborating this are scholars (Beauvais 2017; Fung 2013; Goodin 2007; Young 2000) who find that inclusion is at the fore of democratic processes, since decisions are only democratic to the degree that those affected by collective outcomes are empowered to influence them.
Further, despite its innumerable positive benefits, social media, as found, aids the creation of “false identities and superficial connections, and is a primary recruiting tool of criminals and terrorists” (Amedie, 2015). In so far as social networks grant free expression of thoughts, bridges gaps between the government and the governed, and spurs social change, it can be argued that some employ social media as revenge tools against the government in question. While some of these attacks are somewhat constructive and correctional towards desired reparations, they are sometimes perceived as derogatory, thus deserving legal rebuttal. In addition, sanctions, government threats, laws and ordinances are attempted at bridling the uptake of social media in channeling grievances.

Studies on social media and politics in Africa have also explored the privileges of social media to social movements and political regimes. It is admitted that the kinds of media used by social movements are crucial to processes of claim-making (Dawson, 2012), hence social movements prefer mediums that would rather make them less visible to the public or government, as opposed to mainstream media. In their study of social movements in South Africa, Dawson (2012) found that social media deepens discursive opportunities as well as backstage interactions and mobilisations. This notion is attested to by other studies (Vasi et al., 2015; Mausolf, 2017). For example, Nyabola (2018) finds evidence from Kenya as presenting social media platforms as toxic spaces that repeat offline harm. Their use in Kenya encourages and aids the distribution of violent acts. Connected violence are not only between citizens and the government, but politicians are also seen threatening themselves with physical violence on these platforms. In Nigeria, the government has repeatedly blamed social media as a channel for what is referred to as ‘fake news’ and ‘hate speech’ (Cheeseman et al., 2020). Tendencies for the spread of ‘fake news’ and ‘hate speech’ in Nigeria is blamed on social media’s provisions for anonymity and ubiquity (Udanor & Anyanwu, 2019), and this makes combating it difficult.

Governments respond to perceived negative affordances of social media by making attempts to censor their usage by their citizens. This has been severally demonstrated by countries in Africa through sophisticated and deceptive means. Gumede (2016) conceives social media censorship in Africa as attempts by regimes to “silence democratic opposition, civil society and activists’ mobilization against poor governance” (Gumede, 2016,p413) through grievances channelled via the platforms. It is further captured that the increasing uptake of social media by Africans is as a result of the continent’s history of monopolized mainstream media by political affiliates or politicians, which largely leads to the suppression of dissenting voices or critics who make daring demands on governments (Okocha & Kumar, 2018; Gumede 2010). In answering the question about why governments restrict media freedom, Kellam & Stein (2016) contend that governments are often opposed to ideological stances which do not reflect theirs, and this is common in contexts where the legislature and judiciary hold weak powers relative to the executive. Evidence in Uganda and Zimbabwe (Cheeseman et al., 2020) attests to this. In Nigeria, it is often argued that social media censorship poses more of a threat to freedom of speech than being a panacea to checking online vices (Vareba et al. 2018).

Furthermore, how do we triangulate the repression of dissenting voices and the political and economic institutions foundational to development? Political institutions have fundamental implications on economic institutions (Besley & Kudamatsu, 2006; Mueller, 2007). As noted by Acemoglu & Robinson (2008), democracy being a set of political institutions possess potentials for economic as well as development outcomes. Moreover, the distribution of de jure political power can be altered by changes in the political institutions, but to partly or wholly offset changes in de jure political power, the institutions create incentives for investments in de facto political power. Acemoglu and Robinson (2008) presents this as a model that can imply a pattern of captured democracy whereby the democratic regime may survive, however, the elites reap benefits from the economic institutions. The termination of the Malthusian cycle and the economic growth witnessed after the 17th Century conflicts in Britain resulted in a set of economic institutions which gave property rights to a wide range of people (Thompson 1975). Consequently, the exercise of de facto political power was diffused to the poor and politically disenfranchised groups (Tarrow, 2011).
Acemoglu & Robinson, (2005) further revealed that the rise in *de facto* political power of the poor orchestrated the change in political institutions in the favor of those poor and politically disenfranchised groups. This was a foundation to the future allocation of *de jure* political power, it as well served as a means to ensuring that economic policies in the future would be in their interests. However, in contemporary times, political actors are seen to be threatened by power in the hands of the majority, hence, their repressive tendencies (Suter et al. 2005).

With ongoing evidence on social media use, as well as its repression as a result of its perceived negative privileges by political regimes, reviewed above, more needs to be researched into the development implications of the contraction of social media spaces, as well as how these implications can be understood through the lens of *de jure* and *de facto* political power. Through the insights provided by Acemoglu and Robinson’s theorization about the relationship between institutions and political power, it can be indicated that social media provides an extended space for people to acquire and demonstrate political power. The political power acquired through political institutions (democracy) – *de jure*, and that acquired through revolt and collective action – *de facto*, provides the latitude for people to make demands for changes and policies that are requisite for socio-economic development in any society. As put by Acemoglu and Robinson (2008), with an increased *de jure* political power, citizens are more able to secure the economic institutions and policies that they so desire. Hence, by their demand for democracy through some forms of collective action, they acquire more ‘political say and political power tomorrow’ (Acemoglu and Robinson, 2008).

Notably, social media provides an extended space for these forms of collective action, arising from the mobility the platforms afford users between online and offline spaces, essentially, the latitude to either continue their offline actions, or vice-versa, and perhaps grant the privilege for simultaneous multi-cited actions (Allmann, 2016). Political regimes are not oblivious to these realities, hence they attempt to control political institutions, as a means to ‘regulating the future allocation of political power’ (Acemoglu and Robinson, 2008). Until recently, there has been no substantial analysis of the features of specific social media platforms and how their affordances are perceived by governments, or how they intersect with political power. Hence, what is about the social media that gets political regimes tremulous? Or what about it galvanizes their defensive and belligerent actions? Furthermore, this article contends that social media is a characterization of social buttons (Gerlitz and Helmond 2013; Sumner, Ruge-Jones, and Alcorn 2018) that aid the creation and exponential multiplication of ‘digital bullets’ – in forms of tweets and perceived detestable comments – that impend over the defense lines of political regimes.

3. METHODS

A qualitative approach informed by an interpretivist epistemological position is adopted by this study, through the conduct of eleven (11) key informant interviews with social media users and influencers in Nigeria. The interviews were conducted between February and April 2020. Twitter users and influencers were engaged for this study, Twitter being a notable platform through which the public engages political discourses in Nigeria (Opeibi, 2019; Kperogi, 2016). Key concepts and gaps that emerged from the literature review informed the questions that guide this study. A purposive sampling approach was used to select respondents, in a bid to draw in depth information from consistent Twitter users, who were easily identified by their following and Twitter engagement metrics. Patterns and recurrent themes that emerged from the transcribed interviews served as points of analysis discussed within the framework of Acemoglu and Robinson’s (2008) conceptualization of *de-jure* and *de-facto* political power. Data was also drawn from secondary sources - newspaper publications, government reports and web posts, to corroborate findings from the interviews conducted. This qualitative research is limited, first, by the number of interviews conducted which reduces the extent to which the findings of this research are generalizable. Also, respondents did not include government representatives, which creates a gap in the knowledge that should be drawn.
about perceptions of the Nigerian government on specific features and affordances of social media platforms, and how, if at all, they stir their repressive actions. However, these limitations do not discount the findings of this study. It is hoped that future research would expand on the objectives – putting into consideration the gaps – of this research towards arriving at more in deep and generalisable findings.

4. SOCIAL MEDIA AND LEGISLATIONS IN NIGERIA

Nigeria has repetitively sought to join a league of African countries in taking legal and repressive actions in censoring social media contents which its finds ignoble. As captured by Vareba et al (2018),

Nigeria has adopted various tools to censor the cyberspace within its territory. While some of these tools have been described as natural, others have virtually been extra judicial and quasi-obnoxious in nature. The country’s efforts towards internet censorship can be seen in the bills adopted by the country to criminalize cybercrimes as well as in the various draconian and antidemocratic bills adopted circumstantially by the government to deal with cases of (perceived) abuses of the Internet by political adversaries.

Since the incumbent government of President Muhammadu Buhari assumed power in 2015, bills against the use of social media have been severally rebranded and presented at the floor of the Nigerian Senate. First, in 2015 was the ‘Frivolous Petitions and Other Matters Connected Therewith Bill’ which was proposed by a Senator in Nigeria’s 9th assembly. The bill which targeted online media platforms such as Facebook, Twitter, Instagram, YouTube, WhatsApp and online blogs was widely criticized by Nigerians, describing it as an infringement on individual rights and free speech. However, following public pressure and the report of the Senate Committee on Judiciary, Human Rights and Legal Matters, this bill was withdrawn in the Nigerian Senate on Tuesday May 17, 2016 (Eribake, 2016). This was followed by a sister bill, resuscitated in the Nigerian Senate sooner than was expected, in 2018. This was equally claimed to have been targeted at regulating the use of social media in spreading hate speeches, fake news and false accusations. Also, in preparation for the concluded 2019 general elections, the bill was described to be a measure to curtail the activities of unscrupulous elements who might through the aid of the social media seek to bring down perceived political enemies (Opusunju, 2018). Although the bill passed first reading in the Nigerian Senate, it made no significant headway afterwards, as Nigerians did not fail to mobilize actions and voices against the bill.

Most recently was the re-introduction of a bill titled the ‘Protection from Internet Falsehood and Manipulations Bill, 2019’, by the Nigerian legislature. The bill which was targeted at penalizing false statements communicated to one or more end-users in Nigeria through the internet and on social media platforms, among other reasons, sought to prevent the transmission of false statements/declaration of facts in Nigeria and to enable measures to be taken to counter the effects of such transmission. Although the sponsor of the bill, a senator representing Niger-East Senatorial district was accused of plagiarizing a similar law in Singapore, passed by the Singaporean Parliament on May 8, 2019 and assented to by the President on June 3, 2019. The senator however defended the claims. According to his tweet on November 23, 2019, “it is therefore inevitable that lessons be drawn from other jurisdictions in fashioning out workable solutions in our own country” (Aborisade, 2019).

The specific objectives of the bill are:

- To prevent the transmission of false statements or declaration of facts in Nigeria
- To end the financing of online mediums that transmit false statements
- To detect and control inauthentic behavior and misuse of online accounts
When paid content is posted towards a political end, there will be measures to ensure the poster discloses such information. There will be sanction for offenders (Iroanusi, 2019).

Angry demonstrations by Nigerians trailed the introduction of the bill calling for it to be scrapped. Critics also described the bill as capable of gaging free speech. Further reaction against the bill was seen in a petition that was signed by tens of thousands of Nigerians, unanimously rejecting the bill. Twitter influencers were also not silent about the bill, as their various tweets and posts generated comments and engagements in cumulative millions, which put the government under pressure. A Twitter voice in Nigeria, when interviewed, believes the bill is nothing but:

…an infringement on the constitutional freedom of speech and will not but deepen public intimidation which the government has always desired.

Another, as well, corroborates this point by affirming that:

if the government should succeed with the bill, then the country must be ready for a level of disrespect of the rule of law that it has never witnessed before.

A respondent believes that “the freedom of speech is all that the country has left, should it be taken from us, forget it”. She goes further to praise the freedom of speech that the country enjoyed under preceding administrations in Nigeria. A close reference by a respondent was a tag on the bill as “… war against our collective freedom”. Another respondent appears curious about why the bill has consistently resurfaced in rebranded forms since 2015, the resolution was, however, that there must be some scrupulous machinations going on behind the scenes by some agents of the government.

A contrary viewpoint to the above expressed by an activist who described herself as politically neutral was that:

This is democracy, the will of the majority will surely prevail, the bill must be allowed to undergo due process. Some are against the bill today cos they know their ways have always been bad. They should change and stop spreading fake news.

Some respondents acknowledge elements of government control via the bill. A student activist in South-West Nigeria said:

The government is aware about how powerful the voices of the Nigerian Youths are. One good thing about the social media is how information spreads so fast and easily. This is what the government hates. They don’t want us to announce their ills to the world. They can’t stop us, we refuse to be prisoners in our own land.

Another student activist in South-West Nigeria finds the system of government in Nigeria to be an “unhealthy mixture of democracy and dictatorship, and this is even seen in our universities. There is war against the power and will of the people”. References were further made to Nigeria’s youngest Senator whose news (though leaked CCTV footage) a few weeks before the proposition of the social media bill, went viral on social media. He was captured by the CCTV of a sex toy shop assaulting a young woman. The senator was recorded justifying the need for the bill, when it was presented at the senate. A few respondents found that his support of the bill may be attributed to the Senator’s recent viral condemnation on social media. A respondent suggested that without the social media “these barbaric acts by politicians will go unnoticed”. Another claims he would accept the justifications presented by the senator in support of the bill, provided same penalties as spelt by the bill would be defined for corrupt practices by politicians.
Nigerians continued to express their concerns about the bill from November 2019 when it was first proposed in the National Assembly till March 2020 when a public hearing was held. – an event that shredded the prospects of the bill. Although, at the current time of writing, there are indications that Nigerians would have to deal with more of this in the future.

5. DISCUSSION

The interaction between de jure political power (as determined by political institutions – democracy in this case) and de facto political power (as determined by the organisation of different groups), serves as bedrock to economic and development outcomes. Acemoglu and Robinson (2008) clarifies that although de facto political power drives the determination and distribution of economic resources, these resources are not often allocated by institutions, they are rather possessed by groups on the basis of their wealth or their ability to solve their problems of collective action. Evidence in this article presents the social media has a platform for organisation, mobilisation and claim-making (Dawson, 2012), which can be leveraged for the reinforcement of their de jure political power towards securing the institutions requisite for development outcomes. This primarily spotlights the social media as a target for repression, given its privileges for collective demand and claim-making.

The bill emphasized ‘false declaration’, and ‘false statements’. By false statements, it captured statements that are likely to: be prejudicial to the country’s security, public health, public safety, public tranquility or finances; influence the outcome of an election or referendum; and incite feelings of enmity, hatred, among others. The government’s concern about these presupposes the vulnerability of their defenses. Government actions can hardly hamper the popularity and spread of messaging on social media (Hofheinz, 2011). Through (re)tweets, (re)grams and comments, users are able to easily create online trends, grams and feeds which most times go viral before the reaction of government censors. By doing these, inter alia, social media users can subvert censorship and state-controlled media (Jones, 2017).

Hence, elected representatives are not inaccessible for engagement and perceived virtual attacks. This viewpoint is well condensed by Omojuwa (2019),

...the closest thing to engaging a government official online was being able to tweet at an aide who was himself an aide to another aide who was an assistant to the president... What has changed here is that expectations are now higher, the president is your Twitter neighbor. We now have a voice; our voices are being heard….

Netizens have their ways around the defenses of political regimes towards getting their messaging to being heard in closed and innermost spaces of decision making. Social media is, thus, conceived as an embodiment of virtual bullets that impend over the defense lines of political regimes. Consequently, they respond with repression, as metaphorical ‘flak jackets’.

Social media comments often signal one of three things, (1) an applaud of good deeds, (2) an expression of indifference or neutrality, or (3) an ardent rejection or criticism of a public action. In the case of the latter, distressed citizens will choose to construct their messaging in ways that reflect the depth of their deprecation, not minding how it is received or perceived by the targets. The people can be said to have a shared understanding of the transitory nature of political power (Acemoglu and Robinson, 2000) – the understanding that they might possess the power to take some actions today but might not wake to same the next morning –, hence, they try to “lock in the political power they have today by challenging political institutions” (Acemoglu and Robinson, 2000). Whichever side of the divide that possesses more political power determines who captures the offerings of economic institutions. Further, political institutions that allocate de jure and de facto power determines political power itself (Acemoglu and Robinson, 2008). Consequently, netizens join in the contest for this power against elites who, being small in number, and as a result of their control of politics, have more comparative advantage in investing in de facto power (Olson 1965). In other words, it is a contest between parties in the quest for political power.
Although, some supported the provisions of the social media bill, finding it necessary to sieve rebellious contents from the social media space of Nigeria. However, most found the bill to portend an unguarded future for the citizens of Nigeria, the country’s democratic posture and deference for the rule of law, as provided in the Nigerian constitution (section 22 and 39) – the freedom of expression. Noteworthy is the fact that such perceived obnoxious contents about government policies, actions and inactions are not particularly fruits of hatred or disdain against the government, very importantly, they evince veracities from which the government is being unwittingly veiled. In order to invite government attention and as a form of political participation, the social media is leveraged as a modifier of political attitudes and involvement of users (Rajalakshmi & Velavuthum, 2014), which translates to an expression of political power against regimes (Liqui, 2007; Boker & Elstub, 2015).

Acemoglu and Robinson (2000) connects the diffused participation of non-elite citizens with the constraining of leaders in authoritarian contexts, through protests, revolutions and threats. Although not an authoritarian setting, social media in Nigeria aids diffused participation and mass mobilization for public causes, through demonstrations and campaigns. For instance, campaigns and movements such as the #NotTooYoungToRun, #DGTrends, #BringBackOurGirls, #OccupyNigeria, #RevolutionNow, and most recently, the #ENDSARS protest, among others, are illustrative. The expression of de facto political power through these movements do not only help redirect the focus of the government to the concerns of the people, but they also lay foundation for transformative outcomes. As opined by Jung (2016), there is hardly a political regime that can defeat a people who are a united voice on an issue, a voice that is sustained over time and not weakly tied.

The situation in Nigeria cannot be divorced from mis-governance, corruption and leadership impasse. Further to this, governance in Nigeria, legislative preference, law adjudication and status of citizens most recently queries the defining tenets of the institution of democracy and more importantly threatens the expression of political power by the citizens. Patriots will not ignore approximate costless platforms through which the government can be engaged, as means of expressing and securing their political power and eventually the dividends of governance.

6. CONCLUSION

This study has discussed the rebranding of social media legislation in Nigeria. Interviews conducted also granted insight into the perceptions of Nigerian netizens about the country’s democratic trajectory and what they are up against – the defense lines of the political regime. In Nigeria, it can be argued that the country’s gradually widening democratic space and progress made with internet freedom is attributable to the gridlocks that the current political regime has faced at each episode of its social media censorship agenda, since 2015. The concessions are not credible, neither is repression of social media overly attractive, as evinced by the expression of political power by Nigerian netizens (Acemoglu and Robinson, 2000). This study has argued that political power acquired through political institutions (democracy) provide the latitude for demand for changes and policies that are requisite for development in any society. With political power, netizens are able to defeat the defense lines of political regimes, and through the affordances of social media – digital bullets against which regimes seek to protect themselves through ‘flak jackets’ – censorship.

Notably, these are critical times when Nigeria deserves the collaborative exertion of all sections of governance to alleviate threatening challenges of the citizens. The legislative institution rather than repeatedly rebranding a bill that has not only been greeted by rejections from Nigerians locally and in diaspora, suffered multilateral defeat (as the institution received an ECOWAS court judgement criminalizing the bill), it should take more proactive legislative actions on the demands of its citizens, to which their political power is constantly expressed.
To check media contents against false reports, the government should outlay enlightenment measures and sensitizations through relevant organizations and groups on how to verify stories, against extensive spread, and unhealthy public incitement, rather than sponsor a bill that has been declared needless by existing laws, such as the Cybercrime (prohibition) Act. The hard-earned freedom of a diverse country like Nigeria should not be circumscribed by guised dictatorial gimmicks. While the government and all executors in the echelons of power will continually commit themselves to development initiatives across all sectors, the people who have delegated their trust of leadership to them should be guaranteed freedom of expression and right to express their political power.

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Abstract: Integration of eHealth technologies with healthcare work activities has seen great advancement in many healthcare systems in developing countries. However, these efforts have been tainted by several challenges such as fragmentation, lack of standardization and co-ordination. Subsequently, the undertakings of eHealth articulated in health strategy/policy documents have not been fully realised. The implications of this has been that the majority of the population still access inadequate healthcare services. The aim of this paper is to explain why the current integration efforts do not adequately facilitate healthcare work activities in public hospitals in under-served contexts of South Africa. A critical realist perspective within a qualitative approach was adopted. A total of 21 participants were purposively sampled and interviewed because of their knowledge and experience in the healthcare service delivery process as well as their involvement in the integration of eHealth. The study applied the Activity Analysis and Development (ActAD) model as a theoretical analytical tool and draws on normalization process theory (NPT) as an explanatory framework. The findings highlight generative mechanisms such as the inadequate analysis of system’s fit-for-purpose in healthcare workflows have inhibiting effects in the integration process of eHealth.

Key Words: eHealth, Integration; Healthcare work activities; Healthcare service delivery

1. INTRODUCTION

Access to inadequate public healthcare service delivery is a constant reality for the majority of the population in developing countries. Inequity in accessing quality healthcare services in developing countries is often attributed to scarce infrastructure resources, shortage in healthcare practitioners, poor leadership and management and so forth (Omotoso & Koch, 2018; Maphumulo & Bhengu, 2019). In addition, challenges such as inadequate data management and communication at different levels of healthcare systems result to delays in the delivery of healthcare services (Nobana et al., 2020). Subsequent to these challenges, governments have turned to eHealth technologies to address the inadequacies in their healthcare systems. The term eHealth can be referred to as the use of information and communication technologies (ICT) as well as information systems (IS) to facilitate healthcare work activities for an improved service delivery (Andreassen et al., 2015). eHealth technologies are often regarded as enablers that offer quality enhancing efficiencies to operational and decision making processes in the healthcare sector. eHealth technologies are also expected to increase healthcare practitioner’s productivity and in turn, improve patient experience in the delivery process - by gaining access to timely, cost effective and quality care services (Liu et al., 2013; Negash et al., 2018).

Although there are several benefits associated with eHealth technologies, the implementation and integration of these technologies has always been problematic (Cresswell & Sheikh, 2013; Calligaro et al., 2017). Integration in this paper is defined as the process of putting to use technology interventions within a healthcare setting for the purpose of improving healthcare service delivery.
Cresswell and Sheikh (2013) further postulate that technology integration in healthcare organizations is complex. This can be attributed to the complex nature of healthcare service delivery, coupled with a wide range of inter-related socio-technical factors that are shaped by organisational factors. Failure to adequately identify and address the socio-technical factors further exacerbates the complexities (Farzandipur et al., 2016). The current integration efforts especially in developing countries, have been tainted by several challenges such as fragmentation, lack of standardization, co-ordination and interoperability (Adenuga et al., 2015; Fletcher, 2016; Senyoni, 2020). As such, the integration of eHealth technologies with healthcare work activities has not yielded desired outcomes. The integration of eHealth technologies requires major structural reforms such as implementing policies and strategies that would inform equal funding and infrastructure resource distribution, allow for increased human resource capacity development and many other requirements that would facilitate eHealth integration process. These reforms would result in changes in healthcare setting, practitioner’s work practices, patient’s service expectations and experiences in the delivery of healthcare service and overall improved health outcomes.

In light of these, the research question was, why does the current integration of eHealth technologies with healthcare work activities not adequately facilitating public healthcare service delivery? In addressing this question, the study first determined the context-based factors that influence eHealth integration with healthcare work activities in public hospitals in resource-constrained environments. The study then establishes generative mechanisms in the integration process of eHealth technologies with healthcare work activities that generate current eHealth integration outcomes. Generative mechanisms are described as the “underlying entities, processes or structures which operate in a particular contexts to generate outcomes of interest” (Astbury & Leeuw, 2010, p. 368).

The rest of the paper is structured as follows: section 2 presents a review of eHealth technologies in South Africa. Section 3 presents a discussion on the approach applied in the study, section 4 presents the results of the interview process. Section 5 presents the analysis and discussion on the factors that influence eHealth integration with healthcare work activities and the generative mechanisms in the integration process. In the last section, the study’s conclusions are drawn.

2. ELECTRONIC HEALTH LANDSCAPE IN SOUTH AFRICA

The majority of the population access healthcare services from a dysfunctional public healthcare system characterised by great disparities in funding provision, under staffing and maldistribution of resources (Pillay, 2001; Versteeg et al., 2013). Consequently, many South Africans who rely on public healthcare services have access to poor quality care services (Govender et al., 2018; Malakoane et al., 2020). Subsequent to this, the government has sought innovative ways of strengthening the public healthcare system through the adoption, implementation and integration of eHealth technologies. The eHealth technologies are classified into three categories: (i) patient-care level systems such as clinical care and supporting services; (ii) operational-level systems that are used for monitoring and evaluation, and for administrative purposes; and (iii) strategic-level systems.

The district health information system (DHIS) has been in use in South Africa at the primary health care level since the mid-1990s and has seen a number of success. However, an increase in demand for routine information in the public healthcare sector exposed gaps in the DHIS system such as poor data quality and dataflow bottlenecks. Another example of the eHealth initiatives is the electronic health records (EHR) systems, they are also commonly used in most public healthcare facilities. The TrakCare Lab system, is commonly used by most laboratories and is responsible for all diagnostic pathology tests in the public healthcare sector. The national Health Patient Registration System (HPRS) implemented in healthcare facilities countrywide are mainly used for monitoring and evaluation. The system allows for patients identity verification and records the purpose of visit, this is a reliable source of national patient demographic data (CSIR, 2016). In recent years, the digital and mobile health platforms in South Africa has seen great initiatives. The use of these platforms has resulted in significant reduction in cost to both patients and healthcare facilities as the Department of health is able to collect real-time data easily (Barron et al., 2018). An example
is the MomConnect mobile health initiative that is used to provide pregnant and postpartum women with weekly health information via instant messaging apps (Barron et al., 2018). This initiative is integrated into maternal and child healthcare services.

Despite great achievements that have been realised through the use of eHealth technologies, the public healthcare sector still experiences challenges (Omotoso & Koch, 2018; Maphumulo & Bhengu, 2019). For example, there are still challenges with poor data quality and dataflow bottlenecks (Mchunu, 2013), and reporting discrepancies at different levels.

3. RESEARCH APPROACH

The objective of this paper was primarily to provide explanations for the current outcomes of eHealth integration efforts in public hospitals in under-served contexts. Based on this objective, the critical realist perspective was chosen within which qualitative research methods were employed. The critical realist stance, allows researchers to view the empirical knowledge as one that is socially constructed (Bhaskar, 1979). The critical realist stratified ontology provided the depth of understanding of and explanation for events/effects in the integration of eHealth activities through generative mechanisms. The three-level ontology includes the domain of reality, actual and real (Bhaskar, 1986). Semi-structured interviews were conducted with purposively sampled participants because of their experience in the healthcare service delivery process and involvement in the integration process of eHealth technologies. In total there were 21 participants in the study. Of these, five were managers at the hospital in various units. Two of the participants were managers who oversaw eHealth initiatives at provincial level. The remaining number of participant were healthcare practitioners at the hospital who carried out either clinical care activities or administrative activities using eHealth technologies. The objective of the interviews was to determine participant’s awareness and use of eHealth technologies and also determine their perceptions of eHealth integration with healthcare work activities and its effect on service delivery.

A theoretical thematic analysis technique was employed for the analyses of the empirical data. This technique allowed the researchers to repeatedly search through the empirical data set in order to identify patterns that emerged. The researchers manually identified, analyzed and recorded the patterns (themes) within the empirical data as illustrated in Tables 1 and 2 in the analysis section.

3.1. Case Description

The empirical case, Nelson Mandela Academic Hospital is located in the O.R. Tambo District Municipality in the Eastern Cape province of South Africa. It is one of the largest provincial government funded hospital in the region and serves a number of patients from in and around the municipality. The hospital was primarily selected because it is in a rural or under-served context and also because it makes use of eHealth technologies such as DHIS and HPRS.

3.2. Validity and reliability

Validity and reliability are important factors to consider in a research design or in the analysis of the results. The concept of validity is described across qualitative studies by a wide range of terms. Winter (2000, p.1) states that validity is “…a contingent construct, inescapably grounded in the processes and intentions of a particular research methodologies and projects.” On the other hand, reliability is viewed as the exact replicability of the results. In qualitative research such as this one, the essence of reliability lies with consistency. In this paper, purposive sampling technique was employed to select participants of the study and as such the outcomes of the study are not generalizable. The constructs of the ActAD model as well as the key variables from the objectives of the study were employed to determine and validate respectively. Since the study is largely subjective, reliability was ensured by operationalizing key variables of the objectives. This technique may not yield the maximum reliability due to the subjective nature of the study.
3.3. Theoretical/Analytical Framework

While the paper gives recognition to other social theories and models in the IS field, the ActAD model and NPT theory were adopted as analytical theoretical frameworks. Based on Activity Theory (AT), the ActAD model was employed as an analytical lens. Its constructs include subjects, object, tools, objectives, rules, transformation and outcomes (Korpela et al., 2000). The model also adopts the concept of the work activity system adapted from Engeström’s (1987) systematic structure of work activity. The concept views social activities such as eHealth integration as rules-based, deliberate and collective work by various subjects, in pursuit of a common purpose. The object construct is perceived as the purpose of which a social activity is being carried out. Subject construct is viewed as stakeholders in the work activity system who make use of tools (eHealth), policies and procedures (rules) to carry out their work activities. The transformation construct refers to the actual work process, where policies, tools, procedures and activities converge to produce an outcome.

NPT is a theory on the collective ‘work or effort’ done individually or collectively to implement and sustain an intervention (May, 2006). The enacting of an intervention are done through its four constructs or mechanisms; coherence, cognitive participation, collective action and reflexive monitoring (May & Finch, 2009). Coherence relates to how work activities define and organize interventions in an organizational context are understood, perceived meaningful and the invested in. Cognitive participation relates to the commitment required from individual actors as well as the degree to which those individuals are engaged with the new intervention. Collective action relates to the work that will be required of participants to in the integration process including preparation and training. Lastly, reflexive monitoring relates to participants’ ability and intentions to perform formal or informal appraisals of the interventions (May, 2006; May & Finch, 2009).

The study received ethical clearance as stipulated by the Cape Peninsula University of Technology as well as the department of health in the Eastern Cape province of South Africa and the hospital. Informed consent was also sought from all the individual participants of the study.

4. RESULTS: INTERVIEW DATA

As mentioned in the previous section, one of the objective of the interviews was to determine participant’s awareness and use of eHealth technologies at the hospital. This was used to determine factors that may influence the integration of eHealth technologies with healthcare work activities. To determine the status of use, the researchers during the interview process, searched for indications of awareness and understanding of the purpose of eHealth technologies and its use. The researchers also examined whether the systems were useful in achieving the healthcare practitioner’s work objectives, level of use or non-use of the systems and whether the respondents found the system easy to use or not.

In terms of awareness and use of the eHealth technologies at the hospital, participants both in the administrative and clinical process, indicated their awareness and understanding of the purpose of eHealth technologies. There was a consensus among the respondents that eHealth technologies include ICT tools such as hardware, software, networks, and mobile phones that they used to carry out their work activities. Respondents used the terms ‘system (s)’ and ‘technology’ interchangeably, therefore the researcher took into consideration such factors while asking the questions. For example, one respondent in the clinical process noted “yes, sometimes we use these systems to order patients’ blood tests and receive the results on our mobile phones” (DRG). Respondents within the administrative process gave clear descriptions of their knowledge of existing systems, including Delta™, Rx Solution, PAC system and the laboratory systems (PRS-M; PRJ-M; TP.ITS; NM-EC) that were being used at the hospital.

The respondents also noted the purpose of the systems and had positive perceptions of their usefulness and benefits. Findings from the respondents at the hospital revealed that all groups of participants perceived that eHealth technologies, regardless of how they perceived them were or would be useful in their work activities. For example, respondent (RN-N) states that “…I insisted
that we type our theatre slates …in order for us to always have our softcopy back up because folders get lost…” In the administrative process, one of the common response in terms of the purpose of eHealth technologies was to improve the management of patient registration data at the hospital (TP.ITS; PRS-M). In another case, respondents in management position indicated that in the laboratory unit at the hospital, the electronic gate keeping system was integrated to ease the burden of cost in that unit that had skyrocketed over the years. Some respondents in the clinical process were unaware of what direct impact the eHealth technologies had on their work activities. As one respondents states “I honestly do not see the benefit of using these technologies in my line of work…” (DCL).

These conflicting views may be attributed to the fact that the hospital lacks adequate support in managing some eHealth technologies. This is coupled with the “lack of interconnectedness” (TP.ITS) of the existing technologies, and some cases “lack of connectivity of some tools” (RN-N) to the hospital network. One respondent mentioned that sometimes there was a lack of follow up on the systems, “…there was a software here at the hospital to view x-rays it stopped working at has never been repaired…so we are forced to seek other alternatives” (RN-N).

Table 1 presents the emerging findings on factors that influence eHealth technology use at the hospital.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Categories</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technical factors</td>
<td>✔ Functionality of the system</td>
</tr>
<tr>
<td></td>
<td>✔ User skills/competencies</td>
</tr>
<tr>
<td></td>
<td>✔ Usability of the system</td>
</tr>
<tr>
<td></td>
<td>✔ Constant availability, accessibility and relevance</td>
</tr>
<tr>
<td></td>
<td>✔ Embeddedness of work activities into the structure of eHealth technologies</td>
</tr>
<tr>
<td>Institutional factors</td>
<td>✔ Advocacy for use and support</td>
</tr>
<tr>
<td></td>
<td>✔ Adequate change management</td>
</tr>
<tr>
<td></td>
<td>✔ Clarity of system’s purpose in the workflow process</td>
</tr>
<tr>
<td>Behavioral (human) factors</td>
<td>✔ Reluctance to use</td>
</tr>
<tr>
<td></td>
<td>✔ Perceived usefulness of the system</td>
</tr>
<tr>
<td></td>
<td>✔ Perceived benefit/value of the system in work activities</td>
</tr>
<tr>
<td></td>
<td>✔ Perceived effectiveness of the system in the workflow processes</td>
</tr>
</tbody>
</table>

Table 1: Factors that influence the use or non-use of eHealth technologies at the hospital

Findings reveal that these issues, in most cases, deter participants from making use of the systems, especially those that already see no value in the systems for their work activities. The researchers observed that these issues led to views that the presence of eHealth technologies was disruptive, with one respondent in the clinical process stating “where will you place this technology? It will be in the way” (DCL). The findings show that there is a high level of awareness and relative acceptance of eHealth technologies by administrative staff; however, this is relatively low for clinical staff at the hospital. The high level of awareness and acceptance are attributed to the positive performance expectancy associated with the perceived value of using these technologies in their work activities. Findings also reveal that although there is limited use of the technologies among the healthcare practitioners in the clinical process, there was evidence of a willingness to use. The non-use was attributed to the limited or unreliable ICT infrastructure (such as non-functioning computers, and poor network connectivity at the hospital). Table 2 presents the dominant themes from the finding on the integration of eHealth technologies at the hospital.
eHealth technology integration outcomes

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔ Improved turnaround times in the delivery of care services</td>
<td>As a result of integration of eHealth technology such as the laboratory information system, the hospital has seen improved turnaround times in the results of lab tests. This has also seen duplication of data</td>
</tr>
<tr>
<td>✔ Improved decision-making and reporting process</td>
<td>The DHIS system has enabled the timely movement of clinical information across the hospital and the public health sector for informed decision making on aspects such as resource allocation or management of disease outbreaks, timely health information needs to reach the relevant authorities.</td>
</tr>
<tr>
<td>✔ Lack of systematic integration plan</td>
<td>The hospital has quite a number of eHealth technologies integrated into work activities, however, none of the relevant participants could give a systematic process for integration</td>
</tr>
<tr>
<td>✔ Duplication of healthcare data</td>
<td>Despite eradicating duplication of data in some units the eHealth technologies also create duplication of data and process because most systems are not integrated together resulting in duplication of data across the hospital</td>
</tr>
<tr>
<td>✔ Poor coordination of existing ehealth technologies (leading to fragmentation)</td>
<td>Most of the systems implemented in a silo, ad hoc manner. The eHealth technologies at hospital are integrated for specific tasks but are not integrated with existing systems</td>
</tr>
<tr>
<td>✔ Scalability issues</td>
<td>Some systems like the Delta9 system used at the hospital do not allow flexibility (although there were new modules of the system available, the system had not be upgraded or scaled to meet the needs in the healthcare service delivery process)</td>
</tr>
</tbody>
</table>

Table 2: Themes on the outcomes of eHealth technology integration at the hospital

5. Limitations of the study

A key limitation of this paper is the use of a single-case study. Literature has criticized the limitations of case study strategies, which include lack of ability to generalize the findings, perceived inadequate rigour in case study research, and so forth. The paper acknowledges these critiques, the intentions are not to generalize the findings but to use the outcomes as a starting point in the integration of eHealth in healthcare settings.

6. ANALYSIS AND DISCUSSIONS

In this section, the discussions center on elucidation of the findings reported in the previous section. They draw on the key elements of the ActAD model as a theoretical analytical tool. The explanations and causal analysis are based on the findings from the objectives of this study and are done within the critical realist paradigm.

To frame the study’s theoretical stance, the researchers were guided by the five basic underlying principles of the ActAD model (Korpela et al., 2004). The first principle is that of an object-oriented activity system, in this study, the eHealth technology integration process is taken as the activity system and the prime unit of analysis. The second principle, describes the activity system as having multiple actors, in this case, the actors include all the relevant stakeholders involved in the eHealth integration process including healthcare practitioners, policy makers, leaders and managers at all levels of the healthcare system. The third principle describes an activity system as emerging as a result of historical activities that are typically formed over a period of time. The use of technologies in the South African healthcare system has seen various historical activities such as the integration
The forth principle scrutinizes the fundamental role of contradictions in the activity system as sources of change and development. The fifth principle refers to the possibilities of transformation and the reconceptualisation of the objects and motives in the activity system (Engeström, 2001). The study interprets this as the transformation brought about by inhibiting and enabling factors in the activity system. These factors have the ability to transform the manner in which activities are carried out in the activity system. The outcomes of the transformation process may be desired or undesired. A closer investigation of these principles reveals that they possess similar traits of the critical realism paradigm. The principles are relatively broad with regard to the methods of application. They provide an overarching frame and conceptual tools of enquiry; in essence the principles provide exploratory guidance rather than rigid rules.

The discussions in this section are based on the outcomes (Table 2) of the eHealth technologies integration efforts at the empirical case. As defined in the introductory section of the paper, integration is defined as the process of putting to meaningful use technology interventions within a healthcare setting to achieve the goals of improved healthcare service. The study argues that context-based factors presented in Table 1 determine use or non-use of eHealth technologies at the facility. Drawing on the ActAD model’s fifth principle, the context-based factors informs and transforms the work activities in the integration of eHealth technology work activity system to produce the outcomes in Table 2. Addressing such factors may lead to enhanced integration of eHealth technologies with healthcare work activities for an improved healthcare information collection, processing and reporting. The study argues that the outcomes of the current eHealth integration practices, are dependent variables that are mediated by context-based factors, which in turn transform eHealth integration activities. The outcomes of this transformation process generate either observable or unobservable events in the delivery of healthcare services. Guided by the fourth principle of scrutinizing the presence of contradictions, the study deduces that the outcomes allude to the presence of inadequacies in the current integration practices despite success in other areas. This contradictions, drive the changes in the healthcare service delivery process. Figure 1 depicts the interrelationship between the independent and dependent variables in the eHealth technology integration activity system.

![Figure 1: The interrelationship between context-based factor and eHealth integration outcomes](image-url)
6.1. Discussions on the context-based factors that influence ehealth technology integration

In the following sub-section, the context-based factors that transform the eHealth technology integration activities.

i. Clarity of system’s (eHealth technologies) purpose in the workflow process

A crucial factor that transforms activities in the integration process of eHealth technologies in healthcare settings is the need for clarifying eHealth purpose in the healthcare workflow process. Integration of eHealth in healthcare facilities requires a restructure of workflow processes to accommodate the technologies. It is therefore vital that to understand how eHealth technologies not only align with existing work activities, but also the value they bring to the workflow. Without clear articulation of the need for and purpose of eHealth technologies, in most cases result in sub-optimal use and fragmentation of healthcare services as suggested by some participants in the empirical case (TP.ITS; NM-EC). For a successful integration of eHealth technologies to be realized, the functions of the technologies must align with and form an integral part of the healthcare workflow processes (Eder & Igbaria, 2001).

Another implication of this factor is that without clear articulation of system purpose, is likely to lead to healthcare practitioners’ resistance to use of the systems, as healthcare practitioners would perceive this as extra work. eHealth integration success is dependent on the user’s commitment to use the technology (Holahan et al., 2004). As postulated by Ynalvez and Shrum (2011), the work environment may improve; however, the effects on work activities depend on how individuals make use of the systems.

ii. Change management strategy

Another factor is the need for change management strategy(s), this involves the management and organizing the activities of eHealth integration process, managing expectations of users, training healthcare practitioners and outlining the roles and responsibilities in the integration process. The absence of this elements during the integration process can influence and transform the activities into the observed outcomes. The findings reveal that part of change management strategy is ensuring appropriate resources are allocated and made available in a coordinated manner. This implies that the environment has to be conducive to enable optimal integration of eHealth technologies with healthcare work activities. Another aspect of the change management factor is inform all stakeholders of the values, benefits and purpose of eHealth technologies in the healthcare workflow. Adequate change management strategies all for planning for activities such as planning for assessment of the healthcare setting for relevant adequate resources such as ICT and networking infrastructure, equipping healthcare practitioners with the right ICT skills. This, coupled with factors such as political will from regional managers (DMA) to support the process long term would create an initial facilitating environment for eHealth integration.

iii. Technical and Organizational factors

Technical factors such as functionality of the system influence the use of eHealth technologies. A reliable system improves the confidence of end-users in pursuit of operational objectives. As one participant from the hospital noted, “The hospital experiences a lot of network problems … [as a result] we do get a lot of frustrated users” (TP.ITS). User skills/competencies also influence use or non-use of eHealth technologies at the hospital. User competencies here imply the understanding, literacy and ability to put technologies into effective use. In addition, technical factors include uncoordinated systems at the hospital that force participants to duplicate processes. As mentioned by one participant: “If we could have systems that are connected to the network so that you just fill in patient information and you store it so that even for your referrals your colleague from another
hospital just needs to punch in the folder number and see what was done” (RN-N). Poor technical support of networked systems is also an inhibitor of HIS use: when the support takes long to reach the end user, frustration leads to non-use.

These context-based factors are triggered by underlying generative mechanisms discussed in the next sub-section.

6.2. A discussion of the generative mechanisms in the eHealth technologies integration with healthcare work activities

The discussions in this sub-section centers on the identification, characterization and explanations of generative mechanisms that shape the outcomes of eHealth technologies integration activities. For that reason, the approach in the discussions shifts from ontological to epistemological, where the relationship between mechanisms, events and empirical experiences is stressed (Bhaskar, 1979). NPT categorizes all the work activities in the implementation process according to four main interactive constructs (May & Finch, 2009). According to the authors, although the constructs and their components describe different types of ‘work’ activities, they are correlated. What this means is that the constructs and the components constantly interact, with the potential to influence and change one another.

The first generative mechanisms that is identified is lack of analysis of eHealth fit-for-purpose. This mechanism is considered as a major deterrent to the integration of eHealth technologies with healthcare work activities. This mechanism, can be categorized under the construct coherence as it relates to how work activities that define and organize the eHealth technology integration with healthcare work activities are understood and perceived meaningful. Findings reveal that there are cases at the hospital where healthcare practitioners such as doctors do not perceive the technologies to have any value to their work activities and as such, see no point in using the technologies. In some instances the practitioners view these technologies as disruptive. Based on such views, the researchers deduce that the underlying mechanism that could trigger such views is the lack of analysis of how the eHealth technologies would fit with the work activities of the healthcare practitioners. The result of this is having the paper-based system still being used even for activities that have supposedly been automated. This defeats the purpose of improving healthcare activities and enabling ease of access to updated information at points-of-care by healthcare practitioners. This mechanism has causal powers that produce outcomes such as lack of system customization to fit healthcare practitioners’ work activities, and poorly integrated information systems into the work practices of healthcare practitioners. All these outcomes inhibit HIS implementation for public service delivery.

The second generative mechanism identified is the absence of considerable and coordinated infrastructure resources. The integration of eHealth technologies with healthcare work activities require major structural reforms in the healthcare system that include provision of adequate distribution of resources, increasing capacity of skilled human resource, provision of funding and so forth. A resource-constrained environment influences how actors in the work activity system carry out their activities. As the findings portray, poor network infrastructure at the hospital influence successful integration of eHealth technologies with healthcare work activities. Unequal funding mechanisms between the public and the private healthcare sector is also an underlying mechanism in the integration of eHealth technologies. This is in terms of how the resources are acquired and maintained sustainably.

In terms of skilled human resource, a lack of continuous re-skilling of healthcare professionals with the necessary ICT skills, also deters the integration process. The implications of this mechanism manifests in inaccurate data capturing that leads to repetitive processes and therefore long turnaround times. Findings also revealed that professional skills and competency affect work attitudes, including commitment from top management.
The outcomes of these mechanisms are contingent on other context-based mediators such as the widespread socio-economic challenges the country faces, discrepancies in translating health policies/strategies into practice and so forth. From the analysis, the study observed that the eHealth integration outcomes directly or indirectly experienced may be dependent on the complexity of the multiple generative mechanisms. An understanding of the interplay between observed events, structures, conditions and generative mechanisms may explain why and how eHealth technologies integration does not adequately facilitate healthcare service delivery in public healthcare facilities in resource-constrained environments.

Figure 2: A stratified representation of how events occur in the HIS integration within a healthcare service delivery context

Figure 2 depicts a stratified representation of how events occur in the integration of eHealth technologies with healthcare work activities. The social structures are mediated by context-based factors and generative mechanisms. The generative mechanisms then evoke the events in the actual domain and experiences in the empirical domain. In the actual domain, events experienced include poorly integrated system that hinder work flow in the healthcare setting. In the empirical domain, healthcare practitioners either perceive eHealth technologies as useful or not depending on their experiences with using the technologies. Ultimately, this results into how tasks are carried and how healthcare practitioners perceive their performance in the healthcare service delivery system.

7. CONCLUSION

Integration of eHealth technologies with healthcare work activities requires more than understanding and addressing context-based factors that may influence the integration activities. In addition to this, it is crucial to also identify, characterize and explain the underlying generative mechanisms that have causal effects that produce the outcomes in the current integration efforts of eHealth technologies with healthcare work activities. It is based on this argument and the objectives of this paper that the analysis of the empirical data was done. The analysis in the end reveals the factors such as a need for clarity of eHealth technology’s purpose in the healthcare workflow mediate integration outcomes such as the lack of customised technologies to fit healthcare work activities. The underlying generative mechanism that may trigger such events include the absence of analysing systems for fit for purpose.

The paper also reveals that generative mechanisms such as the absence of continuous re-tooling of healthcare practitioners with ICT skills can help explain the some of the outcomes of the current
integration efforts of eHealth technologies with healthcare work activities in public healthcare facilities. The findings in this paper present a critical analysis can be of benefit for the implementer and relevant government authorities in the healthcare sector. Another contribution the paper makes can be used to better guide future eHealth technology integration with healthcare work activities in different healthcare settings. The paper has provided reasons why integration of eHealth technologies do not adequately facilitate healthcare practitioners work activities. These reasons are due to the contextual and due to the contradictory interplay between social and technical generative mechanisms.

The study proposes that future work on eHealth integration in healthcare contexts should focus on developing frameworks for assessing the sustainability of eHealth in the public healthcare space and also on assessing the process of operationalizing health policy/strategy at facility level to evaluate the impact, benefits and value of these policies and strategies on the healthcare system.

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Abstract: A lack of service delivery and accountability are two characteristic challenges of numerous municipalities (local government) in South Africa. MobiSAM was introduced as a collaborative effort between a local university, civil society, residents, and local government to grow digital citizen engagement, facilitate two-way communication between local government and its citizenry, and contribute to the improved provision of basic services. Through the course of the project, it became clear that power, with respect to knowledge, was at play in the interactions or lack thereof between local government and citizens. This work-in-progress paper begins the journey of exploration of the power/knowledge dynamics at play in the MobiSAM project (using the SECI model and the Power Cube) by unpacking and understanding the nature of knowledge processed in the project and the associated knowledge creation processes that ensued between the different project stakeholders over time. The influence of power in determining the effective transfer of knowledge between key stakeholders of the project, for capacity building and organisational learning has emerged as an important issue in need of thorough investigation and critical analysis. This work in progress paper presents the preliminary framing of the research findings on the phases associated with the interplay of knowledge and power in the MobiSAM project, which are: 1) Realisation, 2) Navigating Responsiveness, and 3) Emergence.

Keywords: citizen engagement, civic technology, knowledge, power

1. INTRODUCTION

The concept of citizen engagement has at times been used as a façade to imply that effective strategies or approaches exist for two-way communication between government and citizens with respect to service delivery gaps and needs. Typically, citizen engagement is a state-led activity, providing spaces to solicit the views and involvement of citizens in decision-making around service delivery. Despite the values behind citizen engagement, the reality is far from its intended purpose; challenges experienced with local government in the Eastern Cape of South Africa are characterised by a lack of service delivery particularly in predominantly poor and rural communities (Algotsson et al., 2009; Ngumbela, 2021). Invariably, power is at play here. The dominant discourse around lack of service delivery links to the inequalities that have emanated from the past Apartheid legacy. However, high levels of imbalance in access to resources, infrastructure and social services still continue to plague the Eastern Cape Province and many similar vulnerable regions (Ferreira, 2021; Matolino & Kwindingw, 2013; Nnadozie, 2013).

In an effort to address the power and information asymmetries that hamper service delivery and the right thereto, the MobiSAM project was introduced in 2012 as a digital citizen engagement initiative (Thinyane, 2013). MobiSAM stands for Mobile Social Accountability Monitoring and was
introduced as a collaborative effort between a local university, civil society, residents, and a municipality (local government). The initiative exists as more than a digital application for residents to report service delivery faults but has grown to holistically influence communication ecologies around service delivery, and enable or incentivise stakeholder engagement that originally did not exist due to friction and suspicion among government and citizen activists or civil society (Machiri & Pade-Khene, 2020; Thinyane et al., 2017). In the process of implementing and operating MobiSAM (a pragmatist interpretivism and participatory action research project) from 2012 to the present 2021, researchers noted the power of knowledge and control in framing the direction of the project. The aim of the project was to contribute new knowledge to research and theory around digital citizen engagement in this context. What is particularly interesting in the current study, is the realisation by researchers (who are also local residents) of their ability to negotiate power and empower citizens (and even local government) to effectively communicate and articulate the existing challenges with respect to service delivery. Using the Power Cube, this research study considers the different aspects of power proposed by Gaventa (2006) (i.e., form, space, and level) in understanding the nature of power and power relations that drove the evolution of the MobiSAM project to what it is today. Given knowledge is the power at play (whether in reference to citizens’ rights and awareness, or effective ways of enabling two-way communication between citizens and government in resource-constrained contexts), the paper also considers the SECI model of knowledge creation dimensions by Nonaka & Toyama (2003) to understand how knowledge as power is negotiated and socialised in the MobiSAM project over time. The study is therefore guided by the following research question:

What forms of knowledge and power frame the integration of a digital citizen engagement initiative over time in a resource-constrained local government context?

The research study applied a pragmatist interpretive approach, facilitated by participatory action research. Pragmatist interpretivism is described by Ansell (2015, p. 13) as an approach “trying to understand how people (and social scientists) draw inferences in specific social contexts about the kind of situations they are in and about the intentions and motivations of others”. Originating from political science, what differentiates this approach from pure interpretivism, is that the researcher is involved in the actual political or collectivist/advocacy process, and has to interpret and reflect on his/her experiences and that of his/her compatriots. Research around MobiSAM and its underlying concept of digital citizen engagement required researchers to engage in the iterative development and implementation, and reflection of actions and practices associated with the project. Here, the logical connection between theory and empirical data are developed in an iterative fashion, symbolising abductive reasoning, with a back-and-forth interaction between beliefs and action (Klein & Myers, 1999; Morgan, 2014; Walsham & Sahay, 2006). Even though this study is contextualised to the municipality that the MobiSAM project was implemented in, many local governments in South Africa, Africa, and other Global South contexts can learn from these experiences to consider strategies for resilient or effective digital citizen engagement integration.

2. DIGITAL CITIZEN ENGAGEMENT IN SOUTH AFRICA

The South African Constitution (Republic of South Africa, 1996) makes municipalities responsible for delivering basic services such as electricity, water, sanitation, and refuse removal. South African municipalities are responsible for ensuring service delivery, accountability, and participation at the local government level to realize a developmental democracy. Local government in South Africa has often fallen short of this mandate resulting in an inability of municipalities to deliver on basic services (Brand, 2018). Commentators have attributed this lack of delivery of basic services to a lack of accountability at local government level, particularly with respect to a lack of public participation (Heller, 2009; Kariuki & Reddy, 2017; Ndevu & Muller, 2018). Pravin Gordhan, the 2014 Minister for Co-operative Governance & Traditional Affairs, noted that the main problems faced by local government in South Africa are “a communication breakdown between councils and citizens; no accountability; political interference in administrations; corruption; fraud; bad
management; violent service delivery protests; factionalism; and depleted municipal capacity” (Lund, 2014, p. 1). South Africa’s Auditor General, in 2018, found that only 13% of South African local municipalities were fully financially compliant. This was attributed to a range of factors, namely, a lack of financial and management skills, political interference, infighting in councils, staffing shortages in key positions, and a lack of accountability (Brand, 2018; Kroukamp & Cloete, 2018).

Despite the numerous challenges (Brand, 2018; Kroukamp & Cloete, 2018; Lund, 2014), local government structures offer opportunities for increased citizen engagement. The immediacy of people’s needs and the proximity of government to those who elected them provide increased motivation for participation. However, success is unlikely without meaningful, informed, and effective participation of citizens in government processes, and the provision of mechanisms and skills to hold service providers to account for their performance in managing public resources and delivering services (Heller, 2009; Kariuki & Reddy, 2017; Ndevu & Muller, 2018).

Social accountability can be viewed as the interaction of five elements to achieve its objectives (Helene Grandvoinnet et al., 2015), namely: state action, citizen action, information, citizen-state interface, and civic mobilization. The successful interaction of these elements is dependent on enablers that allow for the effective exchange of information between government and citizens. Two-way communication is fundamental, where citizens can either supply information or provide feedback to the state and vice versa (J. Gaventa & Barrett, 2012; Gigler & Bailur, 2014; H. Grandvoinnet et al., 2015). When information and communication technologies are used to enable this exchange through evidence-based citizen engagement and social accountability, this is referred to as digital citizen engagement (DCE) (World Bank, 2016, p. 16). The role of DCE and social accountability monitoring is to bring individual and collective voices together, to collaborate effectively through evidence gathered and shared (Peixoto & Fox, 2016). Traditional means of citizen engagement have included community scorecards and questionnaire surveys, to identify gaps in access to government services. However, the timely nature needed to gather real-time data that can be used effectively to address faults with respect to basic services, especially access to clean water (which has become even more critical in this time of the COVID-19 pandemic) are fundamental to dealing with the urgency of access to basic services. This calls for the need for DCE and social accountability monitoring to gather real-time evidence, around which citizens and government can engage as they work towards a negotiated cohesion for service delivery. MobiSAM attempts to offer citizens a methodology to engage in evidence-based Social Accountability Monitoring (SAM) and a set of mobile, web-based tools to facilitate the meaningful participation of citizens in local governance processes. However, the integration of such methods remains a challenge for many civic tech initiatives, as power and knowledge drive effective participation.

Emerging literature suggests that actors in a social system may exercise power in multiple ways: ‘power over’, and ‘power to’, ‘power with’, and ‘power within’ (Acosta & Pettit, 2013; Avelino & Rotmans, 2009). The ‘power over’ refers to actions of actors where there is control over another, for example actor A having more power over actor B in terms of dependency for resources (Avelino & Rotmans, 2009; Hannus & Simola, 2010). ‘Power to’ which is similar to the notion of ‘agency’, refers to the ability of actors to use their capacities and resources; for instance actor A can mobilise more resources than actor B in terms of economic power (Avelino & Rotmans, 2009; Lukes, 2005). ‘Power with’ describes the capabilities that arise out of collective action and collective agency. ‘Power within’ references empowerment. The power-knowledge relation in this research study is adopted to understand the involvement of actors or stakeholders (citizens, civil society, government and researchers) in the MobiSAM project, capable of producing knowledge that is either practical or theoretical, and a matter of episteme that is essentially contextual. The emphasis in this project has been on the role power plays in social change. Analysing power/knowledge relations can be complex in some cases since the power/knowledge relations are hidden within daily practices (Foucault, 1980). Therefore, it is important to envisage how power/knowledge relations could be analysed.
3. THEORETICAL FRAMEWORK

The starting point of exploring the power/knowledge dynamics at play in the MobiSAM project is unpacking and understanding the nature of knowledge processed in the project and the associated knowledge creation processes that ensued between the different project stakeholders. The research study therefore uses the SECI model and Power Cube to explore MobiSAM dynamics over time.

While knowledge fundamentally exists in human minds, its creation, processing, and use happens within broad “communities of interaction” that are shaped by the context; be it a social, cultural, or organizational context (Nonaka, 1994, p. 15). Knowledge therefore has both the individual dimension as well as the collective dimension through which it is created, shared, and communicated (Alavi & Leidner, 2001). One of the prominent knowledge management models that captures the varied dynamics of knowledge creation is the SECI model. The SECI model of knowledge creation was originally proposed for managing knowledge creation processes within organizations, and was centered on the social interactions around tacit and explicit knowledge, through which new knowledge is created by individuals supported by elements within the organization that articulate and amplify the knowledge (Nonaka, 1994). The SECI model identifies 4 cyclical modes of knowledge creation that ensue between tacit and explicit knowledge:

1. **Socialization**: a tacit-to-tacit knowledge creation process, which occurs in contexts of shared experiences and practice between individuals, and is typically encapsulated in organizational culture.
2. **Externalisation**: a tacit-to-explicit knowledge creation process, which occurs when instruments such as policies, guidelines and best practices are utilized to formalize, codify, and document organizations’ knowledge.
3. **Combination**: enables the explicit-to-explicit knowledge creation process through supplementation, combination, analysis, and categorization of existing knowledge.
4. **Internalisation**: the explicit-to-tacit knowledge creation process which typically occurs through organizational learning practices.

The SECI model has not been without criticism - that it has been formulated from a very specific organizational and cultural context (Haag et al., 2010; Li & Gao, 2003), and that it lacks empirical validation. However, it has been shown to provide an effective framework for unpacking the key elements of knowledge management processes (Natek & Zwilling, 2016; Nonaka & von Krogh, 2009); for studying knowledge creation processes in different domains (Faith & Seeam, 2018); and for understanding the role of technology in knowledge creation processes (Alavi & Leidner, 2001; Dávideková & Hvorecký, 2017). When one considers the complex interactions and knowledge flows between the different stakeholders in DCE interventions, the relevance of the SECI framework as an analytical instrument becomes immediately apparent. It helps to locate actants, both human and non-human, across the four knowledge creation processes, and also to explore the role of technology to support those processes. For example, information management and data analytics systems would tend to support processes framed around explicit knowledge (e.g. combination), while interactive communication and social media systems would better support tacit knowledge processing around sharing of experiences and insights between users.

The overarching aim of DCE should be around the effective distribution of knowledge to evoke service delivery change. Typically, power is closely aligned with who has the knowledge to manipulate or drive service delivery operations. In many local government contexts that are resource constrained, knowledge is a monopoly in the hands of government officials or even (affluent) citizens who stand to gain from service inequality (Gaventa & Cornwall, 2006). Nonetheless, social accountability monitoring, with the help of DCE aims to challenge the power of the dominant actor(s), as citizens (especially from marginalised areas) begin to develop a new awareness of their
realities and their rights. Gaventa’s (2006) Power Cube coupled with the SECI model helps to unpack the evolution and resilience experienced in the MobiSAM project.

The Power Cube framework was born out of citizens “efforts to claim political, economic and social rights” (Gaventa, 2006, p. 26). It facilitates the interrogation of power to understand how and if participation and the voice of the citizens can and does have influence to promote inclusion and social justice. Three forms of power (which can be interrelated) are described in relation to the forms, spaces, and levels of power in which citizen engagement takes place:

1. **Spaces**: Gaventa (2006, p. 26) describes ‘spaces’, quoting (Lefebvre, 1992, p. 24) as “a social product …a dynamic, humanly constructed means of control, and hence of domination, or power”. There are three levels of spaces: closed spaces, invited spaces and claimed/created spaces. Spaces tend to be dynamic in their existence and in their relationships to one another; continually opening and closing through transformation, cooperation, resistance, and legitimacy. Whoever creates the space is likely to hold the power in that space.

2. **Levels**: refer to where the “critical, social, political and economic power resides” (Gaventa, 2006, p. 27). These levels are defined as local, national, and global. These levels of power are interrelated; local forms of power are “being shaped in relationship to global actors and forces, and in turn, local action affects and shapes global power” (Gaventa, 2006, p. 28).

3. **Forms** of power refer to the “dynamics of power that shape participation” and are defined as visible, hidden, and invisible (or internalised) forms of power (Gaventa, 2006, p. 26; Lukes, 2005). These forms of power place boundaries on participation to exclude certain actors or viewpoints from engaging in arenas of participation.

Gaventa (2006, 2019) notes that real transformative change happens when power is addressed at each dimension simultaneously. This is not a straightforward process, as we demonstrate in the MobiSAM project, which is still ongoing, and challenged by contextual factors.

4. **POWER PARTICIPATION IN MOBISAM**

The concept of knowledge and knowledge transfer (Szulanski, 1996) in MobiSAM is not new – a previous publication (Pade-Khene, 2018) focused on developing digital literacy around the creation and use of MobiSAM. However, what became apparent over time was the influence of power, in determining the effective transfer of knowledge between key stakeholders of the project, for capacity building and organisational learning. Here, knowledge refers to both civic literacy and responsiveness literacy (Pade-Khene, 2018). In the analysis, two knowledge perspectives with respect to these types of literacy frame the discussion: ‘state of mind’\(^1\) and ‘capacity’\(^2\) (Alavi & Leidner, 2001). Civic literacy considers that citizens possess the domain knowledge, ability, and capacity to make sense of their political world, and hence effectively act individually or collectively to hold government accountable and demand for key services (Henninger, 2017). Responsiveness literacy on the other hand considers the domain knowledge of local government to respond to and acknowledge citizen requests, and engage on communication platforms with citizens. One would consider responsiveness literacy as a choice, *rather* than an element of ‘capacity’ or ‘state of mind’ as a perspective of knowledge (Alavi & Leidner, 2001) – where local government exercises their political power in decision-making. However, understanding citizen service delivery issues, their rights, and the ability of citizens to exercise those rights produces an understanding of and respect for accountability of government performance. Figure 1 provides an illustrative diagram that represents how the authors have begun to reflect on and analyse the progressive developments in the MobiSAM project, based on the interplay of knowledge and power over time. The interplay of

---

\(^1\) a cognitive **state of mind** of knowing and understanding

\(^2\) a **capability** and a potential to influence action, build competency and know-how.
knowledge and power vary in each of the three phases (1. Realisation, 2. Navigating Responsiveness, and 3. Emergence) that MobiSAM has experienced (see Table 1). Future publication will focus on defining, discussing and further evidencing these phases, in relation to the mode of knowledge dominant in each phase, and the spaces, forms, and levels of power influencing the transfer of knowledge.

![Figure 1. The Phased Interplay of Power and Knowledge in the MobiSAM Project](image)

<table>
<thead>
<tr>
<th>Phase</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Realisation</strong></td>
<td>Associated with the introduction of MobiSAM, the realisation of the emanating challenges of service delivery and the lack of effective citizen engagement - the focus of the project was on empowering citizens, which the government tended to characterise as adversarial. Socialisation dominated as a mode of knowledge creation, as knowledge around service delivery issues tended to be shared among individuals - due to mistrust and despondency among citizens who complained among each other rather than officially report on an issue, as well as the power of government to withhold or dominantly share knowledge with each other.</td>
</tr>
<tr>
<td><strong>2. Navigating Responsiveness</strong></td>
<td>This formed what was referred to as MobiSAM 2.0, with an aim to incentivise government (building responsiveness) and citizens to buy-into digital citizen engagement. A less adversarial approach was applied. The operation model incorporated strategy formulation with key stakeholder partners, iterative development of the application to account for needed requirements, citizen training, and evaluation to address uncertainty. The overall aim was to build civic literacy and responsiveness literacy - two key elements that enabled the use of MobiSAM to report and advocate for service delivery. As knowledge around service delivery became more explicit, externalisation as a mode of knowledge creation began to dominate.</td>
</tr>
</tbody>
</table>
3. Emergence

MobiSAM has had to become organic and dynamic - its continued existence has been left to unfold, as researchers have completed the project but continue to support it with limited resources to ensure its continuity. The focus here is incentivising key actors such as civil society and government to support the continuity of MobiSAM, in however they see fit - designing it to support its own activities. For example, MobiSAM is seen as a vital source of communication by the government, and civil society sees it as a tool to generate evidence-based data to advocate for change. Other platform technologies such as WhatsApp and Facebook have been used in conjunction with the MobiSAM platform, to enable other forms of communication that are more accessible. The dominant mode of knowledge creation is Combination and Internalisation, as MobiSAM has become integrated into government’s service delivery operations.

Table 1. Description of MobiSAM Phases

<table>
<thead>
<tr>
<th>Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emergence</td>
</tr>
</tbody>
</table>

5. CONCLUSION

Challenges experienced with local government in the Eastern Cape of South Africa are characterised by a lack of service delivery and accountability particularly in predominantly poor and rural communities, despite the responsibilities thereof written into the Constitution of South Africa. MobiSAM was introduced as a collaborative effort between a local university, civil society, residents, and a municipality (local government) to grow digital citizen engagement, facilitate two-way communication between local government and its citizenry, and contribute to the improved provision of basic services. Through the course of the project, it became clear that power, with respect to knowledge, was at play in the interactions or lack thereof between local government and citizens. The power-knowledge relation in this research study is adopted to understand the involvement of actors or stakeholders (citizens, civil society, government, and researchers) in the MobiSAM project, capable of producing knowledge. The emphasis being on the role power plays in social change. While the concept of knowledge and knowledge transfer is not new to MobiSAM, the influence of power in determining the effective transfer of knowledge between key stakeholders of the project, for capacity building and organisational learning has emerged as an important issue in need of thorough investigation and analysis. Future research and analysis will focus on defining and discussing these phases, in relation to the mode of knowledge (SECI) dominant in each phase, and the spaces, forms, and levels of power (Power Cube) influencing the transfer of knowledge.

REFERENCES


SURVEY OF CYBER VIOLENCE AGAINST WOMEN IN MALAWI

Donald Flywell Malanga, University of Livingstonia, dmalanga@unilia.ac.mw

Abstract: The purpose of this study was to investigate the prevalence of cyber violence against women in Karonga district of Malawi. The study adopted a descriptive survey design. About 67 women participated in the survey questionnaire. The study utilised Technology Facilitated Gender-Based Violence Framework as theoretical lens. The study noted that women experienced various forms of cyber violence such as cyber bullying, cyber harassment, online defamation, cyberstalking, sexual exploitation, online hate speech, and revenge pornography. Perpetrators used digital platforms such Facebook, WhatsApp, online personal accounts, dating sites, and smartphones to carry out their evil acts. The study also found that perpetrators' motivations were driven by revenge, anger, jealousy, sexual desire and political agenda, with the intentions to harm the victims socially, psychologically, economically, and physically. The women used coping measures such as confrontation and blocking the perpetrator or by leaving the online platform. It was found that women never bothered to report the incidences to the police or community to seek for support due to lack of awareness, cultural and patriarchal factors. In conclusion, the study found that the prevalence of cyber violence against women is rising significantly in Malawi. Therefore, the findings provide insights to policy makers and research practitioners on how to implement strategies for combating cyber violence against women in the country.

Keywords: ICTs, digital violence, online violence, cyber violence against women, Karonga, Malawi, Africa.

1. INTRODUCTION

Globally millions of women are subjected to deliberate violence because of their gender (Council of Europe, 2018). Violence against women knows no boundaries, cut across boundaries, culture, race, and income groups harming victims, people around them and the society as whole (Maundu, 2020). Violence against women is defined as any act of gender-based violence that results in physical, sexual, or mental harm or suffering to women, including threats such as coercion or arbitrary deprivation of liberty whether occurring in public or private life (World Health Organisation [WHO], 2020). Studies suggest that 1 in 3 women worldwide have experienced some form(s) of gender based violence in their life time. The growing reach of Information and Communication Technologies (ICTs) such as internet, social media, mobile devices, and digital platforms have presented potential opportunities and enabled efforts to address violence against women (Council of Europe, 2018; European Institute of Gender Equality, 2017; Frisen, Berne &Lunde, 2014). However, the same ICTs that are supposed to empower women, have also become tools to inflict them (Cybersafe, 2020). This form of violence is called cyber violence against women (CVAW).

1.1. Definition of cyber violence against women

Since cyber violence against women is an emerging phenomenon, literature indicates a lack of consistent and standard definitions or methodologies used to conceptualise and measure it
Malanga

Survey of Cyber Violence Against Women in Malawi

(Cybersafe, 2020). To this end, the Council of Europe (2018) concedes that there is not yet a stable lexicon or typology of offence considered to be CVAW. Many of the examples or types of CVAW are interconnected or overlapping or consists of a combination of acts. However, this study adopts a more encompassing definitions which posits that CVAW refers to a type of gender-based violence perpetrated through electronic communication and the internet (Cybersafe, 2020). This may result in physical, sexual, psychological or economic harm or suffering and may include the exploitation of the individual’s circumstances, characteristics or vulnerabilities (Council of Europe, 2018). United Nations (UN) Broadband Commission (2015) indicates that CVAW is just as damaging to women as physical gender-based violence does. The report further estimates that 73% of women have endured CVAW, and are 27 times more likely than men to be harassed online.

1.2 Forms of cyber violence against women

Although cyber violence can affect both men and women, women experience different and more traumatic forms of cyber violence (Frisen et al., 2014). Literature provides various forms of CVAW such as cyber stalking, cyber harassment, cyber bullying, online sexual harassment, nonconsensual pornography, etc (West, 2014). United Nations Broad Commission (2015) indicates that women aged between 18-24 years experienced some forms of cyber violence in their life time. They disproportionately suffer from cyber bullying, cyber harassment, cyber stalking and online sexual harassment, etc. The report further indicates that in the European Union (EU) of 28 membership, 18% of women have experienced cyber violence in form of online hate, online harassment, cyber stalking, and others since the age of 15. This prevalence rate represents 28 million women. Sargent et al. (2016) found that over 50% of girls older than 13 years of age in Slovenia experienced some form of cyber violence. While there are various forms of CVAW, only the relevant ones applicable to this study were adopted as presented in Table 1.

Table 1: Forms of cyber violence against women (Cybersafe, 2020; European Institute of Gender Equality, 2017).

<table>
<thead>
<tr>
<th>Forms of CVAW</th>
<th>Definitions/description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cyber stalking</td>
<td>Involves repeated incidents, which may or may not individually be innocuous acts, but combined undermine the victim’s sense of safety and cause distress, fear or alarm.</td>
</tr>
<tr>
<td>Cyber bullying</td>
<td>Entails receiving unwanted, offensive, sexually explicit emails or SMS messages; inappropriate, offensive advances on social networking websites or in Internet chat rooms</td>
</tr>
<tr>
<td>Cyber harassment</td>
<td>Is a harassment by means of email, text (or online) messages or the Internet</td>
</tr>
<tr>
<td>Online hate speech</td>
<td>Is a type of speech that takes place online with the purpose of attacking a person or a group based on their race, religion, ethnic origin, sexual orientation, disability, or gender</td>
</tr>
<tr>
<td>Online defamation</td>
<td>Involves online publication of a false statement about a person that results in some kind of harm, including financial losses or damage to the subject’s reputation</td>
</tr>
<tr>
<td>Online exploitation</td>
<td>A person receiving sexual threats, being coerced to participate in sexual behaviour online, or blackmailed with sexual content.</td>
</tr>
<tr>
<td>Non-consensual pornography (revenge porno)</td>
<td>Involves online distribution of sexually graphic photographs or videos without the consent of the individual in the images</td>
</tr>
</tbody>
</table>

1.3 Impact of cyber violence against women

Though the available literature on the impact of CVAW is limited, it demonstrates that CVAW has social, physical, psychological, and economic impact on women if left unchecked. Gleenson and Garcia, (2014) investigated the relationship between cyber victimisation and body esteem among Swedish adolescents. The study found that 84% of adolescents reported behavioral impact, 80% a social impact, 56% a cognitive impact, and 12% experienced a physical impact. Study by West report (2014) found that 65% of women from the survey experienced some sort of psychological impact inform of anxiety and damaged self-image. Council of Europe (2018) reported that cyber violence against women undermines women’s core fundamental rights such as dignity, access to
justice and gender equality. The study by West report (2014) concluded that the impact of CVAW are social, physical, economic and psychological. Despite recent increased efforts and investments to curb CVAW prevalence globally, it continues to be a complex and pervasive public health and human rights concern that is being perpetuated in various forms and across multiple contexts and platforms.

By the end of 2020, Africa recorded an 8% increase in ICT penetration (GSMA, 2020) compared from 20% in 2015 (UN Broadband Commission, 2015). Despite this exciting ICT penetration rates, the continent has not been immune to increased CVAW, with countries like Kenyan, Nigerian and South Africa becoming fast growing hubs of CVAW activity. In particular, recent studies reported that 33% prevalence of CVAW in Kenya and South Africa. The study also indicated that mobile phones and social media are currently the major ICT tools used to perpetuate CVAW in most emerging African countries (European Institute of Gender Equality, 2017). Though, efforts to tackle CVAW are emerging at a larger scale, it remains an extensive and widely under-reported online human rights violation African countries (Maundu, 2020).

Much of the studies focus on CVAW in developed world such as Europe and United States (Cybersafe, 2020; Council of Europe, 2018; European Institute of Gender Equality, 2017), and similar empirical studies are lacking in least developed countries like Malawi. Other studies contend that CVAW is an emerging concept in developing countries (Violence against women, 2014). As a result, most available studies are pilot studies in nature, sometimes conducted without theoretical foundations (International Center for Research on Women [ICRW], 2018). In this regard, designing preventive measures using the evidence from developed countries alone has substantial drawbacks due to geopolitical differences and other contextual factors that exist within countries including Malawi (Maundu, 2020).

In Malawi, there is paucity of studies on cyber violence against women. Much of the studies have focused much on gender-based violence on the physical space (Spotlight Initiative, 2020; Reliefweb, 2019; Settergren & Sapuwa, 2015), and have paid little or no attention in the digital space. Due to uniqueness nature of this study, findings from such existing studies cannot be generalised to prevalence of cyber violence against women in the country. The dearth in literature on CVAW, has led to lack of informed policy direction on understanding CVAW, its nature, prevalence and responsive strategies to address it. To address the lacuna of knowledge, this study attempted to pose this main research question: What is the prevalence of cyber violence against women in Malawi? To answer the main research question, the following four sub-questions were posed?

- What form(s) of cyber violent behaviours that women experience?
- What are the perpetrators’ motivation to commit cyber violence against women
- What are the impacts of cyber violence against women?
- What strategies are available to tackle cyber violence against women?

The study drew on Technology-Facilitated Gender Based Violence Framework (TFGBVF) as theoretical lens. Using TFGBVF helped to understand the prevalence of CVAW in Malawi, with a view to increasing its awareness, nature, impacts, and advocate for personal, community and national responses to prevent and mitigate this nature of online aggression. In addition, employing TFGBVF as a theoretical framework for this study led to better conceptualisation of cyber violence study phenomena, thereby contributing to theory and practice in Information and Communication Technology for Social Justice (ICT4SJ) space. The rest of the paper is arranged as follows: background to the study, theoretical framework, methodology, analysis of findings, and discussion and conclusion.

2. BACKGROUND TO THE STUDY
Malawian gained its independence from Great Britain in 1964. It borders Tanzania, Zambia and Mozambique. The country has an estimated population of 17.7 million people of which 85% live in
rural areas. It is regarded as one of the least developed countries in the world with a Gross Domestic Capital per Capita is USD 516.80 (WHO, 2020). Most women are working in the agricultural sector, which is a backbone of Malawi’s economy (Malanga & Chigona, 2018). Of those in non-agricultural waged employment, 21% are women and 79% are men, and the numbers have remained the same over the years (Malanga, 2020). The overall mobile penetration is estimated at 45.5% while internet is 6.5% (Telecommunication Union, 2020; MACRA, 2015). About 34.5% of women own a mobile phone, 0.6% own a desktop computer, 1.8% own a Laptop, while just 4.7% of them have access to the internet. The low rate of ICT penetration in Malawi is attributed to the country’s weak economy, high value added tax (VAT) imposed on importation of ICT gadgets, and other contextual factors (Malanga & Jorosi; Malanga, 2017).

2.1 Gender-based violence situation in Malawi
Section 24 of the Malawi’s Constitution stipulates that “women and girls have the right to full and equal protection by the law, have the right not to be discriminated against on the basis of their gender or marital status”. These rights are also operationalized in Malawi’s Gender Policy (2015) and National Action Plan to Combat Gender-based Violence in Malawi (2014-2020) (Settergren & Sapuwa, 2015). Recently, the Malawi enacted Electronic Transaction and Cybersecurity Act of 2016 and Data Protection Bill (2021) has also been drafted. These legislative frameworks are necessary to ensure that women’s digital rights are protected online. Despite these policy interventions, gender-based violence remains high in Malawi (Malanga, 2019). In addition, undocumented reports that cases of CVAW in the country is rising as more women are interring in the digital space. The root causes point to culture and unequal power relations between men and women, which ensure male dominance over women (Spotlight Initiative, 2020). The unequal status of women is further exacerbated by poverty and discriminatory treatment in the family and public life. As a result, Malawi is ranked 173 out of 188 countries on the UN’s Gender Inequality Index (USAID, 2019). Therefore, it was critical to undertake the current study to understand the prevalence cyber violence against women in Malawi so that the findings could offer policy suggestions to address the vice.

3. THEORETICAL FRAMEWORK
This study was guided by Technology-Facilitated Gender-Based Violence (TFGBV) Framework as a theoretical lens (International Center for Research on Women [ICRW], 2018). The framework attempts to explain two stages how gender-based cyber violence against women occurs: From perpetrator and Survivor/Victim’s perspectives.

From the perpetrator’s view, the framework suggests the motivations and intentions of why perpetrators/attackers commit cyber violent behaviours against women (Cybersafe, 2020). Motivation refers to the emotional, functional, or ideological drivers behind the perpetrator’s behaviour. Motivations can be political or ideological in nature driven by revenge (ICRW, 2018). From motivation comes intent. Intent is a determination of the perpetrator to harm the victim. Intent also varies by type of behaviour which may include psychological, physical harm or enforcement of gender norms. Next, the perpetrator conducts a cyber violent behaviours which could be inform of stalking, defamation, sexual harassment, exploitation and hate (ICRW, 2018). Furthermore, the framework explains the frequency, mode and cross-cutting tactics used by perpetrators or attackers to commit cyber violence against women victims/survivors (ICRW, 2018).

Likewise, on the survivor/victim’s perspective, the framework postulates the impacts of cyber violence on the victim/survivor. The impact can be physical, psychological, functional, social and economic ones. The framework further suggests that the impact of cyber violence depends on the relationship that exists between the perpetrator and the victim/survivor (ICRW, 2018). The relationship can be personal, impersonal or institutional. Most importantly, the theory suggests the help-seeking and coping mechanism that should be put in place for preventing or dealing with victims/survivors of cyber violence (Cybersafe, 2020). The help-seeking and coping mechanisms can be individual, community/social/legal or national support services. To this end, this framework illustrates the range of experiences from the motivations of the perpetrators to the impact and help-
seeking behaviours of the victims or survivors. This process is set within the larger context, because what constitutes cyber violence is locally defined and experienced (Cybersafe, 2020; ICRW, 2018; West, 2014). Based on the evidence, this framework was selected relevant to guide this study. Figure 1 provides an illustrative diagram that summaries the concepts of the TFGBV framework.

4. METHODOLOGY

4.1 Research design
The study adopted a cross-sectional survey design. The reasons for employing survey design were that it is popular and allows the collection of a large amount of data from sizeable population in a highly economical way (Saunders et al. 2014).

4.2 Population, Sampling and site selection
This study was conducted in a town market of Karonga district. This a market place where the majority of low-income merchants including women, are given spaces by the district council authorities to trade their small-scale businesses. Karonga district is situated 220km North of Mzuzu city and 50km south of Songwe border with Tanzania (Malanga & Kamanga, 2019). It has a population of 365,028 representing 1.3% of the country’s population. Women accounts for 51.7% of the population. Number of households is estimated at 74,953 in the district (Malawi Demographic and Health Survey [MDHS, 2018]). The majority of women are involved in subsistence agricultural activities as their main source of household livelihoods. Household ownership includes TVs, radios, landline, satellite dishes, mobile phones, computers and refrigerators, etc (MDHS, 2018). About 80 survey questionnaires with closed-ended questions were randomly distributed to low-income women merchants, aged between 18–45 years old. However, only 67 questionnaires were returned and suitable for analysis. The questionnaire was pre-tested to 8 women administered by the researcher himself. Pre-testing enabled the researcher to correct all ambiguities that were found in the survey questionnaire (Creswell, 2014; Saunders et al., 2014). This ensured that data collection tools were reliable and valid, before they were finally administered to the sampled population of women.

4.3 Research ethics, data collection and analysis
Permission to conduct the study was obtained from Karonga district council. The participants were informed that their involvement in the study was voluntary. To ensure that participants’ privacy and confidentiality are protected, all recordings and transcripts were stored securely. Pseudonyms were used to protect their identities. In addition, individual written and oral consent was obtained from the respondents. Data was collected between 20th July to 5th August, 2020. All Covid-19 preventive measures were adhered to. The collected data was analysed descriptively using Microsoft Excel 2013 to obtained tables, frequencies and percentages for presentation of data.

5. ANALYSIS OF FINDINGS

5.1 Demographic profile of respondents

In terms of demographic profile of respondents, the findings showed that majority of respondents (35.8% or 24) were aged between 18-25 followed by those who were aged between 26-35 (28.4% or19). In education, 41.8% (28) attained primary school, 34.3 % (23) attained secondary school, while few (19.9% or 10) attained tertiary education. In terms of occupation, 31.3% (21) of women were students, 28.4% (19) were farmers, 17.9%(12) were employed women. Only a few of them were business owners (14.9% or 10). For marital status, 50.7% (34) were single women, 38.8% (26) women were married, and only 6.0% (4) were widows. From this analyses, it evident that the substantial number of sampled women were aged between18-26 and had attained primary school.

5.2. Forms of cyber violence women experience

Sampled women were asked about the forms of cyber violence they experienced. As presented in Table 2, results showed that cyber stalking (92.5%), cyber bullying (83.6%), cyber harassment (76.1%), and online sexual exploitation (71.4%) are major forms of gender-based cyber violent behaviours women experience. Few respondents also experienced online hate speech, non-consensual pornographic materials, and online defamation.

<table>
<thead>
<tr>
<th>Women’s experience(s) of gender-based cyber violence</th>
<th>Frequency(multiple response)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>cyber harassment</td>
<td>51</td>
<td>76.1</td>
</tr>
<tr>
<td>cyber bullying</td>
<td>56</td>
<td>83.6</td>
</tr>
<tr>
<td>cyber stalking (e.g. false accusations, threats etc)</td>
<td>62</td>
<td>92.5</td>
</tr>
<tr>
<td>online hate speech</td>
<td>31</td>
<td>46.3</td>
</tr>
<tr>
<td>online sexual exploitation</td>
<td>48</td>
<td>71.6</td>
</tr>
<tr>
<td>non-consensual pornography</td>
<td>36</td>
<td>53.7</td>
</tr>
<tr>
<td>online defamation</td>
<td>29</td>
<td>43.3</td>
</tr>
<tr>
<td>others</td>
<td>13</td>
<td>19.4</td>
</tr>
</tbody>
</table>

Table 2: Showing form(s) of cyber violence women experience

Participants were also asked to state the period or frequency, in which they usually experienced cyber violence. The findings showed that 67.1% of respondents stated that they experienced daily one or more form of gender-based cyber violence, 26.4% indicated that that gender-based cyber violence occurred weekly, while 4.5% of respondents indicated that that did not know. Respondents were also asked to state the ICT mode that attackers or perpetrators used to commit cyber violent behaviours. The majority of participants indicated that social media (62.5% or 42) such as Facebook and WhatsApp, personal online accounts (31.3% or 21) were the most frequently digital platforms used by perpetrators to commit these vices. On the other hand, entertainment and dating sites came the least. It was also revealed that perpetrators used hacking (19.7%), gender trolling (54.2%), fake accounts (33.1%), and doxing (12.3%), and communication threats (4.2%) as main tactics to gain entry into women and girls online spaces.

5.3. Perpetrators’ motivation for committing cyber violence

Another objective was to establish the motivations behind the perpetrators to carry out cyber violence against women. As shown in Table 3, participants indicated that perpetrators’ motives were

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inspired by revenge (83.1%), anger (76.4%), jealousy (69.3%), sexual desire (59.7%), and political agenda (32.8%). The intentions were to psychologically (61.8%) and physically (38.5%) harm the victims or survivors.

<table>
<thead>
<tr>
<th>Motives</th>
<th>Frequency(multiple responses)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jealousy</td>
<td>46</td>
<td>69.3</td>
</tr>
<tr>
<td>Sexual desire</td>
<td>40</td>
<td>59.7</td>
</tr>
<tr>
<td>Revenge</td>
<td>56</td>
<td>83.1</td>
</tr>
<tr>
<td>Political agenda</td>
<td>22</td>
<td>32.8</td>
</tr>
<tr>
<td>Anger</td>
<td>51</td>
<td>76.4</td>
</tr>
<tr>
<td>Monetary desire/agenda</td>
<td>14</td>
<td>21.5</td>
</tr>
<tr>
<td>Maintain social status</td>
<td>12</td>
<td>17.9</td>
</tr>
<tr>
<td>Ideological agenda</td>
<td>8</td>
<td>12.1</td>
</tr>
</tbody>
</table>

Table 3: Perpetrators’ motivation for committing CVAW

5.4. Impact of cyber violence against women

Another important objective was to find out from the respondents on how cyber violence experience impacted them socially, psychologically, economically, and physically. As Table 4 indicates, findings revealed that sampled participants withdrew from online activity (68.7%), lost reputation (17.2%), and cut down from social activity (9.0%).

<table>
<thead>
<tr>
<th>Impact of gender-based cyber violence on women</th>
<th>Frequency (N-67)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Harm reputation</td>
<td>12</td>
<td>17.9</td>
</tr>
<tr>
<td>Withdrew from online activity</td>
<td>46</td>
<td>68.7</td>
</tr>
<tr>
<td>Isolated from family, friends or co-workers</td>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>Cut down from on social activity</td>
<td>6</td>
<td>9.0</td>
</tr>
<tr>
<td>Moved out of the community</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Psychological/Emotional impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anxiety</td>
<td>6</td>
<td>9.0</td>
</tr>
<tr>
<td>Living in a state of fear</td>
<td>33</td>
<td>49.3</td>
</tr>
<tr>
<td>Depression</td>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>Self-image damaged</td>
<td>21</td>
<td>31.3</td>
</tr>
<tr>
<td>Self-harming behaviours</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Thoughts of suicide</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Negative impact on job/school performance</td>
<td>3</td>
<td>4.5</td>
</tr>
<tr>
<td>Economic/Financial impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Loss of income</td>
<td>51</td>
<td>76.1</td>
</tr>
<tr>
<td>Loss of educational opportunities</td>
<td>4</td>
<td>6.0</td>
</tr>
<tr>
<td>Loss of home</td>
<td>5</td>
<td>7.5</td>
</tr>
<tr>
<td>Inability to get a new job</td>
<td>6</td>
<td>12.0</td>
</tr>
<tr>
<td>Loss of property</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Physical impact</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-harm</td>
<td>3</td>
<td>4.5</td>
</tr>
<tr>
<td>Physical abuse exacerbated by online violence</td>
<td>36</td>
<td>53.7</td>
</tr>
<tr>
<td>Physical harm and injury resulting from online violence</td>
<td>23</td>
<td>34.3</td>
</tr>
<tr>
<td>Physical illness</td>
<td>5</td>
<td>7.5</td>
</tr>
</tbody>
</table>

Table 4: Showing impacts of cyber violence against women

Participants were also abused online (53.7%) and harmed online (34.3%), which to some extent led to physical illness (7.5%). Furthermore, the findings found that cyber violence negatively impacted women and girls such as living in a state of fear (49.3%), self-image damaged (31.3%), and anxiety (9.0%). Other women stated that gender-based cyber violence has led them to loss of income (76.1%) and inability to get new employment opportunities (12.0%). Overall, this implies that cyber violence had a negative social, physical, psychological, and economical impact on women.
5.5 Responses/strategies to tackle cyber violence against women

Another objective of the study was to establish the responsive strategies women used to tackle cyber violence. The results are presented in Table 2. In terms of seeking social support services, the study found that half of the respondents blocked perpetrators on digital platforms (50.7%), while others left the digital platform (26.9%) or confronted the perpetrator physically or digitally (10.4%).

<table>
<thead>
<tr>
<th>Responses/strategies</th>
<th>Frequency (N=67)</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seeking social support services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Confronted attacker/perpetrator (s)</td>
<td>7</td>
<td>10.4</td>
</tr>
<tr>
<td>Blocked attacker/perpetrator(s) on digital platforms</td>
<td>34</td>
<td>50.7</td>
</tr>
<tr>
<td>Publicized attacker(s) personal information online</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Left the digital/online platform(s)</td>
<td>18</td>
<td>26.9</td>
</tr>
<tr>
<td>Exposed the attacker/perpetrator(s) to their family, friends, and employers</td>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>Shared information with both print and online media (newspapers, blogs, TVs, radios etc)</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Left to a transition place/house/refuge</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Sought for health/social counselling services</td>
<td>4</td>
<td>6.0</td>
</tr>
<tr>
<td>Seeking legal support services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reported to the police (attacker/perpetrator (s) arrested)</td>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>Reported to the police (police took no action)</td>
<td>21</td>
<td>31.3</td>
</tr>
<tr>
<td>Filed civil law suit against the perpetrator/attacker</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Reported to the police (attacker/perpetrator convicted)</td>
<td>1</td>
<td>1.5</td>
</tr>
<tr>
<td>Never reported to police/community leaders</td>
<td>42</td>
<td>62.7</td>
</tr>
<tr>
<td>Seeking Intervention from digital/online platform (Facebook, YouTube, pornography site, etc.)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Digital/online platform blocked the attacker/perpetrator from using the platform</td>
<td>2</td>
<td>3.0</td>
</tr>
<tr>
<td>Digital/online platform removed the content</td>
<td>5</td>
<td>7.5</td>
</tr>
<tr>
<td>Appealed to digital/online platform but platform took no action</td>
<td>9</td>
<td>13.3</td>
</tr>
<tr>
<td>Never sought intervention from the digital/online platform owners</td>
<td>51</td>
<td>76.1</td>
</tr>
</tbody>
</table>

Table 4: Responses/strategies for tackling cyber violence against women

On seeking legal services, the findings showed that 62.7% of the respondents never reported to the police or community leaders, while 31.3% of respondents reported the incidences to police, but unfortunately the police took no action. However, when it comes to seeking intervention from online digital platforms, the results show that 76.1% of surveyed participants never sought any intervention from the online platform companies, while 13.3% appealed to online platforms, but the online/digital platform took no action.

6. DISCUSSION AND CONCLUSION

This study aimed at investigating the prevalence of cyber violence against women in Malawi. The study targeted low-income women in the market township of Karonga district in Malawi. Specifically, the study looked at the forms of cyber violence women experienced, the motives orchestrated by the perpetrators to commit such cyber violent behaviours, the impact that women suffered against cyber violence, and possible responsive strategies to tackle cyber violence against women.

West (2014) posits that women experience various form of cyber violent behaviours such as stalking, harassment, and bullying, sexual exploitation, among others. These violent behaviours are done by perpetrators and may be repeated with varying frequency. Perpetrators usually conduct cyber violent behaviours against women and girls using ICT and digital media such as mobile phones, social networking sites, email accounts, internet, etc (ICRW, 2018; Dredge et al. 2014).
Likewise, the present study found that women experienced cyber violent behaviours that ranged from cyber bullying, online defamation, cyber stalking, sexual exploitation to hate speech, and non-consensual pornography. Perpetrators used digital platforms such as Facebook, WhatsApp, online personal accounts, dating sites, and smartphones to carry out their acts of cyber violent behaviours against women. This was not surprising considering that the number of women accessing and using such digital platforms in Malawi has increased significantly over the past five years (Telecommunication Union, 2020). Prior studies indicate that gender-based cyber violence is informed by the connection or relationship that exists between the victim/survivor and the attacker/perpetrator (ICRW, 2018; West, 2014). In this study, it was also found that most of the perpetrators were known to the women victims inform of ex-husband, boyfriend and co-workers.

ICRW (2018) defines perpetrator’s motivation as the emotional, psychological, functional or ideological drivers behind the perpetrators behaviour. In this regard, motivation can be political, ideological in nature or driven by revenge. Similarly, this study revealed that perpetrators’ motivation to commit acts of cyber violence against women, were aimed at reventing, anger, jealousy, sexual desire and political agenda, with the intentions to psychologically and physically harm the victims. Similar studies have reported that perpetrators commit cyber violence against women with the intentions of harming them physically or psychologically. Other intentions are to enforce certain gender norms or extortion (Cybersafe, 2020; ICRW, 2018; Sargent et al. 2016)).

Literature suggests that every victim or survivor of cyber violence is impacted in one way or the other by their experience. Those impacts can bring harm to their physical, mental, social status and economic opportunities, or sometimes may lead to death (ICRW, 2018). Likewise, the current study found that women victims or survivors were negatively impacted by cyber violence. These included social, psychological, economical, and physical impacts. In terms of social impacts, the study found that the majority of sampled women withdrew from online activity, lost reputation, and opted to cut down from social activity. Psychologically, the study found that cyber violence experience made women start living in a state of fear, with anxiety and self-image damaged. Women were also impacted physically inform of online harm which led to physical illness to some extent.

Furthermore, the study found that some women suffered economically as a result of cyber violence. For instance, a substance number of sampled women lost their income and were unable to get new employment or participate on new business opportunities. The findings further confirm similar studies that have reported that if cyber violence against women remains unchecked could have a catastrophic impact on victims or survivors’ social, economic and psychological well-being (Cybersafe, 2020; Council of Europe, 2019; West, 2014). Consequently, this is tantamount to the African Declaration on Internet rights and Freedoms (AfDec) which advocates for rights and social justice for women online (AfDec, 2015). AfDec posits that online spaces should provide safer environment for women and other marginalised groups to participate meaningfully in order to realise their social, political, economic and empowerment outcomes.

Prior studies indicate that victims/survivors of cyber violence can report their experiences to the police, seek health/psychological counselling or legal support services, and get help from their social networks (ICRW, 2018). In terms of seeking social support, the study found that women blocked perpetrators on digital platforms, left the digital platform or confronted the perpetrator physically or digitally. On seeking legal services, it was revealed that sampled women never reported cyber violent incidences to the police or community leaders. Only few of them did report the issues at the police, unfortunately, the police took no action. Moreover, seeking intervention from online digital platforms, the study found that the majority of sampled women never sought any intervention from the online platform companies, and only a few appealed to online platforms, but the online/digital platform took no action. The findings therefore was an indication that women avoided their participation of digital spaces for fear of experiences cyber violence. It is also evident that women
never bothered to seek social, community and legal support services due to lack of awareness of such support services (UN Broadband Commission, 2015). Due to systemic cultural and other patriarchal factors, women in Malawi like their counterparts in African countries, are often reluctant to report their online victimizations for fear of social repercussions (Spotlight Initiative, 2020; European Institute of Gender Equality, 2017).

In conclusion, this study has demonstrated the prevalence of cyber violence, forms of cyber violence women experience, and its nature of manifestations. Furthermore, the study has shown the impacts of cyber violence on women victims and survivors and ways of tackling it. The study has revealed forms of cyber violence against women including bullying, defamation, and stalking, sexual exploitation; hate speech, and non-consensual pornographic videos and images, etc. The findings have also shown that cyber violence against women impacted them psychologically, socially, economically and physically. Women victims or survivors of cyber violence never bothered to seek social, community or legal support as coping mechanism due to lack of awareness, cultural, and other patriarchal factors. As a result, this made women refrain from participation on online space. This is against the principles of promoting digital rights and social justice. Therefore, the study findings have both theoretical and practical implications.

- This study contributes to the Information and Communication Technology for Social Justice (ICT4SJ) space. The use of Technology Facilitated Gender Based Violence framework as a theoretical lens, provided a better theoretical and analytical descriptions of the study phenomena.
- The government should formulate strategies for addressing cyber violence against women. The voices of women who are victims of the phenomena
- Government, civil society and other private actors should advocate for awareness-raising campaigns for women about cyber violence. This awareness and training might help women get empowered and make decisions on where to seek social or legal support, in case they have been abused online.
- Online human rights advocates can use evidence generated from this study to inform and gain supportive campaigns and call for legal protections of women abused or harmed against cyber violence.
- Internet and other online platforms such as Facebook should create clear options for getting online images or abusive content removed (Council of Europe, 2018). They should also respond immediately and effectively to complaints from victims of online abuse, and finally establish genuine consent for terms of use.

Despite the empirical contribution of this study makes to ICT4JS research, it has some limitations. This study focused only on one market township of Karonga district. Therefore, future studies should be replicated in other districts so that the findings could be generalised. The study also utilised a small sample of women, utilising descriptive survey design which has its own weakness. Future studies could utilise a bigger sample with mixed method, covering women from both rural and urban areas. This could help to gain more insights into the study phenomena. The study has also shown that prevalence of cyber violence against women is increasing significantly in the country. This study therefore, provides evidence that policy makers, research practitioners and other stakeholders can utilise to put in place urgent responsive strategies to combat cyber violence in the country.
REFERENCES AND CITATIONS


Malanga

Survey of Cyber Violence Against Women in Malawi

COMMUNICATION IS THE UNIVERSAL SOLVENT: ATREYA BOT - AN INTERACTIVE BOT FOR CHEMICAL SCIENTISTS

Mahak Sharma, Vidhya Bhawan Gandhiyan Institute of Educational Studies, India, mahak10sharma@gmail.com
Abhishek Kaushik, Dublin City University; Ireland, abhishek.kaushik2@mail.dcu.ie
Rajesh Kumar, Dublin Business School, Dublin, Ireland, mayanrajesh@gmail.com
Sushant Kumar Rai, Dublin Business School, sush20041993@gmail.com
Harshada Hanumant Desai, Dublin Business School, harshadadesai007@gmail.com
Sargam Yadav, Dublin Business School, sargamyadav719@gmail.com

Abstract: Conversational agents are a recent trend in human-computer interaction, deployed in multidisciplinary applications to assist the users. In this paper, we introduce "Atreya", an interactive bot for chemistry enthusiasts, researchers, and students to study the ChEMBL database. Atreya is hosted by Telegram, a popular cloud-based instant messaging application. This user-friendly bot queries the ChEMBL database, retrieves the drug details for a particular disease, targets associated with that drug, etc. This paper explores the potential of using a conversational agent to assist chemistry students and chemical scientist in complex information seeking process.

Keywords: AIML, Telethon, CHEMBL, Telegram, Chatbot, NLP

1. INTRODUCTION

Human-computer interaction is a recent trend in computing research (Gwizdka, 2010; Kaushik et al., 2020a; Radlinski & Craswell, 2017). Chatbots and voice assistants have become an integrated part of many people’s daily life. Numerous studies have been conducted to investigate the usability of chatbots in the current era (Arguello et al., 2018; Avula et al., 2018; Avula & Arguello, 2020; Kaushik et al., 2020b). These studies outline the opportunities and challenges for using chatbots as human-computer interaction application in multiple diverse areas such as ticket booking, flight booking etc., to assist users. These studies are limited to broad applications, whereas still, there is an enormous scope for application of chatbots in specific areas (Araujo, 2020; Kaushik & Jones, 2021). In this current study, we introduce Atreya Bot. This interactive conversational agent enables interactions between humans and machines via a web interface or mobile interface. This agent is specially designed for our chemical scientist to support them in information seeking. Our research investigates the opportunity to reduce the cognitive load in the information-seeking process, which may assist the users in better, effective and efficient information seeking. Atreya is a unique type of bot with many features that focus on sufficing the chemical needs of scientists and researchers. It works on retrieving the following relationships from the ChEMBL databases (Davies et al., 2015; Mendez et al., 2019): Target-Drugs, Drug-Target, Drug-Disease, Drug-Approval Phase, Drug from gene name, from synonyms SMILES (simplified molecular-input line-entry system). These and many other features (which are discussed in detail further in the paper) make ChEMBL a unique virtual assistant.
The paper is structured to highlight the motivation of the study, an overview of the technical components of Atreya, conclusion and the future scope for this study.

2. MOTIVATION
The motivation behind the project is explained into the following sub-sections.

2.1 Single query conventional search
A query in the search system returns the most relevant document as per their ranking algorithm in a single shot in a conventional search system. The output obtained is not refined concerning the user’s information need. The user may have to make multiple search queries by transforming the search query to meet the information need. There are many limitations associated with a single query search to affect its search success. The following points are the constraints of single-query search, which are intended for application of an interactive search bot (Kaushik, 2019; Kaushik et al., 2020a):

1. User must thoroughly explain the information need in a single query: The user should include all required information in a single query to obtain the most suitable relevant results. On reasonable grounds, this can be a very challenging and difficult task.
2. User may not be able to communicate their information need satisfactorily: Usually, users are not conscious of how to describe the information need in a single query. In common, the user attempts to formulate the search keyword, including words incorporated with the information need. But this may or may not indicate the exact specification of the users.
3. High cognitive load on the user in composing a search query: The point as mentioned above 1 & 2 leads to a cognitive load on the user to form the correct query to obtain the most relevant results meet the user the information need.
4. A search system should return relevant content in a single query: Presenting the best relevant results in a single query is usually a complex task for the search system.
5. The user must inspect returned content to find relevant information: A search engine presents the user with the best results but checking the search result’s relevancy is the user’s liability, which adds to their cognitive load.

The data in ChEMBL database is simple and structured. Therefore, a simple rule-based approach is used to query the database. The Atreya bot is an IR system that uses domain specific and factual knowledge which can be accessed through simple queries. The bot provides a self-driven approach for the user that eliminates the need to perform complex queries. A conversational support funnel is created to help the user to conduct queries and avoid ambiguity. A custom-made toolkit that utilizes text trimming for user-query extraction. We are exploring the need to perform semantic searches, as the information is objective and fact-based.

Atreya Bot is convenient in terms of usage as compared to the search tool of the ChEMBL database. User cognitive load is shown to be very high when querying on interfaces like the search tool discussed above. Conversational agents have proven to greatly reduce the cognitive load on the user. User Engagement is also shown to increase when using a conversational agent as compared to an traditional search interface as discussed above.

3. TECHNICAL OVERVIEW
The section explains the components, operations, workflow and potential functionality and use cases.

3.1 Components
Bot developed by using four components: AIML, ChEMBL, Telegram and Cairosvg.
1. **AIML (Artificial Intelligence Markup Language):** AIML is an Extensible Markup Language (XML) file used to create conversational patterns based on which the conversational agent maintains the conversation.

2. **ChEMBL:** The database which is used to retrieve information is ChEMBL. So, to access data from ChEMBL, ChEMBL web source client API is used\(^1\). This is the only official client Python library developed and supported by CHEMBL.

3. **Telegram:** The bot is deployed on Telegram\(^2\) which is a freeware, cross-platform and cloud-based instant messaging software and application service. It has been deployed using the Telethon library\(^3\). The interface is similar to a messaging application. User can select to perform an operation by choosing an operation from the button grid.

4. **Cairosvg:** Images of the molecular structures of the drug molecules are displayed by the bot using the cairosvg library\(^4\) which downloads an image from the URL and converts the SVG image to PNG format. To perform data manipulation and transformation operations, Pandas library has been used.

**Conversation with a bot can be categorised into two intents: casual talk and chemical talk.** In the casual talk, the bot is responsible for greeting the user and answering some basic questions about itself. In the chemical conversation, the bot can perform all the use cases explained in this section as per the user’s requirement.

### 3.2. Operations

The bot starts when initiated to use with /start message. Then an API authentication process is completed. If the API key id is valid, a connection with the ChEMBL database is established. The Bot then displays an interface which allows users to select an option to carry out an operation. The user can interact with the bot by choosing the operation to perform from the options displayed. A grid of buttons is displayed which allows user to select one of the following options:

- Molecule Info: allows user to search for the information of the molecules.
- Tissue Info: allows user to get information about the target tissue.
- Similar compounds: allows user to search for similar compounds.
- Chat to Bot: allows user to chat with the bot.
- Exit: allows user to exit the operational interface.

The bot also allows user to download a csv file of the 50 approved drugs. The query is executed, and the result is displayed on the Telegram. The user can exit from the search interface by choosing the Exit option.

### 3.3. Workflow of Atreya

The workflow divided into two main components: conversational management and search management as shown in Figure 1. The details regarding the components are described as follow:

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\(^1\) https://github.com/chembl/chembl_webresource_client
\(^2\) https://telegram.org/
\(^3\) https://pypi.org/project/Telethon/
\(^4\) https://pypi.org/project/CairoSVG/
3.3.1. Conversational Management

The bot allows user to perform an operation by either selecting an option from the menu displayed or by clicking on the buttons displayed. Figure 2 shows the initial steps that are taken in the Atreya bot. Users can also chat with the bot and search for their intended data. There is an option “Chat to bot” in the displayed options which allows users to implement the use cases discussed in the section 3.4. A use case will be selected by typing the specific keywords and then entering the desired query. For example, if the user wants to search for compounds similar to “Panadol”, then after selecting the “Chat to bot” option, user will have to enter /msy:Panadol. Thus to initiate the search process, user will have to remember the keywords related to each use case. Please refer to this video demo\(^5\) of the chatbot.

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\(^5\) https://drive.google.com/file/d/1LBM1a6Rgflp0n6ZG_nSuCvzAkrCl9GgM/view?usp=sharing

Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021
● Dialog Manager: Dialog manager is used to manage the dialog structure. The input to the dialog manager is the user query and the search is performed with the help of search guidance. The subsequent dialog state is then provided to the user.
● AIML-Bot-API: It is a simple restful API used to implement chatbots using AIML scripts.
● ChEMBL web resource client: It is the official Python client library that can be used to access ChEMBL data and cheminformatics.

3.3.2. Search Management
This is responsible for searching and displaying the results. This bot is unique in the way that it displays the image of the molecular structure of the molecule user intends to search. Along with other details of the molecule, the bot also displays an image of the molecule which makes it more interactive. Another type of feature that is implemented in this bot is that it provides users to download a list of top 50 approved drugs in the csv format. Thus, by using a conversational interface, users can retrieve information from the ChEMBL database to suffice their requirements. The details as follows:

• Initiate the search process by starting the bot with command /start. The bot will display the list of use cases for the user to select from them using the keywords given aside every case.
• In the bottom widget, user can also select the button grid to display the menu from which an operation can be chosen.
• In order to search for information related to molecules, select the molecule info button.
• A list of guidelines will be provided from which the user can select the desired operation related to molecules.
• To search for a molecule name by Synonym, enter the keywords msy/Paracetamole (this is our desired search query in this example). Figure 3 illustrates a query for molecular information.
• On entering the query keywords, the bot will display the images of all the molecules synonymous to Paracetamol along with the ChEMBL Id, name and structure of the molecule displayed below the image of the molecule.
3.4 Potential functionality and use cases

This section presents all the possible information-seeking service provided by the chatbot. Figure 4 subsequently represents the stages after the query is performed.

• **Search molecule name by Synonym**: This functionality will allow the user to search for a molecule by its specific name or by any synonym of the molecule which can be its common name too.

• **Search target by gene**: A drug target is basically a molecule, a protein that is associated intrinsically with a particular disease that can be addressed by a drug to produce the desired result. Atreya Bot allows the user to search for the target associated with a disease using the gene name.

• **Search compounds similar to the given drug**: User can search for compounds that are similar to the desired drug by entering the name of the drug. The Bot returns the SMILES of the similar compound, name and molecular formula. The similarity percentage is returned in descending order so that the user can select the most similar compound according to their relevancy.

• **Search molecule by SMILES**: Atreya bot provides users with a functionality to search for desired molecules by specifying the SMILES (simplified molecular-input line-entry system). The bot then returns the ChEMBL ID of the molecule with its molecular formula, InChI Key and name.

• **Search molecule by ChEMBL ID**: User can search for a molecule by mentioning the ChEMBL ID of the molecule. The bot returns the molecular formula, InChI key and name of the molecule. Another unique functionality provided by the bot is that it shows the molecular structure of the molecule which will allow the user to get more details of the desired molecule.

• **Similar compounds by SMILES**: By specifying the SMILES, users can retrieve similar compounds from the database. The bot thus returns the name of the molecule, its ChEMBL ID and molecular structure.

• **Get tissue by Uberon ID**: Uberon is an anatomical ontology that represents body parts, organs and tissues in a variety of animal species, with a focus on vertebrates. The ontology includes comprehensive relationships to taxon-specific anatomical ontologies, allowing integration of functional, phenotype and expression data. Users can search for a tissue by specifying the UberonId.

• **Get tissue by name**: Users can search for a tissue by specifying the name.

• **Get the drug approval year by USAN stem**: United States Adopted Names (USAN) are unique non-proprietary names assigned to pharmaceuticals marketed in the United States. Users can get the
approval year for a drug by specifying the USAN for the molecule. The bot returns classification code, first approval year, ChEMBL Id, canonical SMILES and synonym for the molecule.

- **Get approved drugs by disease name:** Users can get the approval year for a drug by specifying the name of the disease for which that drug is used. The bot returns first approval year, ChEMBL Id, name and formula for the molecule.

- **Get a list of all the approved drugs:** This unique functionality of the Bot returns a list of top 50 approved drugs in a csv format. The users who intend to get information about the drugs can download the file to serve their purpose.

- **Get tissue by ID:** Users can search for a tissue by specifying any Id such as BTO Id, Uberon Id, EFO ID, name, ChEMBL Id.

![Result after Query](image1.png)
![Results and Exits](image2.png)

**Figure 4. Results and Exits**

### 4. CONCLUSION AND FUTURE WORK

This paper investigates the potential of the conversational search interface used by chemical scientists and chemistry students. This project’s main objective is to produce an intelligent interactive IR System that reduces the user’s efforts to find the relevant subject information. The project’s future direction is to have chemistry teachers and students evaluate the bot using different usability metric types to explore user search experience and cognitive load. The functionality of Atreya Bot is rule-based and simple in the paper. The simplicity was designed to provide a proof of concept and thus only simple queries were used. The next step in the project would be to incorporate more complexities into the system to account for factors such as previous knowledge of the user. A QA system can also be developed to support complex queries through the use of deep learning models. A comparison of the Atreya Bot and state-of-the-art models can then be conducted to highlight the benefits and drawbacks.
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ARTIFICIAL INTELLIGENCE ETHICS: AN INCLUSIVE GLOBAL DISCOURSE?

Cathy Roche, Science Foundation Ireland, CRT-AI, Trinity College Dublin, croche7@tcd.ie
Dave Lewis, ADAPT Centre, Trinity College Dublin, dave.lewis@adaptcentre.ie
P. J. Wall, ADAPT Centre, Trinity College Dublin, pj.wall@tcd.ie

Abstract: It is widely accepted that technology is ubiquitous across the planet and has the potential to solve many of the problems existing in the Global South. Moreover, the rapid advancement of artificial intelligence (AI) brings with it the potential to address many of the challenges outlined in the Sustainable Development Goals (SDGs) in ways which were never before possible. However, there are many questions about how such advanced technologies should be managed and governed, and whether or not the emerging ethical frameworks and standards for AI are dominated by the Global North. This research examines the growing body of documentation on AI ethics to examine whether or not there is equality of participation in the ongoing global discourse. Specifically, it seeks to discover if both countries in the Global South and women are underrepresented in this discourse. Findings indicate a dearth of references to both of these themes in the AI ethics documents, suggesting that the associated ethical implications and risks are being neglected. Without adequate input from both countries in the Global South and from women, such ethical frameworks and standards may be discriminatory with the potential to reinforce marginalisation.

Keywords: Artificial intelligence, AI, ethics, standards, gender, inclusion

1. INTRODUCTION

Increasing advancements in AI have changed how we interact, live and work. The unprecedented transformative potential of these technologies to address the many and varied challenges outlined in the SDGs, including the eradication of poverty, zero hunger and good health, cannot be ignored. Accompanying the evolution of the technology itself, there has been increasing discourse on the topic of AI ethics, with many principles, guidelines, frameworks, declarations, strategies, charters, policies and position papers being issued by a variety of agencies, non-governmental organisations (NGOs), and governments. These are important discussions, as both the AI technology itself and the ethical frameworks and standards emerging around it can reproduce and reinforce a variety of biases if not designed, developed and deployed on the basis of inclusive participation. If the voices of all affected communities are not included, then such ethical frameworks and standards can remain discriminatory and reinforce marginalisation (Molnar, 2020). As the body of AI ethics and governance documentation continues to expand, it is appropriate to examine and analyse this emerging literature from the perspective of inclusivity. In particular, it is important to examine AI ethical frameworks and guidelines through the lenses of gender and the Global South as women in such contexts are often the most impacted by technological developments while also being marginalised in their design, development and operation.

The existing body of documents on AI ethics has to date focussed on discerning concordance on ethical principles or differences in approach by organisational sectors. This research therefore seeks to address a gap, by examining the existing body of work for reference to gender and sustainability
(serving as a proxy for inclusion of the Global South) in order to assess whether there is underrepresentation, both in terms of gender and geographic areas such as Africa, Central and South America, Asia and Oceania. Such underrepresentation is likely to be indicative of unequal participation in the debate around the ethics of AI, exposing an international discourse marked by power imbalance. Based on this, the following research question is posed: is there equality of participation in the global discourse on AI ethics, or are women and countries in the Global South underrepresented in this discourse?

Positioning this research broadly within the ICT4D field, it makes a specific contribution to the growing sub-fields of AI for global development (AI4D), gender in ICT4D, and the body of work concerned with the ethical implications of AI and other advanced technologies for global development (ALethics4D). This is an important contribution for many reasons: most importantly, if the ethical agenda around AI is being set by countries in the Global North, there exists the potential to compound inequalities and further embed colonial ideologies in the Global South.

The paper proceeds as follows: firstly, the bodies of literature concerning AI ethics and standards are considered before examining the body of work on AI and social structures. Section 3 then presents the research methodology adopted, with research findings to date presented in Section 4. The paper concludes with Section 5 where brief conclusions are presented.

2. LITERATURE REVIEW

As mentioned, there is a rapidly expanding body of work on the topic of AI ethics, principles and guidelines. This section commences with a brief examination of this work, before moving on to present the literature on social and power structures in AI.

2.1. AI Standards, Principles and Guidelines

A variety of studies have identified emerging commonalities and levels of consensus across the body of work concerned with AI principles and guidelines. A key study delineates a global convergence around key ethical principles such as justice and fairness, transparency, non-maleficence, privacy and responsibility (Jobin et al., 2019). At the same time, this study also highlights significant divergence around interpretation of these principles and their proposed implementation. In addition, other authors identify differences among the documentation associated with the provenance of the literature (Schiff et al., 2021). In their analysis of ethical topics across documents issued by private and public organisations as well as NGOs, they found greater ethical breadth and more engagement with law and regulation in the documents from NGOs and public sector issuers when compared to those from private sources.

2.2. Social and Power Structures

Regardless of origination in the public or private sector, any proposed ethical framework or governance model is reflective of power structures within the society in which they are developed. As technology is “ultimately influenced by the people who build it and the data that feeds it” (Chowdhury & Mulani, 2018), it is therefore reflective of the cultural and social biases of its context. By extension, ethical frames of reference and concerns are a product of their context and are therefore also subject to the prevailing culture and the risk of ethnocentrism.

In many ways, AI has augmented existing inequalities inherent in societal structures that are sexist and patriarchal but also racist and colonial. Concerned about a perceived structural domination by the United States (US) in the Global South, exercised through control of the digital ecosystem, Kwet (2019) describes an “insidious new phenomenon, digital colonialism”, which is shaping the digital destiny of many African countries. US dominance of network connectivity, hardware and software in turn grants great economic and social power to large technology corporations, such as Microsoft, Apple and Google. Looking more closely at AI, Birhane posits the concept of algorithmic
colonialism, wherein domination politically, economically and ideologically is achieved through approaches such as ‘technological innovation’, ‘state-of-the-art algorithms’, and ‘AI solutions’ to social problems’ (Birhane, 2020). In the context of this perceived technological imperialism, it is of immense importance that those setting the ethical agenda around AI are cognisant of the potential to compound inequalities and further embed ideologies originating in the Global North. Indeed, any discussion of inequality and power, as relating to AI, cannot be ahistorical and will be incomplete if they do not take cognisance of “colonial continuities” (Mohamed et al., 2020).

As the impact of AI is not felt equally, such technologies embody the risk of further strengthening global digital inequality, especially amongst marginalised populations. Such groups encompass ethnic and racial groups, those with disabilities, young and LGBTQ people, poor rural and urban communities and especially women and those at the intersection of such identities. The prevalence of gender bias replicated in and by AI systems (Bolukbasi et al., 2016; Buolamwini & Gebru, 2018; Dastin, 2018) affects women globally but has the potential to be more damaging to women in the Global South. As highlighted in a recent report “these gender biases risk further stigmatizing and marginalizing women on a global scale” and that due to the ubiquity of AI in our lives, such biases put women at risk of being left behind “in all realms of economic, political and social life” (UNESCO, 2020). A complex interplay of issues exists at the intersection of AI ethics, the Global South and women. Therefore, in tandem with a concern for representation from the Global South more generally, should be one for the inclusion of women from the Global South in the global discourse around the ethics of AI.

3. RESEARCH METHODOLOGY

3.1. Document Collection

This study uses the same corpus as collected by Jobin et al. (2019) in their scoping review of existing non-legal norms or soft-law documentation. Comprising 84 sources or parts thereof, this collection includes policy documents, such as guidelines, institutional reports and principles but excludes legal and academic sources. Within the synthesised listing are sources written in English, French, German, Greek and Italian which explicitly reference AI in the title or description. All documents are considered to express a normative ethical stance defined as a “moral preference for a defined course of action” (Jobin et al., 2019). Further, the collection contains documents by issuing entities from both public and private sectors.

As there is no single database for AI ethics frameworks, principles or guidelines, the final synthesis of 84 documents garnered by Jobin et al. (2019) can be considered to constitute a corpus of ethical guidelines. This approach of using an externally defined collection also avoids any unconscious selection bias on the part of the authors of this study. In some instances, small deviations from this body of papers were necessary, where the original sources were no longer available at the given location or where a document has been superseded by a newer version. Where the document was unavailable, an equivalent source from the same issuer was selected and in the case of the new versions, the most recent was substituted thereby maintaining the integrity of the collection in terms of both content and issuing body. In all instances the volume remained the same (N=84). Documents were collected between January and February 2021, and Appendix A lists all documents/sites, issuing body and country of issuer.

To enable deeper sectoral analysis, the corpus was classified according to type of issuing entity. Categorisation as either ‘NGO’, ‘Private’ or ‘Public’ is an adaptation of the classification used in the Schiff et al. review of 112 AI global ethics documents (Schiff et al., 2021). Their findings revealed distinct differences in the handling of AI ethics by organisation type, with NGO and public documents both more participatory in origin and engaged with the law and private sources more focussed on ethical issues relating to customers or clients. Of particular interest to this study is the
conclusion from that paper that NGO documents cover “a range of ethical issues that are given less attention by other sectors”. It was therefore deemed of relevance to include such categorisation in this study to investigate if there were any sectoral dimensions to considerations of gender, feminism, the SDGs and the Global South in ethical guidance around AI.

<table>
<thead>
<tr>
<th>Organisation Category</th>
<th>Number of documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>NGO</td>
<td>35</td>
</tr>
<tr>
<td>Private</td>
<td>18</td>
</tr>
<tr>
<td>Public</td>
<td>31</td>
</tr>
</tbody>
</table>

Table 1: Categorisation by Organisation Type

As the Schiff et al. (2020) and the Jobin et al. (2019) papers analyse different corpora, the classification process was conducted manually for the 84 documents in this study. In terms of sectoral categorisation, ‘Public’ here includes sources issued by government entities and intergovernmental bodies, ‘Private’ contains for-profit companies and corporations while ‘NGO’ incorporates advocacy agencies, research groups, professional associations and academic collaborations. Based on the categorisation of the issuing entity or entities, one of the three labels in this taxonomy was assigned to each source and appended to the list in Appendix A. Table 1 shows the totals following classification of documents by sector/issuer type.

3.2. Content Analysis and Coding

Content analysis of the documents was conducted in three main phases: the first involved coding for ‘Sustainability’ and related search terms before categorical (sectoral) analysis on the theme; the second coding cycle tackled analysis for ‘Gender’ and associated search terms and mapping by sector for this theme; a final phase incorporated comparative analysis of the two themes across documents and by issuer type. Consistency checks were performed throughout the analytical process by manual assessment of accuracy and reliability. This entailed researchers checking a random selection of the documents to assess if the software tool (see details below) was returning search terms correctly, finding all occurrences of given terms and not including terms outside the defined scope. As a result, coding underwent a process of refinement and was subsequently broadened or narrowed as required to ensure as many relevant terms as possible and their occurrences were captured. While not exhaustive, the final suite of terms used is broad and complete enough to achieve a thorough and robust examination for both themes.

Commencing with 8 simple terms that would evaluate if the documents took into consideration the concept of sustainability or a focus on the Global South, coding was amended through an iterative process. Adjustments to the coding were made to take account of a breadth of terms that could capture such concerns, such as ‘developing economies’ and ‘emerging economies’ as synonyms for developing countries. A list of all included codes is presented in Table 2. The codes are not case sensitive and take account of both American and English spellings. Also some applications of the terms are excluded due to being unrelated to the theme. For example, ‘global justice’, ‘global gap’ and ‘global poverty’ are counted under the “Global South” search term but ‘globalisation’ is excluded. Similarly, occurrences of ‘third countries’ are discounted as unrelated to the theme and having a very specific meaning in a European context. While the majority of the documents in the corpus were in English (either as language of origination or translated), one source in Italian and one in French were analysed in their original language, when translations could not be found.

Following finalisation of the coding for the Sustainability theme, data analysis was performed using R in RStudio version 1.4.1106 for Mac. This design decision is based on the potential for
replicability of the research so that it can be repeated with additional corpora and at regular intervals, thereby generating a gender or inclusion observatory on AI. All documents were first converted to PDF format and web sources were saved down in MS Word before PDF conversion. Use of the R package ‘pdfsearch’ was considered the most appropriate tool as this package includes functions for keyword search of PDF files, but also provides a wrapper (‘keyword_directory’) that includes a function to loop over all PDF files within a single directory. Specifying multiple keywords for the search was achieved by creating a character vector. Other operations included ignoring case, removing hyphens and returning surrounding lines in addition to the matching line. As noted, outputs and results were checked manually for reliability and accuracy. Due to the complexity of incorporating multiple languages into the automated process, and given the majority of the documents (82 of 84) could be handled this way, English was set as the corpus language. Manual analysis of the French and Italian documents was performed.

The last step in this first phase of analysis takes the output of the keywords search for the Sustainability theme and compares results across categories, based on the ‘NGO’/‘Private’/‘Public’ taxonomy outlined earlier. Table 3 shows the classification of documents by sector/issuer type. Categorical analysis was undertaken to identify any potential divergence across the documentation that might be attributable to the type of issuing organisation.

The second phase of content analysis comprised coding for the Gender theme before conducting the categorical analysis of search results for this theme. Again, starting with 8 simple terms that should assess the presence of the concepts of gender equality and feminism, after a small number of initial iterations, the coding was modified to include ‘Feminisation’. This concept, while related to the other search terms, is distinct in the context of the feminisation of the workplace or the feminisation of personal assistant devices or robots. For the resultant 9 search terms, a list of included codes is given in Table 2. As described earlier, the codes again include English and American spellings and are not case sensitive but certain uses of the terms are deliberately excluded due to potential skewing of results in an over-represented way. For example, while ‘sexual harassment’, ‘sexual violence’ and ‘sexualised’ are included, ‘sexuality’ is not as this appears in the documentation solely in relation to sexual orientation rather than in terms of gender or gender identity. Similarly, occurrences of ‘gendered’ are counted but those of ‘engendered’ are excluded as this does not relate to the theme. The Italian and French documents were again evaluated manually while the majority of the corpus was analysed using R. Finally, for this phase, results from content analysis of this theme were compared on a sectoral basis.

Subsequently, a synthesis analysis of the two themes was performed across all documents and by issuer type to give an overview of the comparative presence of the themes in the corpus and to assess if sectoral differences or similarities could be discerned.

4. FINDINGS

This section will present the findings of the research. While all codes are included in Table 2, the focus here is on the findings resulting from the Sustainability theme. The number and percentage of sources in which the key terms for the Sustainability theme occur are listed in Table 2 and in Figure 1 the codes are ordered by frequency of occurrence across the corpus. ‘Sustainability’ occurs in more of the documents than any other term in this theme, appearing in 33% of the documents, with a gap to the next highest occurring, ‘Africa’ and ‘Developing World’ at 12% and 11% respectively. The least frequently mentioned terms are ‘Third World’ (3.5%) and ‘Low Resource’ (2.4%) and associated codes. An entry was returned for each of the search terms around Sustainability. However, in 55% of the documents there were no occurrences of any of the 8 key terms for this theme.
<table>
<thead>
<tr>
<th>Search term</th>
<th>No. Documents</th>
<th>Included codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable</td>
<td>28/84 or 33%</td>
<td>Sustainable, sustainability, sustainably, sustainable development, sustainable society, ecological sustainability, environmental sustainability, sustained participation, agronomic sustainability, unsustainable agriculture, unsustainable, technology [durable, durabilités, sostenibilità]</td>
</tr>
<tr>
<td>SDG</td>
<td>7/84 or 8%</td>
<td>SDG, SDGs, Sustainable Development Goal, Sustainable Development Goals [objectifs de développement durable, des ODD, obiettivi di sviluppo sostenibile, OSS]</td>
</tr>
<tr>
<td>Global South</td>
<td>5/84 or 6%</td>
<td>Global South, global justice, global gap, global poverty [sud global, sud del mondo]</td>
</tr>
<tr>
<td>Low/Middle Income</td>
<td>6/84 or 7%</td>
<td>Low income country, Low income countries, middle income country, middle income countries, low or middle income country, low and middle income countries, LMIC, LMICs [pays à faible revenu, pays à revenu intermédiaire, paesi a basso reddito, paesi a reddito medio]</td>
</tr>
<tr>
<td>Developing World</td>
<td>9/84 or 11%</td>
<td>Developing World, developing countries, developing country, developing nation, developing nations, developing economies, emerging economies [monde en développement, mondo/paesi in via di sviluppo]</td>
</tr>
<tr>
<td>Low Resource</td>
<td>2/84 or 2%</td>
<td>Low resource country, low resource countries, resource constrained country, resource constrained countries, under-resourced states, resource-poor populations [faible ressources, ressources limitées, risorsa/e bassa, risorse limitate]</td>
</tr>
<tr>
<td>Third World</td>
<td>3/84 or 4%</td>
<td>Third World, third world countries, third world nations [Tiers-Monde, Pays du tiers-monde, terzo mondo, paesi del terzo mondo]</td>
</tr>
<tr>
<td>Gender</td>
<td>45/84 or 54%</td>
<td>Gender, gendered, gendering, genderless, transgender, gender-based [genre, genere]</td>
</tr>
<tr>
<td>Sex</td>
<td>24/84 or 29%</td>
<td>Sex, sexism, sexist, sexual harassment, sexual violence, sex-based, sexualised, sexualized, sex robots, sex industry, sex trafficking [sexe, sesso]</td>
</tr>
<tr>
<td>Women</td>
<td>27/84 or 32%</td>
<td>Women, trans-women [femmes, donne]</td>
</tr>
<tr>
<td>Woman</td>
<td>12/84 or 14%</td>
<td>Woman, trans-woman [femme, donna]</td>
</tr>
<tr>
<td>Female</td>
<td>18/84 or 21%</td>
<td>Female, females, feminine [femme, féminin, femmina, femminile]</td>
</tr>
<tr>
<td>Equality</td>
<td>55/84 or 65%</td>
<td>Equality, equity, equitable, equal access, equal rights, inequality, inequalities, inequity, inequities [égalité, inégalité, uguaglianza, uaguale, disuguaglianza]</td>
</tr>
<tr>
<td>Feminism</td>
<td>0/84 or 0%</td>
<td>Feminism [féminisme, feminismo]</td>
</tr>
<tr>
<td>Feminist</td>
<td>2/84 or 2%</td>
<td>Feminist [féministe, femminista]</td>
</tr>
<tr>
<td>Feminisation</td>
<td>2/84 or 2%</td>
<td>Feminisation, feminization, feminise, feminize, feminised, feminized</td>
</tr>
</tbody>
</table>
While ‘Sustainable’ (and associated codes) occurs most frequently across the documents (in 28 sources), it is also the term with the highest number of mentions (116) in a single document. However, this is an outlier when examined against occurrences of key terms within sources for this theme. Several terms are mentioned rarely within the documents, such as ‘Global South’ with a maximum of 3 mentions and ‘Third World’ which never occurs more than once in a source. Analysis of term distribution within sources highlights the low base of occurrences of key terms for this theme. From an examination of the within-document pattern of term occurrences, it is evident that sparse data is a feature, resulting in extremely low median values. A mode of 1 is the most common.

Analysis of results by classification of issuer shows distinct differences between documents from Private sources when compared to those issued by Public and NGO sectors. In Table 3, results for each of the three source categories are shown. Again, while the categorial results for both search themes are included, the focus here is on the Sustainability theme. In the Private documents group, 6 of the 8 search terms associated with sustainability and the Global South are missing. Only ‘Sustainable’ and ‘SDG’ occur in any of the 18 documents in this category and these appear in only 3 of the sources, representing 16% of this class. Documents in the Public group do not feature any references to ‘Low Resource’ and associated codes. In the NGO class, there are occurrences of each of the 8 key terms.

<table>
<thead>
<tr>
<th>Search term</th>
<th>NGO Documents</th>
<th>Private Documents</th>
<th>Public Documents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable</td>
<td>8/35</td>
<td>2/18</td>
<td>18/31</td>
</tr>
<tr>
<td>SDG</td>
<td>3/35</td>
<td>1/18</td>
<td>3/31</td>
</tr>
<tr>
<td>Global South</td>
<td>3/35</td>
<td>0/18</td>
<td>2/31</td>
</tr>
<tr>
<td>Low Income</td>
<td>5/35</td>
<td>0/18</td>
<td>1/31</td>
</tr>
</tbody>
</table>
Results from the terms present in the documents differ across issuer types, especially between those from the Private and the other two issuing sectors. Found most frequently in each category of documents, ‘Sustainability’ occurs in 58% of Public documents. This is much higher than in the 23% of the NGO sources, which again is higher than the 11% total for the Private category. The second most frequently referenced key term for both NGO and Public classes is ‘Africa’, appearing in 17% and 13% of documents in their respective categories. Notably, these second ranked terms are at a higher percentage than the first ranked term in the Private class. Within the Private grouping, the second and only other occurring key term ‘SDG’ is found in 5.5% of documents.

Regarding the occurrence of individual terms, there are some similarities between the NGO and Public groups, but they are not as obvious as in the search relating to gender and feminism. The distribution of search terms across documents shows some parallels between sources issued by the NGO and Public sectors. However, the distribution within the Private grouping of documents is very different to the other two categories. When corrected for scale, the gap between NGO and Public documents on one hand and Private on the other, becomes clear. While Public sources scale from 0% to almost 60%, NGO documents have a narrower range from 6% to 23%, while the values for the Private category are restricted to a scale spanning 5.5% to 11%. This will be discussed in the analysis in the next section.

5. DISCUSSION

The results presented in the previous section reveal a dearth of references to both gender and sustainability in the AI ethics documents, especially those issued by the private sector, which could be indicative of a concerning imbalance in the global discourse on ethical AI. If the corpus analysed here is representative of the broader landscape, then these findings could be considered evidence of a worrying absence of significant voices in the AI ethics debate, specifically those often most marginalised by the technology, namely women and the Global South. If the debate is being shaped disproportionately by higher-income countries and a largely male-dominated industry, are gender diversity, global fairness and cultural pluralism being neglected?

<table>
<thead>
<tr>
<th>Category</th>
<th>Count (Public)</th>
<th>Count (NGO)</th>
<th>Count (Private)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing World</td>
<td>6/35</td>
<td>0/18</td>
<td>3/31</td>
</tr>
<tr>
<td>Low resource</td>
<td>2/35</td>
<td>0/18</td>
<td>0/31</td>
</tr>
<tr>
<td>Africa</td>
<td>6/35</td>
<td>0/18</td>
<td>4/31</td>
</tr>
<tr>
<td>Third World</td>
<td>2/35</td>
<td>0/18</td>
<td>1/31</td>
</tr>
<tr>
<td>Gender</td>
<td>23/35</td>
<td>5/18</td>
<td>17/31</td>
</tr>
<tr>
<td>Sex</td>
<td>14/35</td>
<td>0/18</td>
<td>10/31</td>
</tr>
<tr>
<td>Women</td>
<td>13/35</td>
<td>1/18</td>
<td>13/31</td>
</tr>
<tr>
<td>Woman</td>
<td>6/35</td>
<td>1/18</td>
<td>5/31</td>
</tr>
<tr>
<td>Female</td>
<td>9/35</td>
<td>0/18</td>
<td>9/31</td>
</tr>
<tr>
<td>Equality</td>
<td>27/35</td>
<td>6/18</td>
<td>22/31</td>
</tr>
<tr>
<td>Feminism</td>
<td>0/35</td>
<td>0/18</td>
<td>0/31</td>
</tr>
<tr>
<td>Feminist</td>
<td>2/35</td>
<td>0/18</td>
<td>0/31</td>
</tr>
<tr>
<td>Feminisation</td>
<td>1/35</td>
<td>0/18</td>
<td>1/31</td>
</tr>
</tbody>
</table>

Table 3: Theme Results per Category
Perhaps the lack of consideration of sustainability and gender found in this study is rooted in the geographical origin of the documents analysed. From Figure 2\(^1\), the dominance of ethics sources from more economically developed countries and a glaring absence of documents from the Global South is evident. Of a corpus of 84, the US contributes 21 sources (25%) and 13 (15%) originate in the United Kingdom (UK): these two countries therefore provide 40% of the documents analysed. This could be explained by a language bias towards English in the Jobin et al. (2019) study. However, it would appear from other synthesis papers and surveys that the proliferation of AI ethics grey literature is coming from the Global North/ Western world (Fjeld et al., 2020; Floridi et al., 2018; Morley et al., 2020).

![Figure 2: AI Ethics Documents in Corpus by Country (N=84)](image)

Furthermore, this phenomenon is again visible following an examination of the Council of Europe’s (CoE) data visualisation of AI initiatives\(^2\). This site, which collates documents relating to AI had 456 documents at the date of access (March 2021), sourced from think tanks, professional associations, civil society, academia, international agencies, national governments or authorities, multi-stakeholder programmes and the private sector. While not exhaustive, this collection is nonetheless telling, in that of the over 450 sources, only 3 are from the Global South. It would appear therefore that not all global regions are participating equally in the AI ethics discourse. Notably, the most common concepts found in the CoE documents relate to privacy, human rights, transparency, responsibility, trust and accountability. Although sustainability and the SDGs are found as concepts in the sources, they appear with much less frequency and there is no reference to gender as a concept within the documents.

Given that the documents in the Jobin et al. (2019) corpus used for this survey are concerned with a variety of topics within the broad sphere of AI, it is perhaps not surprising to find a lack of coverage of the gender and sustainability themes. Although the sources focus on such diverse topics as robotics, radiology, automated driving, data analytics and AI for business, all of these documents are part of a corpus of literature primarily concerned with the ethics of AI. The absence of any real consideration of these themes across the grey literature is a troubling gap. With an ever-growing body of literature on AI ethics, which has a potentially normative influence, it is concerning that

\(^{1}\) The map does not include documents classified as ‘International’ or ‘N/A’.

\(^{2}\) https://www.coe.int/en/web/artificial-intelligence/national-initiatives
certain topics are not only lacking prominence in the discourse but are paid so little attention that they are not deemed worthy of ethical concern.

What are the social and ethical implications of not having a more inclusive AI ethics landscape? A lack of attention in ethical debates around AI, to concerns pertinent to sustainability and the Global South, is problematic. If these are not part of the mainstream discussion, they are unlikely to be featured in public debate or policy development. As a consequence, considerations around such issues as the environmental impact associated with AI computational resources requiring vast energy sources might be overlooked and decisions made which can have a devastating effect on communities who are already vulnerable such as those in sub-Saharan Africa. Moreover, the sectoral results in this study indicate that the Private sector, in particular, has a lacuna when it comes to sustainability concerns which has crucial implications for those in the Global South where multinational corporations are prominent in infrastructural investment.

Equally, if the voices of women and the Global South are not included in the grey literature, they are likely to be ignored by policy makers as well as multinational organisations. If such issues are not part of the current discourse around AI ethics, there is a great risk of AI impeding gender equality and reinforcing paternalistic ideologies. With an emerging focus on fairness in AI, it is, as Leavy observes, “essential that women are at the core of who defines the concept of fairness” (Leavy, 2018). However, if women are not at the table and not considered by those setting the agenda, progress already achieved in gender equality, sustained by feminist thought, could be undermined. Furthermore, narrow representation at the level of grey literature is reflective of not only a geographical dominance but also of an imbalance of certain social and demographic groups. AI and the ethical framework that supports it could better reflect the diversity of the global community by addressing the power imbalance within international discourse on the ethics of AI.

6. CONCLUSIONS

This study assessed a body of AI ethics documents collected by Jobin et al. (2019) and categorised by issuer-type (NGO, Private, Public), for inclusion of 17 key terms associated with sustainability and gender. Findings reveal a dearth of references to these themes in the AI ethics documents, especially those issued by the Private sector. While these documents reflect a breadth of ethical and social issues around AI, it would appear that gender and the Global South are neglected. These results, as interpreted here, indicate a lack of attention to inclusivity in the framing of the ethical discourse around AI. The sparsity of data across the literature, regardless of sector, is suggestive of a potentially concerning imbalance in the global discourse on AI ethics where women and the Global South are underrepresented. This presents a double disadvantage: while gender inequality is a global problem, it can be particularly so in the Global South.

While there is still much to learn, these findings help to reveal a lack of inclusivity in the ethical framing of key issues in AI. Such findings have implications for policymakers, international organisations, technology companies and all working to design, develop and implement AI in a fair and ethical manner. Any exclusion of significant voices means much of the globe (and half the world’s population) could be forced to use and adapt to technologies developed without their input but also guided by an ethical framework which may not reflect their real, lived experience or the reality of the social, cultural, political, environmental, and ethical environments in which they exist. Continued underrepresentation has implications for the reinforcement of sexist, paternalistic, ethnocentric and colonial ideologies and associated power structures.

Although it is disappointing that these AI ethical and governance documents do not take appropriate account of the importance of gender or sustainability, it is still possible to inform discourse and shape the future of emerging AI policy. Identifying and understanding the power structures in play in AI ethics is an important area for research. Future work is required around how best to challenge existing systems and approaches to bring better balance and improved inclusivity to the AI ethical
discourse. This could be through applications of feminist, intersectional, decolonial and post-colonial thought. Bringing these differing lenses to the AI ethical debate could help influence the direction of AI ethics in a more inclusive and participatory way.

ACKNOWLEDGEMENTS

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APPENDIX A

Ethics Principles by Country of Issuer and Category

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SMART CITIES: POTENTIALITIES AND CHALLENGES IN A CONTEXT OF SHARING ECONOMY

Ben Hur Monteiro Barizon, Federal University of Rio de Janeiro, Brazil, ben-hur.barizon@pped.ie.ufrj.br
Renata Lèbre La Rovere, Federal University of Rio de Janeiro, Brazil, renata@ie.ufrj.br

Abstract: The purpose of the present paper is to show how blockchain and IoT technologies can benefit smart city projects, which tend to spread in the context of the sharing economy. The article also aims to describe the challenges and potentialities of smart city projects. It was found that technology platforms can serve as a strategy to build the basis for product development (goods and services) and technology-based innovation.

Keywords: Smart Cities; Internet of Things, Service Innovation; Blockchain; Technology Platforms; Sharing Economy.

1. INTRODUCTION

Smart cities are designed to create efficient and sustainable urban spaces that meet the demands of the citizens in an inclusive way using tools and technological management systems based on Information and Communication Technologies (ICT). The recent development of ICT, particularly blockchain systems, the Internet of things (IoT), and communication networks, can improve the quality of life, providing more efficient infrastructure and generating positive impact on other indicators related to the innovation processes described by ISO standard 37122.

The sharing economy is highly compatible with the smart city model. This is because the adoption of key ICT and of blockchain and IoT systems consolidates a new model of construction and renewal of urban spaces. Smart city applications are aimed at improving the quality of life, but the outcome of the implementation of this model also includes the generation of new businesses, which impacts the economy as well. (McKinsey & Company, 2019). Moreover, it should be noted that even though the sharing economy precedes the aforementioned technologies (La Rovere & Punzo, 2019), the advent of sharing platforms has accelerated the spread of this economic model.

The aim of the present article is to identify how smart city projects, which use blockchain technologies and IoT, can accelerate the development of a sharing economy in urban systems. Thus, we intend to contextualize and show how smart cities can restructure city life and improve urban centers with innovative goods services. To this end, section 2 describes the concept of sharing economy. In section 3, we will discuss how valuable blockchain and IoT technologies are for city projects. Section 4 presents the potentialities and challenges of smart city models in a context of social and economic transformations related to the sharing economy. In section 5, a conclusion and a synthesis of the results will be presented, as well as the implications for future studies.

2. SHARING ECONOMY

It is important to note that there is no consensus regarding the definition of the sharing economy. The difficulty to find a single definition for this phenomenon is to some extent due to its multiple interpretations and to the many concepts that are often associated with it, such as digital economy, gig economy, platform economy, peer economy, crowd economy, collaborative consumption, among many others. (Suciu et al., 2020)
La Rovere and Punzo (2019) defined the sharing economy as a phenomenon related to the growth of collaborative consumption. The main features of this type of consumption are: direct user-producer interaction; traceability, transparency and trust among agents; and customer participation. Tigre (2019) described the sharing economy as a recent phenomenon driven by the dissemination of online services and by widespread technology platforms. These innovative services seek to achieve hybrid synergy between the possession and the use of a product (goods or services). In other words, the sharing economy is a new business model aimed to meet the immediate and essential expectations of the user by using various resources that are idle or underused in a more dynamic way. Thus, the sharing economy aims to meet customers’ needs while reducing new investments. This economic model is a good fit for a new type of consumer who values a more personalized experience focused on their identity and on their sense of community, without eliminating intermediaries from the value chain, but efficiently using new digital distribution models. The sharing economy is based on the development and application of ICT and of innovative services that can meet society’s newest purchase and consumption habits. In that vein, smart city projects can accelerate the dissemination of innovative services related to the sharing economy.

In his studies on the importance of the factors of the sharing economy, Tigre (2019) states that the application of smart cities can include the technological platforms that are used in the sharing economy and that are the foundation of the development of products (goods and services). This new platform model comprises a set of standardized technologies and components, which indicates that sharing economy strategies may involve diverse ecosystems whose disruptive innovations promote new economic activities, which then can become new business models. These new business models may range from the selling of products to aggregate and more complex services focused on the customer experience, which, in turn, can promote disruptive models of customer service. These online platforms rely mainly on the technological capabilities made available through the Internet and seek to facilitate and optimize the resource allocation (connecting supply and demand) through ICT and data processing system infrastructures, creating new and innovative organizational models. Structures, assets and resources can be accessed directly on the aforementioned platforms or shared in a complementary and competitive way. The flexibility of the sharing economy represents an opportunity to achieve economies of scope, in which it is possible to adapt the supply to different activities, circumstances and to the needs of the demand.

A research by Davidson and Infranca (2016) identified that sharing has become an important feature of urban systems, since the society’s needs and resources have increased. However, several implications are still not clear and transparent and, consequently, are not completely understood. In most large cities, sharing is a matter of necessity. Cars, bicycles, and even homes are shared, like numerous activities that are part of our daily lives. All of this was possible due to the extensive and intensive growth of communication technologies, positioning control technology (GPS), and to the widespread use of the Internet. Although new and innovative platforms are extensively studied by scholars from several research areas, there are still many fields to be explored in order to raise the understanding of how these platforms have changed the urban landscape, the social experience of living in cities, and even social interactions.

Curtis and Lehner (2019) showed that even without a precise definition, the sharing economy emphasizes the importance of ICT systems, which provides a means of communication and interconnection that can facilitate people's access to the products and services that drive this economy. The authors also mention how the sharing economy is compatible with smart cities’ processes and models as the former increases efficiency, improves the quality of life and, above all, promotes effective cost reduction. On the other hand, as mentioned by Suciu et al. (2020), many authors have different opinions about the importance of the sharing economy when it comes to sustainability and viability. For instance, Botsman and Rogers (2011) praised the social impact of this economic model in urban spaces, since it promotes trust and social collaboration, whereas Belk (2010) points out that the use of idle capacity in the sharing economy can be good for the
environment due to the reduction in energy consumption and also to the reduction of solid and liquid waste, actions that support sustainability within a community.

Other authors such as Frenken et al. (2015) and Kallis (2013) note that the sharing economy is a business model based on ICT that takes advantage of loopholes in regulatory norms, once it functions with unorthodox labor practices and it implements profitable or even offensive practices since, for the most part, workers are self-employed professionals who do not have any perks nor permanent contracts.

3. SMART CITIES, BLOCKCHAIN AND IoT

3.1. Blockchain

One of the main applications that can consolidate communication and exchange of information within the smart cities model using ICT, is available through the use of blockchain technology. This communication system, which is known worldwide by the virtual currency application base (cryptocurrencies), being bitcoin one of the best known examples, also represents a new communication system (transactions and proofs) in a safe way that can be implemented over the Internet and can even become a management model in which smart cities will be able to enjoy the synergy of this process in the form of an urban coordination service. The main objective is to use blockchain as a tool that allows the expansion of the reach and implementation of new technologies applied to smart cities.

Tigre (2019) describes blockchain as a chain of blocks of data or chained data. The author states that blockchain technology connects chunks of content in a process that resembles a fingerprint cross check. In other words, information is separated into different pieces, that is, the blocks. Each new block of data is stored, and it contains pieces of information from the previous block in the chain plus its own new content. Then, the new content is scanned and cross-checked. The process continues indefinitely as new data blocks generate the next “fingerprints”. That is why the technology is called blockchain; these data blocks are somewhat chained to one another. The name refers quite literally to the architecture of the process. Blockchain technology aims to preserve trust in cryptographic transactions by avoiding the centralization of these data blocks. The technology also eliminates the disparities that users may come across in this type of transaction. Blockchains could be applied to various contexts and its benefits include the creation of smart contracts, and the promotion of self-pay and of more efficient decision-making in smart cities, so that the obstacles imposed by bureaucracy are removed and wealth generation becomes less complex for the society as a whole.

According to forecasts prepared by the American bank Merrill Lynch (2018), blockchain technology can assure that today's cities can be prepared to become, in the future, smart metropolises that will house a global population of 6.3 billion people by 2030. Additionally, it is worth mentioning that the blockchain technology generated global investments that amounted to nearly 1.3 trillion Euros in 2020.

To expand the scope of this technology in synergy with smart cities, a project called Blockchain4cities (BC4C) was created by the United Nations (UN) in 2016, which was initially a study group with representatives from different countries to control, integrate and coordinate various urban services more efficiently and transparently within urban management models. In this project a working group was created to identify examples of innovations in services within systems of digitization, urban management and sustainability, energy efficiency, mobility, citizen participation, waste treatment, among other activities. This study was attended by 26 specialists from several countries and four selected cities: Dubai (Middle East), Singapore (Asia), Chicago (America) and Gothenburg (Europe). The specialists were able to measure, among the main results of the research,
the potential that blockchain technology has in of municipal governance, ensuring security, flexibility, in the safe transmission of information without intermediaries, under specific conditions applied to urban management problems and can serve as an example to be implemented on a larger scales to other countries around the world. The researchers within the Blockchain4Cities - BC4C (2016) project were able to measure some benefits and observe competitive advantages in the functioning of the cities that incorporated the blockchain system, which include: a) Connectivity and transparency => cities can generate interconnection with digital services (energy, mobility and security) using a real-time system that is open, single, transversal and accessible in the transmission of data to citizens; b) Direct Communication => cities can eliminate bureaucratic and time-consuming processes (notary offices and City Halls) allowing a direct communication without digital intermediaries between the public administration and citizens; c) Integrity of information => the use of technology allows encryption of information by sharing the data privately, securely and without risks of manipulation; d) Efficient management => the use of technology allows efficient control of resources in addition to ensuring citizen privacy in any public service.

Xie et al. (2019) is another study that highlights the potential that blockchain technology has of promoting the development and of improving services in smart cities. The study compared this technology with a database (shareable, immutable, decentralized and public). The authors then mention the main advantages of the blockchain system, which include: a) Decentralization => Blockchain systems normally work peer-to-peer without a centralized third party; b) Pseudonym: in the blockchain system, each node is linked to a pseudonymous public address, keeping real-world identities hidden. The inherent pseudonym is suitable for cases where the users' identities must be kept confidential; c) Transparency: Blockchain technology allows everyone to access all transaction records, which makes them transparent; d) Democracy: consensus algorithms are executed by all decentralized nodes to reach an agreement before a block is included in the blockchain. Thus, in the blockchain system, decisions are made by all nodes in a peer-to-peer way, which makes it more democratic; e) Security: In blockchain-based decentralized systems, it is rare to have a single point of failure. Thus, network security is improved; f) Immutability: In the blockchain system, all transactions are signed using digital signatures. In addition, data blocks are linked and protected through unilateral cryptographic hash functions. Any small modification generates a different hash and can be detected immediately, which makes the shared ledger immutable.

3.2. IoT (Internet of Things)

According to the description of the Internet Society (2015), the term Internet of things (IoT) is an emerging topic of technical, social and economic significance. It intends to cover, among other things, a universe of products (consumption, durable goods, cars and trucks, industrial and utility components, sensors and other everyday objects that will be connected to the Internet and have data analysis resources). IoT was designed to transform the way we work, live and play. The study estimated the impact of IoT on the Internet and on the economy, and the results are impressive. In some cases, the estimation projected up to 100 billion devices connected to the Internet, and a global economic impact of over $ 11 trillion by 2025. At the same time, as it happens with any projection, there are significant challenges that can constraint the unrealized potential of IoT. Some limitations include: cyber attacks to the devices connected to the Internet, surveillance issues, and the fear that the privacy of citizens and corporations may be at risk. Technically, it may be possible to restrict these effects, but there are still other political, legal, and personal challenges that will have to be addressed.

Regarding IoT, a study prepared by CISCO (2016) describes that the construction of an intelligent city is necessary, and the following aspects are indispensable in the process: a) Communication networks; (b) intelligent sensors; (c) mobile devices. All these components will have to be part of this great system that will be managed by a new technology called the Internet of things (IoT) that will be the backbone of the construction of smart cities, which will stimulate various initiatives that
can improve and make the city more efficient and dynamic for all the people involved. Within this theme, this study shows that this model brings about guidelines in which new technologies called smart will have to deal with some of the problems crucial in urban planning, namely: a) Safety and Environment => it will be necessary to implement sensors that will monitor several different factors, from pollution control, water flow in the city to the verification and measurement of infrastructure conditions of bridges, streets, roads, signs, etc. b) Buildings and Edifices => it will be necessary to plan and monitor the initial phases of new constructions and adaptation of the old ones considering the innovations that can have controlled energy efficiency (lighting, energy, gas emission, water flow, air conditioning, etc.); c) Urban Mobility => With the spiked urban population growth there will be a greater need that transportation is efficient. This quality control can be carried out by sensors that are monitored in real time, in order to have integrated solutions to handle heavy traffic and bottlenecks in urban systems (this includes the subway, bus, ferry, train, VLT and new technologies such as driverless cars and buses or people movers); d) Public Services => In an urban environment, we need to focus our energy on a synergy of options that can improve the way citizens live. Thus, a smart network project that manages the efficient use of energy and water is fundamental for the development and operation of the city.

3.3. Smart Cities

According to a report elaborated by the UN – World Urbanization Prospects (2014), by 2050 70% of the global population will be living in urban spaces, Therefore, it is necessary to build one or several models of smart cities that are inclusive and sustainable. The model of intelligent cities seeks to modify the dynamics and restructure the lives of the citizens, improving and promoting efficiency in the infrastructure of urban centers by supporting digital technologies. Blockchain technologies provide safer transactions and information and, in turn, by using IoT we will have more robust, comprehensive and resilient connection networks, facilitating the access to basic digital services that respond quickly and conveniently to the society’s demands. With planning, structure, and strategic public policies, this model can be implemented effectively in any city that follows the required procedures and makes use of innovative and efficient technologies such as those used by blockchain and IoT. It is imperative to categorize the sectors involved in the application of smart cities, and the most promising areas to explore in the process. It is also important to explore the main applications of services focusing on the society’s demands, and what lessons can be learned by using this model, comparing successful cases that have succeeded coupling public policies with technological and infrastructure input.

According to another study developed by the UN (United Nations) for their “2030 Agenda for Sustainable Development” initiative, the substantial population growth and the technological evolution have had exponential increase, especially during the 21st century. In this scenario, urban spaces and the society must adapt to globalization and to the migration phenomenon that occurs in many countries. Hence, it is indispensable that public and private managers have discussions on how to improve and adapt their urban and technological planning. In this context, smart cities are becoming more and more relevant.

A study conducted by the consulting firm McKinsey & Company (2019) showed that the intelligence of a city is not causally related to the installation of digital models and connections, basic infrastructure facilities, or to the strategic and digital operationalization of cities, but rather the correct use of all forms of technology as tools provide fast and accurate data and information analysis. According to the study, this is important so that public and private managers are able to make the best decisions to help the construction of processes that improve the quality of life of the population. The research presented the most important factors that can be listed as priorities to turn urban spaces into smart cities. Based on the results, it is possible to understand which indicators should be applied in the smart cities’ model, as shown below:
The McKinsey & Company study (2019) found that there was an improvement in the quality of life, evidence shown in Figure 1, in which it is possible to see that the several models of implementation of ICT have the potential to improve key indicators by 10-30 percent.

4. POTENTIALITIES AND CHALLENGES OF SMART CITY MODELS

Suciu et al. (2020) show that a study developed by the European Commission (2020) defined smart cities as places where traditional networks and traditional services become more efficient through digital and telecommunications technologies to the benefit of residents, enterprises, and the society as a whole.

However, smart city projects face many challenges in their implementation. Xie et al. (2019), based on a study by Biswas and Muthukumarasamy (2016), mapped out these challenges listing both technological and non-technological factors. Among the latter, it is possible to mention high financial investments and the availability of skilled labor. Technological factors include: a) Effective data treatment => the efficient collection and analysis of data, maintaining its reliability and integrity, promoting strategic planning that allows the provision of accessible public services and improves city management; b) Connection of devices in a decentralized way => in a decentralized system all nodes and connections can function in a flexible manner, adjusting each network to the dynamic scenario in which they are inserted, even with the increased number of electronic devices and sensors and complex applications, and with the increased volume of data; c) Participatory and transparent Public and Private Management => in this model government managers can disseminate information about city management (government affairs, environmental
processes, decision-making) and companies (information about their clients) to meet the citizens’ desire for participation, democracy and transparency; d) Efficient data sharing => efficient data sharing (IoT, organizational, personal) generates positive effects on the population, improving the supply of high-valued services, improving management, and promoting more accurate decision-making, because when the governments fail to share with organizations and individuals, it generates a lack of incentives and increases mistrust among agents.

A solution that could generate the necessary level of trust among agents, which is one of the pillars of the sharing economy, is the establishing of governance mechanisms from government institutions. According to Fernandez-Añes (2016), the aspects related to governance, sustainability and technological processes are considered by society to be the most important aspects in an intelligent city project. The establishment of transparent governance mechanisms are valuable to cities because they allow the provision of more efficient services that create change that favor the society, playing a fundamental role in improving the quality of life of the population.

To highlight the importance of governance services within smart city models as a public policy strategy, Mechant and Walravens (2018) show that these services have had a significant and substantial demand in the most recent years both in quantity of activities and in complexity. A study developed by the UN in 2014 showed an increase in demand for governance services by 46% within the countries of the European Union. Features such as ease of use, accessibility, trust value, and friendly services were pointed out, which is evidence of all the efforts governments have been making to provide services that meet the demands of their citizens.

Mechant and Walravens (2018) focused on the three main aspects of smart city projects: data, governance and participation. Concerning data, the authors stated that governments hold a wealth of information related to some aspects of a city and, consequently, of the citizens’ lives. However, these data are not openly available, nor can they be easily interpreted, as they require mechanisms to process them. This lack of openness and transparency raised a movement that sought to have these data made available, structured, and machine-readable. The movement is now known as "open data", which gained significant strength in local and national governments. The second aspect is governance. The authors mentioned that new forms of governance and social innovation are related to the interactions between public managers and citizens, in which smart cities models are discussed and proposed. These interactions promote greater responsiveness of the public servants and more participative citizenship. This enhances the presence of governance mechanisms to provide synergies among governments, enterprises, Non-governmental Organizations (NGOs) and citizens. The third aspect is participation, in which the government explores new forms of collaboration and cooperation with the use of technology in a participatory design process (collection of principles and practices that include citizens as part of the design process of objects, services, spaces, and technologies), stimulating the creation of platforms that facilitate participation in lawmaking and policymaking.

A study by Suciu et al. (2020) pointed out the implications and strategies of the sharing economy in a smart city. In 2019, the authors had already identified that 54% of the world population lived in urban spaces. At the time, the degree of urbanization in Europe had already reached 74% of the total population of the continent. These projections corroborate the findings of a study conducted by the UN (2018) which estimated that over the course of 30 years the urban population worldwide would increase by 2.5 billion people, assuming geometric growth. In this context, it is worth mentioning that urban growth includes smaller cities and the so-called megacities. Hence, many are the challenges to be faced on all topics regarding the ISO standard 37120 (2014), including transportation, energy systems, housing, education, health, employability, among other types of infrastructure. In this regard, smart cities are designed to improve the quality of life of the population, turning cities into more inclusive and more sustainable urban spaces, stimulating the development of new business models that cross the borders between suppliers and consumers,
aiming to reduce and restrict idle capacity and generating income for many new workers. Thus, the sharing economy model fits perfectly into this new global order.

Gori et al. (2015) describe that even with the current use of innovative platforms, the sharing economy has been growing for over 10 years. This has drawn the attention of organizations and institutions which have researched sharing economies in order to try to explain and also to evaluate their full potential. These studies show that smart cities and sharing economies have synergies as both promote innovative ideas that meet the needs of consumers to share resources, time, efficiency, skills and data first and foremost. Both smart cities and sharing economies rely on the support of ICT.

The scenario shown by Suciu et al. (2020) indicates that these new sharing technologies used in smart cities seek to change the way the citizens, the user or the customer, perceive access and consumption, depending on different types of resources. The authors also mention how they believe that new urban lifestyles are seen differently around the world. New purchase and consumption models transform the urban landscape, including the transportation, tourism, food, and retail industries that are creating new financial opportunities for the working class through the creation of new business models which represent a challenge for many traditional companies and institutions, forcing them to adapt in order to promote transparency to their consumers, thus paving the way and contributing to a more sustainable business culture.

5. FINAL REMARKS AND CONCLUSION

The present article showed that smart city projects can accelerate the trend of the current sharing economy, that is, the use of platforms for agents to interact freely and openly with transparency and, consequently, promoting higher levels of trust among agents.

It was seen in section 3 that new technologies such as blockchain and IoT are highly beneficial for smart city projects. However, as shown in section 4, the current context of the sharing economy requires data transparency and higher levels of trust among the agents who may not necessarily be present in these projects. Therefore, it is important to define governance of projects by establishing clear and open communication channels between the local government and the society through electronic government tools.

The use of blockchain technology and the IoT system in the context of the sharing economy will only be possible with the use of technology platforms that offer standardized preference services that optimize the existing resources in an innovative way by using ICTs. Moreover, these technologies stimulate the creation of more innovative and efficient organizational models, helping businesses adapt to provide new services that meet the society’s demands and needs.

With strategic planning, investment in infrastructure, and public policies, smart city projects can be implemented effectively in any city that follows the required procedures. Therefore, it is important to categorize the sectors involved in the development of these cities to identify the most promising economic activities. Smart city projects can meet the society’s wants and needs. In this sense, the guidelines for transparency of data are also important as they facilitate access to information on best practices and analysis of the possibilities of application of these practices to other cities.

Thus, it is important to note that smart city projects can only succeed if integration and commitment between public and private actors occur, allowing citizens to enjoy healthier and more sustainable lives. These projects can highly benefit from the blockchain technology and from interactions with the IoT system. Hence, this is an indication that investments made to favor the society can turn urban spaces into a universe in which everyone can share, take action, and contribute to promote
sustainable development. In this context, knowledge generation will be indispensable for the growth and evolution of smart cities.

REFERENCES AND CITATIONS


FACTORS THAT DETERMINE CONTINUOUS INTENTION TO USE MOBILE PAYMENTS IN MALAWI

Jones Ntaukira, Malawi University of Science and Technology, jones.ntaukira@zuwaenergy.com
Priscilla Maliwichi, Malawi University of Science and Technology, pmaliwichi@must.ac.mw
James Kamwachale Khomba, Malawi University of Science and Technology, jkhomba@must.ac.mw

Abstract: The proliferation of mobile phones has made mobile payments to be widely used in developing economies. However, mobile payment usage in Malawi is low, and there are many limitations to encourage users to continuously use mobile payments. The purpose of this research was to examine determinants of continuous intention to use mobile payments in Malawi. A conceptual framework adapted from Technology Acceptance Model was developed. Data was collected through a survey while data analysis used Structural Equation Modelling Partial Least Squares using SmartPLS software. The findings of this study showed that society norms significantly influence continuous intention to use mobile payments ($p=0.012$). Most interestingly, prior knowledge ($p=0.000$) and seamlessness ($p=0.000$) had the strongest influence as compared to structural assurance ($p=0.008$). Seamlessness significantly influenced satisfaction ($p=0.002$) and society norms ($p=0.001$). Seamlessness and service quality had significantly negative effects on satisfaction. The findings of this research provide several considerations to guide the mobile payments industry in Malawi. The findings may also improve the existing mobile payments system’s business models, marketing strategies, customer engagement on security issues, transparency, and interoperability of payment systems. Regulators may also find the findings of this study very insightful in advancing the mobile payments agenda in Malawi.

Keywords: mobile payments, mobile phone, continuous intention, seamlessness, social norm, PLS-SEM

1. INTRODUCTION

Electronic commerce's emergence and success have led to the digitization of payment systems, referred to as electronic payments or e-payments (Casado-Aranda, Liébana-Cabanillas, & Sánchez-Fernández, 2018). E-payment is defined as the buying and selling of goods and services on the web (Tiwari, Buse, & Herstatt, 2006). The United States Bureau of the Census has defined e-payment as any payment completed over a computer-mediated network that involves the transfer of ownership or rights to use goods or services using free software or mobile application (as cited by Tiwari et al., 2006, p.39). However, various researchers refer to e-payment as all payments that are initiated, processed, and received electronically (Ahmed & Ali, 2017). Sometimes, it can generally be referred to as digital payments and may be linked or not be linked to a financial institution or a bank (Ahmed & Ali, 2017; Diniz, Porto de Albuquerque, & Cernev, 2011). The most common e-payments systems in the world are credit cards, debit cards, and email-based PayPal transactions (Casado-Aranda et al., 2018). However, due to the widespread adoption and usage of mobile phones worldwide, mobile commerce has emerged, giving a new dimension to e-commerce (Casado-Aranda et al., 2018).
Mobile commerce (m-commerce) uses mobile payments to pay for goods and services (Diniz et al., 2011). There are currently two kinds of mobile payment systems in use around the world: telecommunications-led mobile payment platforms and bank-led mobile payments (Madise, 2014). Comparing the two types of mobile payment platforms in Malawi, telecom-led mobile money platforms have become a key financial player (Madise, 2014). Telecom-led mobile payment is popular among the millions of people who do not use banks in Malawi, particularly in rural areas (Madise, 2014; Reserve Bank of Malawi [RBM], 2017). With commercial banks concentrating in urban and semi-urban areas, rural areas remain highly financially secluded (Madise, 2014). Mobile payments that are telecommunications-led are also referred to as mobile money, an electronic currency for transactions (Diniz et al., 2011).

Mobile money is a fast-growing industry, not only in Malawi but also in the developing world (Madise, 2014). However, despite an increase in mobile payment solutions in Malawi, data on usage suggests that very few people are using these services (Madise, 2014; RBM, 2017). In their Monthly National Payment Systems Report for July 2017, RBM reported that of the 4 million subscribers of telecom-led mobile payments, only 22.1% of registered users were active during the previous 30 days (RBM, 2017). Thus, it was due to this background that this study sought to investigate factors that determine continuous intention to use mobile payments in Malawi. Several studies have examined factors that determine continuous intention to use mobile payments (Agwu, 2017; Ahmed & Ali, 2017; Onsongo & Schot, 2017). However, little is known of the factors that determine continuous intention to use mobile payments in Malawi (Madise, 2014; Nyirenda & Chikumba, 2014; Tsilizani, 2015). Therefore, the question which guided this study was:

- What factors determine the continuous intention to use mobile payments in Malawi?

The study used a conceptual framework to understand the factors determining people’s continuous intention to use mobile payments in Malawi. Based on the findings of this study, we then laid out considerations that may assist the mobile payment service industry in Malawi on how they could make mobile payments in Malawi to be used at its fullest potential.

2. Literature Review

This section discusses theoretical models and literature on continuous intention to use technologies, which is a post-adoption behaviour. To understand continuous intention to use technologies, the researchers suggested and employed several models and theories. Some of these were extended Technology Acceptance Model and IS Impact Model. The study also adopted constructs from other theoretical models implemented to extend Technology Acceptance Model (TAM) to understand key determinants of continuous intention to use technologies.

One major flaw of TAM model is its inability to offer actionable guidance to developers (Bradley, 2009; Park, 2009). UTAUT, as an updated TAM model, has also received various criticism, some of which is its complexity (van Raaij & Schepers, 2008) and ‘chaotic’ (Bagozzi, 2008), hence the need to stick to simple models with proper screening procedures. This study, therefore, used Extended TAM and incorporated concepts from IS Impact model to explain continuous intention. By incorporating constructs from IS Impact Model, the researchers aim to address a concern of understudying usage in TAM (Bradley, 2009) while also using Task Technology Fit (TTF) (a construct in IS Impact Model) to explore actionable guidance for developers. The following sections discuss the genealogy of the constructs used in this study.

2.1. Extended Technology Acceptance Model (TAM)

Technology Acceptance Model (TAM) was developed by Davis, Bagozzi, & Warshaw (1989). Davis, Bagozzi, & Warshaw (1989) found two main reasons people adopt or reject a technology, namely perception of the technology usefulness and perception of ease of use of the technology. TAM is one of the most widely used model when predicting information technology adoption, and
according to different scholars, it consistently explains between 40% to 50% of user acceptance and actual usage (Surendran, 2012; Venkatesh & Bala, 2008).

TAM was then extended to include a possible explanation of subjective norm, perceived usefulness and usage intentions (Venkatesh & Davis, 2000). Later, TAM was extended by Rose & Fogarty (2006) to include perceived risk as one of the construct as shown in Figure 1.

![Figure 1. Extended Technology Acceptance Model - Adapted from Rose & Fogarty (2006)](image)

2.1.1. Perceived Usefulness, Perceived Ease of Use and Attitude Towards Intention to Use Technologies

Perceived usefulness and perceived ease of use were original constructs of TAM and are key determinants of acceptance of an information system (Davis et al., 1989). Perceived usefulness is the degree to which consumers believe that a particular technology will facilitate the transaction process. While, perceived ease of use is the degree to which a consumer believes that using a particular technology will be effortless. Applying these constructs in mobile commerce, in Nigeria, it found that electronic banking provides a higher degree of convenience that enables customers to access their money at all times and places (Agwu, 2017). Perceived usefulness directly influence attitude or intention to use, but perceived ease of use acts indirectly through usefulness (Pavlou, 2003).

2.1.2. Perceived Risk, Service Quality and System Quality versus Satisfaction

Over the years, researchers have extended TAM to better understand attitudes. In 2005, Wixom and Todd developed a model using construct from TAM, theory of reasoned action (TRA) and unified theory of acceptance and use of technology (UTAUT) to understand beliefs and attitudes when using a system. In their model satisfaction and system quality were some of the constructs of their model (Wixom & Todd, 2005). Later, the model was extended to include service quality by Xu, Benbasat and Cenfetelli (2013).

Satisfaction has been identified as a major predictor of behavioral intention to use mobile payments (Ahmed & Ali, 2017; Wixom & Todd, 2005). To measure satisfaction, other factors must be used to explain the major predictor. Several prior studies used perceived risk, service quality, and system quality as antecedent factors of satisfaction (Agwu, 2017; Ahmed & Ali, 2017). Generally, consumers associate risk with loss of money; hence, security and privacy are highly significant predictors of adoption (Agwu, 2017). In contrast, Sinha (2010) found that perceived risk was not significant in online shopping, but at the gender level, they found that men and women behaved differently due to perceived risk. Therefore, service quality and system quality are antecedent factors...
that significantly determine the continuous intention to use mobile money transfer (Ahmed & Ali, 2017).

2.2. IS Impact Model
IS Impact Model was developed by Ahmed and Ali (2017) to understand the determinants of continuous intention to use mobile money payments technologies. IS Impact Model is a combination of Task Technology Fit model, Theory of Reasoned Action, Technology Acceptance Model and Information Systems Success Model (Ahmed & Ali, 2017). In this study, the researchers adopted trust, task technology fit, firm reputation, structural assurances and continuous intention constructs from the integrated model.

2.2.1. Satisfaction and Continuous Intention
Literature suggests that one of the key determinants of continuous intention to use technologies is customer satisfaction (Susanto, Chang, & Ha, 2016). A satisfied customer is more likely to continue using a service or product. In Information Systems (IS) field, user satisfaction with technology is also vital in influencing the adoption and continuance use of technology (Ahmed & Ali, 2017; Susanto et al., 2016). Ahmed and Ali (2017) reported a significant positive relationship between satisfaction and continuous intention to use mobile money transfer. They concluded that satisfied customers are more likely to continue using a mobile money transfer.

2.2.2 Trust and Continuous Intention
User’s trust towards mobile payments impacts their continuous behaviour intention to use technologies (Pavlou, 2003; Susanto et al., 2016). Trust defined as a belief that the other party will behave in a socially responsible manner and, by so doing, will fulfill the trusting party’s expectations without taking advantage of their vulnerabilities (Pavlou, 2003). Several studies have found that trust is positively related to continuance intention to use technologies (Dupas, Green, Keats, & Robinson, 2016; Susanto et al., 2016). In a study to understand the challenges of mobile banking in Kenya, it was found that, out of the 63% of people who opened an account, only 18% actively used it (Dupas et al., 2016). Survey evidence from the study suggested that people did not begin saving in their bank accounts because they did not trust the bank (Dupas et al., 2016).

2.2.3. Subjective Norms and Continuous Intention
Subjective norms, also called social factors, may negatively affect users’ continuous behaviour to use mobile payments (Ahmed & Ali, 2017). Subjective norm is defined as the perceived social pressure to perform or not perform the behaviour (Ahmed & Ali, 2017). In India, the lower usage of online shopping was highly attributed to social-psychological factors influence of friends and relatives (Sinha, 2010).

Similarly, others have also found that the opinion of one’s surroundings, including friends, colleagues, and family members, significantly contributed to one’s adoption of mobile money transfer (Ahmed & Ali, 2017). Ahmed & Ali (2017) specifically found that subjective norm was the best predictor of continuous intention to use mobile money transfer among their study respondents (Ahmed & Ali, 2017).

2.2.4. Task Technology Fit versus Perceived Usefulness
Task Technology Fit is another antecedent factor that this research introduced to further our understanding of mobile payments’ perceived usefulness, especially for corporate users and SMEs. The researchers were curious to find out if, at all, a better fit between task requirements and mobile payment system functionalities increases perceived usefulness. Others have argued that task technology fit may impact perceived usefulness (Ahmed & Ali, 2017).
2.2.5. Firm Reputation and Structural Assurances versus Trust

Trust is a defining feature of most economic and social interactions in which uncertainty is present (Pavlou, 2003). Trust has always been an important element in influencing consumer behavior (Pavlou, 2003). Several studies have found that trust is a major determinant of intention to adopt or continue using mobile banking services among different users (Ahmed & Ali, 2017; Lin & Wang, 2006). For example, a study in Iran found that customer’s intention to adopt mobile banking was significantly influenced by how much trust the customers exert on the service provider (Hanafizadeh, Behboudi, Abedini Koshksaray, & Jalilvand Shirkhani Tabar, 2014). Hence, firm reputation and structural assurance are antecedents that addresses institutional based trust (Ahmed & Ali, 2017). It has been urged that trust has a significant positive impact on customer satisfaction and loyalty (Lin & Wang, 2006).

3. CONCEPTUAL FRAMEWORK

The conceptual framework used in this study is a combination of extended Technology Acceptance Model and other adoption models based on TAM, and integrated model which test continuous intention to use technologies.

3.2. Seamlessness

Seamlessness is a construct that the current study introduced to understand user behaviour towards mobile payments in Malawi. In this study, seamlessness is defined as the technical and operational compatibility between two different mobile payment systems regardless of whether the users are on the same network or not.

3.3. Constructs on Determinants of Continuous Intention to Use Technologies

Based on the constructs discussed in the literature review section and a construct introduced in this section (seamlessness), Figure 2 summarises the hypothetical model that was developed for this study.

![Figure 2. Hypothesised Model for Determinants of Behaviour for Using Mobile Payments in Malawi.](image)

A list of hypothesises used in this study based on figure 2 are listed in Table 1.

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<table>
<thead>
<tr>
<th>H1a</th>
<th>Satisfaction with mobile payment systems positively determines the user’s continuous intention behaviour to use mobile payments.</th>
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<tbody>
<tr>
<td>H1b</td>
<td>Satisfaction with mobile payments systems positively determines user’s attitude on the use of mobile payments</td>
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<tr>
<td>H2a</td>
<td>User’s trust towards mobile payments systems and companies positively determine continuous intention behaviour to use mobile payments technology</td>
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<tr>
<td>H2b</td>
<td>User’s trust towards mobile payments positively determines their attitude on the use of mobile payments</td>
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<tr>
<td>H3a</td>
<td>Perceived usefulness of mobile payments positively determines continuous intention behaviour to use mobile payments technology</td>
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<tr>
<td>H3b</td>
<td>Perceived usefulness of mobile payments positively determines user’s attitude on the use of mobile payments</td>
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<tr>
<td>H4a</td>
<td>Societal norms towards mobile payments positively determines user’s continuous intention behaviour to use mobile payments</td>
</tr>
<tr>
<td>H4b</td>
<td>Societal norms towards mobile payments positively determines user’s attitude on using mobile payments</td>
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<tr>
<td>H5a</td>
<td>Perceived ease of use of mobile payment technology has a positive impact on continuous intention to use mobile payments</td>
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<tr>
<td>H5b</td>
<td>Perceived ease of use of mobile payment technology has a positive impact on user’s attitude on the use of that mobile payment technology</td>
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<td>H5c</td>
<td>Perceived ease of use of a mobile payment technology has a positive impact on the perceived usefulness of mobile payments.</td>
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<tr>
<td>H6</td>
<td>Attitude of users of mobile payments towards the use of the same positively determines their continuous intention behaviour to use mobile payments</td>
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<tr>
<td>H7a</td>
<td>Seamlessness of mobile payment technology has a positive impact on perceived usefulness of mobile payments</td>
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<tr>
<td>H7b</td>
<td>Seamlessness of mobile payment technology has a positive impact on perceived ease of use of mobile payments</td>
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<tr>
<td>H7c</td>
<td>Seamlessness of mobile payment technology has a positive impact on society norms of mobile payments</td>
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<td>H7d</td>
<td>Seamlessness of mobile payment technology has a positive impact on user’s trust in mobile payments</td>
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<td>H7e</td>
<td>Seamlessness of mobile payment technology has a positive impact on user’s satisfaction with mobile payments</td>
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<tr>
<td>H8a</td>
<td>Prior knowledge of mobile payment technology has a positive impact on user’s trust in mobile payments</td>
</tr>
<tr>
<td>H8b</td>
<td>Prior knowledge of mobile payment technology has a positive influence on society norms on mobile payments</td>
</tr>
<tr>
<td>H9a</td>
<td>The perceived risk that user’s associate with mobile payments has a positive influence on their satisfaction with mobile payments</td>
</tr>
<tr>
<td>H9b</td>
<td>The perceived risk that user’s associate with mobile payments has a positive influence on their trust in mobile payments</td>
</tr>
<tr>
<td>H10</td>
<td>Service quality of mobile payments providers has a positive influence on user’s satisfaction with mobile payments</td>
</tr>
<tr>
<td>H11</td>
<td>System quality of a mobile payments platform has a positive influence on user’s satisfaction with mobile payments user’s satisfaction</td>
</tr>
<tr>
<td>H12</td>
<td>User’s perception of a mobile payment technology fitting their tasks and roles has a positive influence on user’s perceived usefulness</td>
</tr>
</tbody>
</table>
Table 1. List Hypotheses Based on the Conceptual Framework

<table>
<thead>
<tr>
<th></th>
<th>Hypotheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>H13a</td>
<td>Structural assurances that service providers give to users of mobile payments have a positive influence on their society norms on the use of mobile payments</td>
</tr>
<tr>
<td>H13b</td>
<td>Structural assurances that service providers give to users of mobile payments have a positive influence on user’s trust in the use of mobile payments</td>
</tr>
<tr>
<td>H14</td>
<td>A mobile payments firm’s reputation has a positive impact on user’s trust in the use of mobile payment</td>
</tr>
</tbody>
</table>

4. METHODOLOGY

This study used quantitative research methods. Data was collected using a survey approach to understand the determinants of continuous intention to use mobile payments in Malawi by current users. The questionnaire was developed based on the conceptual framework discussed in Section 2. Data analysis used Partial Least Squares Structured Equation Modelling (PLS-SEM) using SmartPLS3 software and SPSS (version 22). Structural Equation Modelling (SEM) is a second-generation multivariate data analysis method used in behavioral sciences to test theoretically supported linear and additive causal models (Wong, 2013). On the other hand, PLS is a soft modelling approach to SEM, which makes no assumptions about data distribution (Vinzi, Chin, Henseler, & Wang, 2010).

4.1. Research Design

The specific quantitative strategy that was used for this study was a survey design. Survey research provides a quantitative or numeric description of trends, attitudes, or opinions of a population by studying a population sample (Creswell, 2009). It can be used in cross-sectional and longitudinal studies using questionnaires or structured interviews for data collection to generalize results from a sample to a population (Creswell, 2009). The survey design was preferred for this study for many reasons. Firstly, a small sample of mobile payments users would need to be studied in order to make conclusions about the population other than studying the whole population. Secondly, survey research is economical and does not require many resources if it is done effectively. Thirdly, there is a rapid turnaround in data collection. The survey conducted for this study was cross-sectional, whereby data was collected at one point in time rather than spread over a long period of time.

4.2. Setting and Population

The study was conducted in Lilongwe, covering both Lilongwe city and Lilongwe rural. Data was collected from mobile payment service users, both telecom-led and bank-led services between end January 2018 and February 2018. The population for this study was defined as subscribers who have an account with any mobile payments service providers. Inclusion criteria comprised the following: above 18 years of age, male or female, able to read and write English, must have used their mobile payment service in the last six months.

3.3. Sampling frame and Sample size

According to Jackson (2009), a sampling frame is the set of people who has a chance to be selected given the chosen sampling approach. Because the population size was greater than 50,000 (actual population was 4,581,244), the formula for calculating a sample for infinite populations was used as proposed by Godden (2004). Thus, a formula was used to calculate sample size with 90% confidence level and a probability of 5% with a margin of error of 4% as given in Godden (2004). Hence, our sample was 422 respondents.
3.4. Data Analysis

Data was coded and entered into Microsoft Excel before exporting it into Statistical Package for Social Scientists software (SPSS) for descriptive analysis (i.e. mean, standard deviation, variance, frequency, percent, and correlation). To understand the relationships between the constructs, the constructs were first tested for validity and reliability using Exploratory Factor Analysis (Ahmed & Ali, 2017). After confirming the reliability and validity of the constructs, structural model analysis followed. Structural model analysis was done following a procedure for Partial Least Squares Structural Equation Modeling using SmartPLS 3 software, as shown in Figure 3.

![Figure 3. Step by step Structural Model Assessment Procedure for this study - Adapted from Hair, Hult, Ringle, & Sarstedt (2014)](image)

5. RESULTS

The study distributed 422 questionnaires, but only 400 questionnaires were returned, representing a response rate of 95% of the original sample size. From the 400 returned questionnaires, seven questionnaires were not used because three respondents said they had not used mobile money before. Four respondents only partially answered the questions or some pages were missing from their questionnaires. Therefore 393 questionnaires were used for data analysis representing a final response rate of 93%.

5.1. Demographic Characteristics of the Respondents

This section presents the demographic characteristic of the respondents. These characteristics are based on demographic attributes, as well as the uses of mobile payment services.

5.1.1. Demographic Characteristics of Respondents

Women represented 60.3% of the respondents, while 39.4% were men and 0.3% did not want to disclose their gender. By age, the age bracket of 21 to 30 had the highest respondents at 57%. More than 80% of the respondents had at least a Malawi School Certificate of Education (MSCE) as minimum education qualification. In terms of marital status, most respondents (66.7%) were single. Table 2 summarises the demographic characteristics of the respondents.

<table>
<thead>
<tr>
<th>Variable (n=393)</th>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td>Male</td>
<td>155</td>
<td>39.4</td>
</tr>
<tr>
<td></td>
<td>Female</td>
<td>237</td>
<td>60.3</td>
</tr>
<tr>
<td></td>
<td>Rather not disclose</td>
<td>1</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Ntaukira et al.  
Determinants of Continuous Intention to use Mobile Payments

<table>
<thead>
<tr>
<th>Age</th>
<th>Less than 20</th>
<th>21-30</th>
<th>31-40</th>
<th>41-50</th>
<th>&gt;50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>69</td>
<td>224</td>
<td>59</td>
<td>32</td>
<td>9</td>
</tr>
<tr>
<td>Percentage</td>
<td>17.6</td>
<td>57.0</td>
<td>15.0</td>
<td>8.1</td>
<td>2.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Education</th>
<th>Primary school</th>
<th>Secondary (MSCE)</th>
<th>Certificate/Diploma</th>
<th>Bachelors degree</th>
<th>Postgraduate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>11</td>
<td>132</td>
<td>128</td>
<td>113</td>
<td>9</td>
</tr>
<tr>
<td>Percentage</td>
<td>2.8</td>
<td>33.6</td>
<td>32.6</td>
<td>28.8</td>
<td>2.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Marital Status</th>
<th>Married</th>
<th>Single</th>
<th>Widow/Widower</th>
<th>Divorced</th>
<th>Separated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>119</td>
<td>262</td>
<td>9</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Percentage</td>
<td>30.3</td>
<td>66.7</td>
<td>2.3</td>
<td>0.0</td>
<td>0.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Head of household</th>
<th>Head of household</th>
<th>Not Head of house</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>139</td>
<td>254</td>
</tr>
<tr>
<td>Percentage</td>
<td>35.4</td>
<td>64.6</td>
</tr>
</tbody>
</table>

Table 2. Demographic Characteristics of Respondent

5.1.2. Uses of Mobile Payment Services
The findings of this study have shown that 58.5% of the respondents used mobile payment services for sending money to others, while 24.9% used mobile payment services for buying airtime on their mobile phones. Only 9.4% of the respondents used mobile payment services for shopping in stores and shops. Table 3 summarises uses of mobile payment services in Malawi.

<table>
<thead>
<tr>
<th>Variable (n=393)</th>
<th>Category</th>
<th>Frequency</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use of mobile payments</td>
<td>Buying from shops/stores</td>
<td>37</td>
<td>9.4</td>
</tr>
<tr>
<td></td>
<td>Sending money to others</td>
<td>230</td>
<td>58.5</td>
</tr>
<tr>
<td></td>
<td>Buying airtime</td>
<td>98</td>
<td>24.9</td>
</tr>
<tr>
<td></td>
<td>Paying school fees</td>
<td>5</td>
<td>1.3</td>
</tr>
<tr>
<td></td>
<td>Paying utility bills</td>
<td>12</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>Buying things online</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>Other</td>
<td>8</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Table 3. Uses of Mobile Payment Services

5.2. Internal Consistency
All the Composite Reliability (CR) scores for the measurement model were found to be above the recommended value of 0.7 (Hair et al., 2014) which means that very high levels of internal consistency reliability were demonstrated among all reflective latent variables as shown in Figure 4.
5.3. Assessing significance and Relevant of the Structural Model Relationships

Regression estimates (RE) and the p-value were used to explain relevance and significance, respectively. The study found that at 95% confidence interval, society norms (RE=0.153, p=0.003) and perceived usefulness (RE=0.159, p = 0.005) had the strongest effect on continuous intention at 15.3% and 15.9% of the total variance in continuous intention to use respectively and their paths were significant. Also, perceived ease of use (RE =0.126, p = 0.016) and attitude (RE=0.111, p = 0.048) had 12.6% and 11.1% of continuous intention to use respectively and their paths were significant. However, satisfaction (RE = 0.057, p = 0.243) and trust (RE = 0.020, p = 0.676) had low effect on continuous intention to use at 5.7% and 2% respectively and their paths were not significant at 95% confidence interval. Figure 5 shows the results of the structural model.

Figure 4. Composite Reliability
Figure 5. Results of the Structural Model

5.2.1. Satisfaction
Satisfaction was strongly explained by system quality at 33.6% (RE = 0.336, p = 0.000) followed by seamlessness at 15.6% (RE = -0.156, p = 0.001). Both service quality (RE = -0.109, p = 0.023) and seamlessness portrayed a negative relationship with satisfaction while their paths were both significant. This means that one unit drop in service quality and seamlessness leads to 10% and 15% loss of satisfaction respectively. Perceived risk (RE=0.10, p = 0.034) explained 10% of satisfaction and its path was significant.

The findings of this study have shown that there is no positive effect of satisfaction on continuous intention to use mobile payments (p = 0.770). This finding contrasts with Ahmed and Ali (2017) findings that satisfaction positively affected continuous intention to use mobile money transfer. However, most studies do not include satisfaction as a predictor of continuous intention or behaviour intention (Bradley, 2009; Lee et al., 2003).

5.2.2. Trust
The findings of this study have shown that trust was highly predicted by firm reputation (RE = 0.381, p = 0.000), then prior knowledge (RE = 0.133, p = 0.003) with both paths being significant. But worth of noting here is the negative relationship portrayed by seamlessness (RE = -0.85, p = 0.064), although the path was found not to be significant. Perceived risk (RE=0.58, p = 0.08) and structural assurances (RE = 0.35, p = 0.476) had low trust and the paths were not significant.

This finding has shown that user’s trust does not have a positive effect on continuous intention. This is similar to other mobile money transfer findings and mobile banking (Ahmed & Ali, 2017; Koenig-lewis, Palmer, & Moll, 2010). Perhaps, this finding may be explained well if we look at the predictors of trust. However, a possible explanation could be that trust is earned over a long period of time and therefore, mobile payments users might not have used the systems for a long time to know whether they have trust in the system.

5.2.3. Attitude
The finding of this study has shown that 40% of attitude variance was influenced by perceived usefulness (RE=0.400) and the path was significant (p=0.000). This is quite high considering the other constructs contributed less i.e. society norms at 15.8% (RE = 0.158), perceived ease of use at 14.4% (RE = 0.144), satisfaction at 7.9% (RE = 0.079), and trust at 5.5% (RE = - 0.055). The paths for society norms and perceived ease of use were both significant (p = 0.001 and p = 0.002 respectively) while the paths for satisfaction and trust were not significant (p = 0.770 and p = 0.203 respectively).

The attitude construct had one major hypothesis that attitude positively affects the continuous intention to use mobile payments. The estimates for H6 were β = 0.111, t-value = 1.99, and p-value = 0.048, which means that the hypothesis was supported. Therefore, the hypothesis was accepted.

5.2.4. Perceived Usefulness
Perceived usefulness was found to be strongly influenced by perceived ease of use (RE =0.326) followed by task technology fit (RE = 0.307), with both paths being statistically significant (p = 0.000). Seamlessness had only 4.5% (RE = 0.045) of perceived usefulness, and the path was found not to be significant (p = 0.312).

In this study, perceived usefulness was hypothesised to positively affect both attitude and continuous intention. It is implied from these results that the more useful people find a mobile payment system or service, the more likely they are to develop a positive attitude towards that system or service and, in turn, the more likely they will continue using that system or service.
5.2.5. Perceived Ease of Use
Perceived ease of use was hypothesised to positively influence continuous intention and perceived usefulness. Hypothesis H5c has already been discussed above. The estimates of H5a (β = 0.126, t-value = 2.42, p-value = 0.016) and H5b (β = 0.144, t-value = 3.09, p-value = 0.002) supported the hypotheses and therefore both hypotheses were accepted.

5.2.6. Society Norms
Society norm was hypothesised to positively influence continuous intention and attitude. However, explaining society norms to understand what these results mean might be difficult if we do not explain and understand the predictors of society norms.

In this study, Society norms was found to be highly influenced by structural assurances (RE = 0.219, p = 0.008) followed by prior knowledge (RE = 0.193, p = 0.000) then seamlessness (RE = 0.165, p = 0.000) with all paths being significant.

6. DISCUSSION
The findings of this study have shown that young adults (57%) were the majority users of mobile payments. This could be because young people are the ones who are most likely to be technologically savvy and are happy to try new things. Furthermore, women (60.3%) used mobile payments more than men. It is most likely that most of these female users are still in school and, therefore, tend to use mobile payments to receive and send money from and to their family and friends. There was no big difference between those with lower education and those with higher education in terms of usage of mobile payments.

On mobile payment usage, the findings of this study were similar to the findings of the Reserve Bank of Malawi that many people use mobile payment services to send money to others (RBM, 2017). This could be because when mobile payment services were introduced in Malawi in 2011 by Airtel, the emphasis was on sending money before other services were incrementally introduced. The second most used mobile payment service was buying airtime (24%) for both telecom-led and bank-led services. This could be because telecommunication companies drive the mobile payment services agenda, and in their marketing, they just emphasise on buying airtime using one's mobile wallet. Surprisingly, just 9.4% use mobile payment services for buying goods in shops and stores. These findings are in contrast with the current trends in other African countries. For example, in Kenya it was reported that in 2016, the major uses of mobile payments (particularly mobile money) were paying and receiving salaries and bulk payment (90%), depositing money (85%), withdrawing money (98%), buying airtime (69%) and receiving remittances (64%) (The Economist, 2016). This shows that mobile payment users in Malawi are not using mobile payments to their fullest capacity. Therefore, the industry players and regulators should inform mobile payment users to leverage the services available to them.

6.1. Considerations for Mobile Payment Industry in Malawi
Based on the findings of this study, several considerations to the mobile payment industry have been proposed to help the industry reach out to its customer base and influence customers’ continuous intention to use mobile payments in Malawi.

6.1.1. Improved business models
Perceived usefulness was found to be the most significant factor which influenced continuous intention to use mobile payments. Several studies in the mobile banking space had reported similar findings (Agwu, 2017; Ahmed & Ali, 2017). Significance in perceived usefulness was influenced by perceived ease of use and task technology fit. To boost people’s perceived usefulness of mobile payments, the regulator could make a policy that every merchant must start accepting mobile payments. This includes paying for government services like road traffic services and fines, immigration services like passport application and renewal. This could make people see this befitting their tasks and lifestyle and increase their perception of mobile payment's usefulness. As it
is now, most people in Malawi do not see how mobile payments fit into their daily tasks because it is not widely available and accepted. Changing this perception would improve people’s perception of mobile payments.

6.1.2. Marketing strategies

Perceived ease of use of mobile payments was found to influence perceived usefulness, and ease of use was directly influenced by both attitude and continuous intention to use mobile payments. This finding is similar to other studies in Fintech and augmented reality (Chuang, Liu, & Kao, 2016; Chung, Han, & Joun, 2015). Therefore, marketing efforts by service providers should focus on showing people how easy it is to use mobile payments. This could be done by using visual arts like videos, comic stories, and even infographics. Current marketing efforts by service providers are customer acquisition-centric and not informative-centric. If industry players understand this, they could save money by speaking directly to the people’s hearts and, in turn, changing their perceptions.

6.1.3. Customer engagement on security, privacy and transparency issues

Society norm was found to be highly significant in influencing continuous intention to use mobile payments. Other studies have found similar results (Ahmed & Ali, 2017). In this study, society norms were significantly influenced by structural assurances, prior knowledge and were negatively influenced by seamlessness. Structural assurances are more about customers feeling safe about their privacy and trust in the system in case of system failure and having no hidden costs. Banks and telecom companies should educate users about security threats of their funds and privacy of their transactions and themselves as individuals. For example, providing assurances that their funds are safe in terms of system failure or a possible hack. They could go further to have agreement statements during registration, thereby taking responsibility to refund people funds should such cases happen. This would create a generally positive image of mobile payments in the public domain, which will inform opinion about using mobile money since society norms influence continuous intention.

6.1.4. Interoperability of payment systems

Seamlessness was found to be highly significant in influencing society norms. This means that people value interoperability, and a lack of it leads to a negative image to the public. The need for more interoperability was also proposed and discussed by the global mobile telecommunication Companies’ Association (GSMA) in their state of the industry 2014 report (GSMA, 2014). If mobile payments industry players want to reap the benefits of their investments, they need to start making their services seamless as this will help create confidence and trust among the general public and will lead to better attitude and continuous intention to use mobile payments.

7. CONCLUSION

The findings of this study have suggested that for users to continuously use mobile payments society has a crucial role to play and the industry must put more efforts to understand their users. Enhancing structural assurances by improving privacy and guaranteeing safety of funds and making systems and services as seamless as possible will most likely positively improve society’s attitude towards mobile payments and eventually leads to continuous intention to use a service. Therefore, based on society norms, what society thinks about a service has a significant impact on individual usage of that service. For mobile payments to succeed, service providers must do all they can to make sure that they are maintaining a positive image with society. In return, society norms may be influenced by the seamlessness of services and structural assurances.

In addition, when users find mobile payments to be useful, the more the users may continuously use mobile payments. Perceived usefulness also has great positive impact on user’s attitudes. Therefore, service providers must create a need among the users so that they continue to find mobile payments useful and eventually positively affect their attitude and influence their continuous intention to use...
behaviour. Furthermore, the easier it is to use a mobile payments service, the more the users may find that service useful.

REFERENCES AND CITATIONS


“SHARING WISDOMS FROM THE EAST”: DEVELOPING A NATIVE THEORY OF ICT4D USING GROUNDED THEORY METHODOLOGY (GTM) – EXPERIENCE FROM TIMOR-LESTE

Abel Pires da Silva, Centro de Estudos Estratégicos de Timor-Leste (CESTIL), abel.dasilva@alumni.anu.edu.au

Abstract: There have been repeated calls made for theory-building studies in ICT4D research to solidify the existence of this research field. However, theory-building studies are not yet common, even though ICT4D as a research domain is a promising venue to develop native and indigenous theories. To this end, this paper outlines a theory-building study in ICT4D, based on the author’s experience in developing a mid-range theory called 'Cultivating Sustainability' of E-government projects, a native mid-range theory of ICT4D. The paper synthesizes the GTM literature and provides a step-by-step illustration of GTM use in practice for research students and early career ICT4D academics. It introduces the key strategies and principles of GTM, such as the theoretical sampling strategy, the constant comparison strategy, the concept-emergent principle, and the use of literature throughout the study process. Then discusses the steps involved in the data collection and analysis process to develop a theory using case studies as sources of empirical data; it concludes with a discussion on using the strategies and principles in the three case studies. It is expected that this paper contributes to the diversification of research methodology, particularly to our collective quest for developing native and indigenous theories in the ICT4D research domain.

Keywords: Theory-building, ICT4D, GTM, Case study, Timor-Leste.

1. INTRODUCTION

Theory development studies in ICT4D have long been encouraged to legitimize and recognize the existence of ICT4D as a separate academic discipline (Sahay & Walsham, 1995). However, progress has been slow on this front (Avgerou, 2017; Walsham, 2017). It has been noted that most ICT4D studies are focusing on the description of findings and the use of theory to help explain their findings (Lin et al., 2015). Few published studies have attempted to develop any forms of theory based on empirical evidence extracted from ICT4D initiatives/projects.

Even though GTM's use in the information systems (IS) field research has proliferated in the last decades (Wiesche et al., 2017), its application in the ICT4D area remains low. Even fewer are the guidelines for theory-building studies in the ICT4D context. This paper aims at promoting theory development studies in ICT4D by showcasing a process to develop a substantive theory called “Cultivating Sustainability” of E-gov projects, using GTM and the case study method. The theory itself has been discussed thoroughly by Da Silva & Fernández (2020), and this paper focuses on the methodological aspects of the theory-building process. According to Straub (2012, p. v), “a native (indigenous) theory is a theory specifically developed to describe, explain, predict, or design IS [or ICT4D] phenomena”. As this theory-building study was based on three E-government projects in Timor-Leste, a developing country, the theory is a native theory of ICT4D.

The paper contributes in two ways: (1) synthesize the GTM literature (using data collected from case studies) for research students and early career academics, and (2) provide a step-by-step illustration of GTM use in practice. It is expected that the theory development process outlined in this paper may be used as a reference for future studies to develop more native theories of ICT4D

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and also to identify and construct *indigenous* theories in ICT4D based on the local wisdom of the societies living in the less-developed countries (LDCs).

This paper *first* presents an overview of GTM, its strategies, and principles, its data collection and analysis process, *then* outlines the use of GTM to develop a substantive theory in ICT4D using data from three (3) case studies of E-government projects; and *lastly*, the conclusion.

2. **GROUNDED THEORY METHODOLOGY (GTM)**

GTM was first introduced more than 50 years ago by Barney Glaser and Anselm Strauss in 1967 and is now one of the most widely used qualitative research methodologies in IS research (Wiesche et al., 2017) and also globally (Birks & Mills, 2011; Gummesson et al., 2007). Out of the main three variants of GTM available, the Glaserian (classic) GTM was adopted in this paper simply because of its close adherence to the original teaching of the GTM introduced by Glaser and Strauss (Glaser & Strauss, 1967).

In GTM, theories are developed inductively from data through the incremental and systematic progression of knowledge based on real-life cases (Glaser & Strauss, 1967). Thus, the theory will be able to explain the subject studied, fit, and relevant to that particular research topic. The inductive process of exploration also facilitates our understanding of complex organizational phenomena (Locke, 2001; Martin & Turner, 1986; Ven & Poole, 1989), such as the complex change process that takes place when delivering ICT4D technologies in LDCs (Avgerou, 2001). Also, the theory is modifiable as new data are collected (Glaser, 1998). The inductive theory development process is the main differentiating factor between GTM and other qualitative research methods (Urquhart et al., 2010).

3. **GTM AND CASE STUDY**

In GTM, data collection and analysis are conducted simultaneously (Urquhart et al., 2010); however, GTM only specifies the analytic strategy and not the methods for data collection (Charmaz, 2003). For this reason, this study follows Walsham’s (1995) discussion on the use of GTM in interpretive case study research to collect primary data.

The integration of a case study in GTM and its validity and reliability has been thoroughly discussed by Diaz-Andrade (2009); therefore, this paper focuses on the mechanization of the theory-building process. The use of case studies is essential for IS/ICT4D researches because it brings the focus of study on 'contemporary phenomenon within a real-life context' (Yin, 2009, p. 2); as such, it is ‘well-suited to capturing the knowledge of practitioners’ (Benbasat et al., 1987, p. 370). The combination of GTM and case studies allows researchers to link their research with the latest developments in practice (Benbasat et al., 1987). Thus, it enables the achievement of dual objectives of rigor and relevance because the theories developed are firmly grounded to empirical reality (Benbasat & Zmud, 1999; Fernández & Lehmann, 2005; Glaser & Strauss, 1967).

In conducting a GTM study using case studies, it is crucial to begin the study with a single case called the foundation case that serves as the gateway to the theory development study in the proposed research topic (Lehmann, 2001). Subsequent cases will be selected based on the results of the first case.

4. **GTM DATA ANALYSIS PROCEDURE**

In GTM, the analytic strategy can be best presented as a package that guides a researcher from the first moment entering the field (where the researcher still has very little knowledge of the research subject) to the final publication (where the researchers have become theorists in their respective areas); the package detailed steps is known as 'double-back steps' (Glaser, 1998).

The double-back steps are described as moving back and forth throughout the research activity (Glaser, 1978, p. 16) and include data collection, open coding, theoretical sampling, memo writings...
to facilitate the coding and sampling process until the emergence of the core concepts. The core concepts then guide more selective coding, sampling strategies, and memoing. These double-back steps continue iteratively until the findings are saturated, at which point the analyst continues to the sorting of memos to produce theoretical frameworks. After the sorting step, the analyst starts working on the publication of the research findings.

Throughout the research process, GTM researchers are guided by the following two strategies and one principle: (1) ‘theoretical sampling,’ (2) ‘constant comparison’ strategies, and (3) the ‘conceptual emergent’ principle. These three characteristics are facilitated by the use of ‘memo writing’ and engagement with the literature. The following sub-sections discuss these characteristics of GTM.

4.1. Theoretical Sampling Strategy

The theoretical sampling strategy is the backbone of the GTM process to generate theory where data collection, coding, and analyses occur simultaneously. When using case studies, there are two main sampling strategies used in GTM: the 'intra-case sampling strategy' and the 'inter-case sampling strategy' (Fernández & Lehmann, 2011). The intra-case strategy focuses on ‘selecting more “slices of data” from within each case to saturate concepts and maximize their conceptual yield’ (Fernández & Lehmann, 2011, p. 9). Once no new findings can be obtained from one particular case, the next stage of sampling is to include more data from other cases (inter-case sampling). The selection of the new cases is guided by the findings that emerged so far from the existing case(s). Data collected from this inter-case sampling strategy will help to confirm and/or revise emergent (core) concepts and their properties, thus, help to saturate the findings (Fernández & Lehmann, 2011; Glaser & Strauss, 1967).

In order to develop theory, the data is analyzed in two phases (Christiansen, 2007; Glaser, 1978): 'substantive coding', which takes place during both the intra-case and inter-case sampling, and 'theoretical coding', which mainly takes place during inter-case sampling. Substantive coding is the coding in the substantive area with the primary aim to produce 'core concepts' in the area being studied. Two coding processes take place at this stage: first, the ‘open coding’ and then the ‘selective coding’ process. Open coding is the first coding process used to openly code data until the core concepts have emerged from data. This open coding process involves a rigorous investigation of data to generate concepts based on a set of empirical indicators by constantly comparing the data (Glaser, 1978, p. 62). The comparison continues: (1) between indicators, (2) between indicators and concepts, and (3) between concepts until the core concepts emerged (Glaser, 1978). These indicators may point to the existence of patterns of behavior, and the concepts can thus, be generated by naming these patterns.

Once the core concepts have emerged, the next step is to selectively code data only around the emerged core and its related sub-core concepts (selective coding process) until these concepts have been saturated. If there is more than one core concept emerged, the researcher has the freedom to select the most suitable concept for further investigation. Once the saturation has been reached, the next step is to focus on developing relationships between the core concept and its properties (sub-core concepts and their properties). This step is the ‘theoretical coding’ phase in the theoretical sampling of GTM (Glaser, 2005).

4.2. Constant Comparison

As discussed in the last sub-section, the constant comparison strategy is central to the GTM analysis process because it is ‘the driving technique of GTM’s data analysis [and] the facilitator of theoretical sampling’ strategy (Urquhart and Fernández 2013, p.225). Glaser (1978) sets three types of comparisons in GTM to develop the theory: first, indicator to indicator to establish underlining uniformity and its varying conditions, both uniformity and the conditions are in the form of concepts; second, comparison between emerged concepts and more indicators, thus, generating new theoretical properties of the concepts; third, between the emerged concepts to produce an even
higher degree of abstract concepts. This higher degree of conceptualization and the integration into the relationships (hypotheses) between concepts will produce a theory.

4.3. Conceptual Emergence
The double-back steps in the GTM research process discussed above will allow the full emergence of concepts that are truly developed from data. It is important to note that conceptualizations from data require the ability to ‘lift’ data to an abstract level to understand what is going on in data beyond a mere mechanistic effort to assign names into indicators (Glaser, 2002; Suddaby, 2006; Urquhart & Fernández, 2013). Conceptual emergence is an essential principle in GTM because, with it, the theory will explain the subject being studied, fit, and relevant to the research area. The theory will also be modifiable as new data becomes available (Glaser, 1998).

4.4. Memo Writing
Glaser (1978) emphasizes that memo writing in GTM studies is essential; it sits at the core of the theory generation process because ‘memos are the theorizing write up of ideas about codes and their relationships as they strike the analyst while coding’ (Glaser, 1978, p. 83). Memos also represent a researcher’s thinking process about ‘what is really happening in data,’ and the literature consulted so far and how they relate to each other. Thus, memos are constantly revised as new understandings of data are developed from new slices of data.

Birks and Mills (2011) suggests useful types of memos for conducting GTM studies, and these are ‘operational memos’, ‘coding memos’ and ‘analytical memos’: (1) operational memos are written to record and facilitate the researcher’s thinking about data collection and analysis process; (2) coding memos are written to explain what a particular code is, and the reasons behind the labeling of the code; and (3) analytical memos are written to record insights into conceptualizations developed from data and the relationships between concepts which will be integrated into the theory to facilitate ‘theoretical coding’ process.

4.5. Theoretical Sorting
The theoretical sorting step in GTM is conducted at the end of the study when the researcher is well into the fieldwork stage and has almost reached saturation (Glaser, 1978, pp. 116–127). Guided by the key question of ‘where does [this memo] fit?’, theoretical sorting of memo funds (that was developed throughout data collection and the analysis process) is a crucial step to formulate the emergent theory, and thus, it involves the sorting of concepts instead of data (Glaser, 1978, p. 116). This process involves a constant comparison strategy by moving back and forth between memos and the potential outlines of the theory, which in turn, produces more memos to be sorted. This process involves the promotion/demotion of concepts and facilitates the development of a core concept. This core concept might also be in the form of a process called the basic social process (BSP) in GTM’s term (Glaser, 1978; Glaser & Strauss, 1967).

4.6. Core-Concept and BSP in GTM
GTM studies focus on identifying the core concept of the studied phenomena (or core ‘category’ in GTM’s term). It is a concept that ‘sums up the pattern of behavior’, and thus, it is ‘the substance of what is going on in data’ (Glaser, 1978, p. 94). A core category (concept) is the highest level of a category (concept) because it “relates to most other categories and their properties, [and] through these relations the core category accounts for most of the on-going behavior in the substantive area being researched” (Glaser, 1998, p. 135).

Due to this explanatory power, the emergence of the core concept will help researchers focus and sort the theory around it and explain the phenomenon studied using as few concepts as possible (Glaser, 1978). One type of core category/concept is BSPs. This type of concept has a process-out explanation power and has at least ‘two or more clear emergent stages’ (Glaser, 1978, p. 97). BSPs also have core properties of ‘pervasiveness’ and ‘full variability’ (Glaser & Holton, 2005). BSPs are
pervasive because the concepts are fundamental, patterned processes in social organization, and thus 'unavoidable irrespective of conditional variations' (Glaser & Holton, 2005, p. 9). BSPs are also 'fully variable' because the concepts are abstract conceptualizations of data, which transcends beyond their original unit of analysis, and consequently, are stable and can account for change (Glaser and Holton 2005, p.10). Therefore, BSPs have the conceptual grasp and 'transcends, organizes and synthesizes large numbers of existing studies' (Glaser, 1992, p. 34). This power of BSPs becomes the main contribution of GTM studies because BSPs fulfill two prime attributes of theory: parsimony and scope (Glaser, 1992, p. 34).

4.7. Engaging Literature in GTM

In GTM, both ‘theoretical sensitivity’ and ‘keeping an open mind’ are essential parts of the methodology. Glaser (1992) states that theoretical sensitivity refers to researchers' knowledge, understanding, and skill to assist the generation of concepts from data. At the beginning of the study, theoretical sensitivity can be achieved through reading the literature (Martin, 2006; Urquhart & Fernández, 2013). However, researchers must keep their minds open when entering the field so that the sensitivity mentioned above will not contaminate their efforts to generate concepts from the data (Glaser, 1978, 2012).

Originally, as discussed by Glaser and Strauss (1967), there was a concern that the results of any literature review might potentially shape researchers’ ‘a priori’ conceptualizations and could cause bias in dealing with data collection and analysis processes. Consequently, the condition may prevent researchers from discovering the actual truth from data. However, there has been a shift away from this concern when Glaser (1978, p. 45) suggested that researchers can start with a general perspective with beginning concepts and field research strategies. The underlying argument is that it is possible for a researcher to access the literature without accepting it as the final truth (Walsham, 1995).

To facilitate the use of literature in GTM studies, Martin (2006) outlines four steps in engaging with the literature: (1) noncommittal, (2) comparative, (3) integrative, and (4) transcendent phase. These steps are discussed as follows:

4.7.1. Noncommittal

Glaser (1998) acknowledges the situation where avoiding literature is impossible, especially when the researcher is trying to fulfill PhD formal requirements or when the researcher is applying for a research grant. Therefore, Glaser (1998) suggests that the review of literature is conducted with the attitude of data collection, thus, treating the literature as data to be compared with other data obtained from the field in the later stages of the research. The review is conducted ‘on the fundamental understanding that the generated grounded theory will determine the relevance of the literature’ (Urquhart & Fernández, 2013, p. 230).

This noncommittal step helps the researchers avoid being committed to specific theories at the beginning of the research and the subsequent abandonment of the theories at a later stage when they became irrelevant to the emergent findings. For instance, Walsham and Sahay (1999) shared their experience where initially their study was influenced by structuration theory and social construction of technology. Later on, the study moved to focus on the actor-network theory (ANT); they shared that (p. 41):

“[T]he theoretical basis of the study evolved over time in response to both our deepening understanding gained through the collection of field data and our changing ideas concerning appropriate theory.” This valuable experience shared by Walsham and Sahay (1999) highlights the importance of the ‘open-minded principle’ (no preconception) in GTM.

4.7.2. Comparative

The next level of literature engagement in the GTM study occurs, when based on the data analysis, it is found that the data obtained have relevancies with parts of the literature for comparisons
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4.7.3. Integrative

During the mature stage of the theory development process, it is time to engage with the relevant literature at the theoretical level of comparisons to formulate the final theory.

4.7.4. Transcendent

The primary objective of literature engagement in this phase is to develop a formal theory that transcends the substantive theory (Martin, 2006). In this 'transcendent' phase, the researcher, guided by the data collected, engages with more literature beyond the substantive area being studied, such as psychology, sociology, and others.

In summary, GTM provides a set of principles and strategies for the data analysis process, which covers: (1) how to code (open and selective coding processes), (2) how to sample for more data (theoretical sampling strategy), which is guided by the emergence of concepts from data, (3) how to engage with the literature throughout the study, and (4) the whole process is facilitated by the use of memo writings.

5. THEORY BUILDING EXPERIENCE USING CASE STUDIES

Based on the above discussion on GTM data collection and analysis processes, this section discusses an example of a theory-building study using data collected from three (3) case studies in Timor-Leste. This example of GTM use is presented in two main stages: first, the data collection process, which involves how case studies are selected based on their data richness, their similarity, and their differences, and second, the data analysis process, which involves how the collected data are analyzed according to the GTM procedures presented in the previous section.

5.1. GTM using Case Study: Data Collection Process

During the early stage of the research, several potential cases were identified using publicly available information from the official websites and news outlets. In the end, based on theoretical sampling strategy, three case studies were selected in this study.

Table 1 summarizes the characteristics of the three case studies. Following the research ethics protocol of this study, all names of individuals, projects, and institutions are presented using pseudonyms.

<table>
<thead>
<tr>
<th>First Case: Alpha Project</th>
<th>Second Case: Beta Project</th>
<th>Third Case: Gamma Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Implemented in the finance sector</td>
<td>• Implemented in the justice sector</td>
<td>• Implemented in the education sector</td>
</tr>
<tr>
<td>• Funded by the host institution</td>
<td>• Funded by a donor country</td>
<td>• Co-funded by UN agencies (Delta and Epsilon)</td>
</tr>
<tr>
<td>• Proprietary system</td>
<td>• Open-source system</td>
<td>• Open-source system</td>
</tr>
<tr>
<td>• Supplied by a for-profit multinational corporation</td>
<td>• Supplied by a for-profit multinational corporation</td>
<td>• Supplied by individual international consultants</td>
</tr>
</tbody>
</table>

Table 1: Summary of Characteristics of the Three Case Studies

At first, the initial concepts identified in the preliminary literature review were used as ‘a beginning foothold’ (Glaser & Strauss, 1967, p. 45) for this research to facilitate the early identification and
selection of the first case (the foundation case). A foundation case is a case selected from significant ICT4D projects, one that will provide the initial set of data for this study.

In this study, the first case was selected based on its potential data richness because the Alpha project has the following characteristics: (1) the E-gov technology was implemented in a very crucial area within the Government of Timor-Leste, the Finance Ministry which handles the State’s annual budget execution process, (2) the project was funded by the host government, and (3) the E-gov technology was delivered by a for-profit multinational enterprise based in Canada.

Using the theoretical sampling strategy, the second case was selected based on findings that emerged from the first case; and then the final case was selected based on the combined findings of the previous cases. For each case, data were collected using interviews, observations, informal conversations, electronic correspondence, and relevant project documents.

5.2. GTM using Case Study: Data Analysis Process

The data analysis process in this research followed the double-back steps outlined in the earlier section. The following strategy and principles in GTM are used throughout the analysis process: theoretical sampling strategy, constant comparison, conceptual emergence, memo writing, theoretical sorting, and the use of literature throughout the study. These sets of steps interplay with each other throughout the three case studies.

5.2.1. First Case Study: Alpha Project

The process of selecting this first case already involved the theoretical sampling strategy because the Alpha case was selected based on its potential data richness. The specific GTM data analysis process for this case is summarized below.

**Theoretical Sampling Strategy:** In this first case, the sampling strategy involved only one strategy: the ‘intra-case sampling strategy’, because the focus of data collection was to develop and saturate concepts and their properties within this case only (Fernández & Lehmann, 2011). It is within this case that the 'substantive coding' process of GTM took place. At first, it solely involved the 'open coding' process, where data were analyzed openly to allow possible concepts to emerge. Later on, when the main concepts and their properties (project phases and sub-processes) had emerged, data sampling and coding were conducted selectively based on the emergent concepts ('selective coding'). This process continued until data had repeated itself and data collection from different sources yielded no new concepts and/or properties. Memos were used to record understanding of data (alteration/confirmation of concepts).

**Constant Comparison Strategy:** The primary strategy used throughout the data analysis process was the comparison strategy. For each interview/observation transcript, the author openly conducted the analysis process by investigating the transcript line by line, sentence by sentence, or paragraph by paragraph, and so on, to develop concepts. Each new indicator that pointed to a specific concept was constantly compared with other indicators. At the same time, any new potential concept was also compared with existing concepts to determine their differences and/or similarities. This process allows to either: (1) confirm or revise an existing concept, (2) develop a new concept that fits the indicator, and (3) develop a higher level of concept if the new indicator pointed to the existence of a concept that is higher than the existing concepts. This coding process continued until the main pattern emerged and the core concepts were developed.

From this Alpha case, one pattern emerged from data: all project stakeholders are trying to deliver an E-gov technology wanted by the Minister. There were also three main project phases identified together with their sub-processes in each of the project phases.

The pattern and core concepts and their properties were constantly compared to new slices of data from this case until data repeated itself and yielded no new higher abstract concepts. This means that the existing core concepts became saturated.
The use of literature in the first case: Literature was also used in this Alpha case with the primary objective of comparing the emergent concepts with the previous findings in the literature; this step is called the comparative stage (Martin, 2006; Urquhart & Fernández, 2013). For instance, the concept of forms of capital by Bourdieu (1986) emerged as a valuable input to further fine-tune the analysis process when it was becoming clear that all of the actors involved had an interest in the forms of capital.

When saturation has been reached in the intra-case sampling stage, it is time to bring in more ‘slices of data’ from other cases (the ‘inter-case sampling’ strategy). The next case should have maximum differences compared to the first case to increase the potential for the emergence of new concepts and/or properties of concepts. It has to be noted that these “maximum differences” between projects must be within the focus (scope) of the research, which is the E-government projects in Timor-Leste. For this reason, the Beta case was selected.

5.2.2. Second Case Study: Beta Project

A foreign donor country funded the Beta project, and the system was delivered to institutions in the justice sector in Timor-Leste. This E-gov technology was delivered by a multinational open-source enterprise based in the United States of America and India. The specific GTM data analysis process for this case is summarized below.

Theoretical Sampling Strategy: In this second case, the sampling strategy involved mainly the ‘inter-case sampling strategy’ because the focus of data collection was to confirm, reject or revise the concepts and their properties that emerged from the first case (Fernández & Lehmann, 2011). Within this case, the primary coding process was still the ‘substantive coding’ and involved mainly the ‘selective coding’ process because the coding was based on findings from the first case.

A new pattern emerged from this Beta project implementation where all the stakeholders are trying to deliver a sustainable E-gov technology to the institutions in the justice sector. However, data from the Beta case confirm that the three main project phases emerged from the Alpha case. For this research project, the second pattern was selected as the primary focus simply because this finding fits with the overall concern in the ICT4D research on the sustainability issue of the ICT4D initiatives. This process continued until data had repeated itself, and further data collection from different sources, in this case, yielded no further concepts and/or their properties. The subsequent case, the third case, was selected to confirm and enrich the findings that emerged from the previous two case studies.

Constant Comparison Strategy: In the second case, the constant comparison was also the primary strategy used. The coding process continued until the core concepts, and their properties were developed. The pattern and core concepts and their properties were constantly compared to new slices of data from this case until data repeated itself (saturation of data).

The use of literature in the second case: In the second case, literature is also used with the primary objective of comparing the emergent concepts: the comparative stage (Martin, 2006; Urquhart & Fernández, 2013). In this case study, the author began to engage with the literature on sustainability issues in ICT4D research. When saturation has been reached in this first inter-case sampling strategy because no more new concepts or properties of concepts emerged from data collected from this second case, it was time to bring in more ‘slices of data’ from other cases (Fernández & Lehmann, 2011). Similar to the first inter-case sampling strategy for the second case, the next case should also have maximum differences compared to the first and second cases to increase the potential for the emergence of new concepts or properties of concepts. For this reason, the Gamma case was selected.

5.2.3. Third Case Study: Gamma Project

The Gamma case was also selected using the theoretical sampling strategy, based on its maximum differences compared to the first and second cases. The Gamma case was co-funded by two United Nations (UN) agencies operating in Timor-Leste, and the system was delivered to the Timorese
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Education Ministry. Different from the two previous cases, the E-gov technology in the Gamma case was delivered by individual international consultants. The specific GTM data analysis process for this case is summarized below.

**Theoretical Sampling Strategy:** Same with the second case, the sampling strategy in this third case involved mainly the 'inter-case sampling strategy' to confirm, reject or revise the concepts and their properties that emerged from the first and the second cases (Fernández & Lehmann, 2011). Within this case, the primary coding process was still 'substantive coding' and involved mainly the 'selective coding' process based on findings from the first two cases. This process continued until data had repeated itself and yielded no further results that may be sufficient to confirm, revise or reject the existing concepts (or their properties). At the end of this case study, the analysis in this research project was based mainly on the 'theoretical coding' process to develop relationships between concepts that emerged from the three cases.

**Constant Comparison Strategy:** In the third case, the constant comparison strategy was also used. This coding process took place by constantly comparing the existing pattern in the Gamma case and the core concepts that emerged from the second case until data repeated itself and yielded no new higher abstract concepts. This means that the existing core concepts have become saturated. In this Gamma case, another project pattern emerged where all the stakeholders are trying to deliver the E-gov technology sponsored by the UN agencies. However, there were no further significant findings emerged to alter or enrich the findings developed previously.

**The Use of Literature in the Third Case:** At the end of this third case, the existing core concepts that were developed in the first and second cases had been saturated. During this mature stage of the theory development process, it was time to engage with the relevant literature at the theoretical level of comparisons to formulate the final theory (Urquhart & Fernández, 2013).

This study developed a substantive theory of "cultivating sustainability" of E-gov projects in developing countries based on the three case studies. This theory explains how an ICT4D project, specifically an E-gov project, can be designed in a way to achieve its sustainability throughout the project implementation process.

6. **CONCLUSION**

This paper outlines the concepts around GTM and showcases a theory development process using data collected from three E-gov case studies in Timor-Leste. There have been a few theory development studies conducted in the ICT4D area (Avgerou, 2008; Heeks, 2006; Sahay & Walsham, 1995). Therefore, the theory development process presented in this paper serves as a reference for research students and early career academics in the ICT4D area to explore potential research methodologies for their research. In the end, it may help to encourage new studies to develop more native and indigenous theories of ICT4D. Thus, allowing us to share the pearls of wisdom of societies in developing countries with the rest of the world.

**REFERENCES**


Abstract: Although digital technologies are contributing to human development, several information systems (IS) interventions for development, especially in developing countries, do not perform as expected nor deliver anticipated outcomes at scale. This raises questions about how to develop and enhance resilient IS for development, an area that requires more research attention. A sound and systematic understanding of the mechanisms local communities apply to maintain resilience and the key transformation areas for a resilient IS development will help to improve the situation. This study addresses how stakeholders can ensure resilient information provision within the Agricultural Extension Information Service (AEIS) and identifies the challenges in designing resilient IS. Conceptually, the study draws from the IS resilience framework. Empirically, it draws from interview data collected from the AEIS provision practice in Ethiopia. The findings show the robustness, self-organization, learning, redundancy, rapidity, scale, diversity and equality mechanisms, the challenges and the key transformations required to advance the resilience of IS for AEIS. The study contributes to the conversation on the application of the IS resilience framework in analyzing local information provision practices as well as to practice highlighting the key transformation areas to improve the effectiveness and impact of AEIS.

Keywords: Resilience, Information Systems, Information Services, Agriculture Extension, Resilient Information systems, ICT4D, Digital Development.

1. INTRODUCTION

The contribution of information and communication technology for development (ICT4D) is widely acknowledged in the literature, although its role in achieving sustained impact remains debatable. Some ICT4D projects fail (Heeks, 2002) and/or lack critical resilience properties (Heeks & Ospina, 2018). To address this, several approaches have been tried. For instance, participatory design strategies that define users’ right to be involved in the process of design and that give some power to users (Carroll & Rosson, 2007) are proved to be firm-centric and not ideal for IS solutions in the ICT4D domain (Walsham, 2010). Others focused on analyzing how ICT can foster “development” (Sahay et al., 2017); improving inclusion and participation of marginalized subjects (Masiero, 2018); and context-specific ICT4D theorizing (Qureshi, 2015; Avgerou, 2017; Andoh-baidoo, 2017). While these efforts have contributed to the advancement of the ICT4D subfield, research on resilience within the ICT4D field is limited (Heeks and Ospina, 2018). In the same token our understanding of the mechanisms that would help to figure out building resilient IS for AEIS is limited. This is because ICT4D is embedded in a multi-faceted socio-technical reality that involves several stakeholder interactions across structures (Atinaf et al., 2020). This complexity requires unraveling resilience maintaining mechanisms, challenges and
transformations, an area that needs further investigation particularly in the agricultural context, which is the main stay of economy and employment for most developing economies.

Specifically, the contributions of local practices towards AEIS resilience, the key transformations required as well as the challenges towards problematizing the development of resilient information systems for AEIS has yet to be investigated. This study addresses this need guided by the following research question: How do stakeholders in an AEIS system ensure resilient information provision and what are the challenges to design resilient IS for AEIS? The objective is to identify how stakeholders ensure resilient information provision within the agricultural extension service by overcoming the challenges through transformative actions to develop resilient IS for AEIS. Such an understanding is important both for identifying relevant systems affordances and deciding the scope and nature of future interventions (Lewis, 1992).

The AEIS interest for this research is in Ethiopia, where agriculture is the backbone of the country’s economy and the source of livelihood. It constitutes more than half of the country’s GDP; accounts for over 80% of the labor force; and is a major source of export earnings (Atinaf et al. 2020). The AEIS in Ethiopia is designed to deliver a wide variety of agriculture related information services and is characterized by a complex service ecosystem with a range of stakeholders that differ in education, participation, and capacity (Barau & Afrad, 2017; Atinaf et al., 2020). The Ethiopian AEIS eco-system therefore provides an ideal setting to explore the mechanisms local agents and practitioners apply to enable the resilience of information services provision within a multi-stakeholder environment. It also offers the opportunity to reflect on how the circumstances of a particular context influences and is influenced by the attributes of resilience (Heeks & Ospina, 2018; Davison and Andrade, 2018).

The rest of the paper is organized as follows: the next section provides a background to the domain of IS resilience. This is followed by description of the research methodology employed in our empirical study. Next, we present the findings and results from analysis of the empirical data. We then discuss the results and findings based on the resilience attributes and markers. The final section presents the implications of our study to a resilient AEIS system.

2. BACKGROUND LITERATURE

Both supply and demand considerations that balance institutional and technical elements are important to enhance the sustainability of ICT4D initiatives (Pade-Khene & Lannon, 2017). Nevertheless, the sustainability of ICT4D interventions are challenged due to supply driven perspectives that focus on augmenting the supply side resources and that develop IS that reflect the values and views of suppliers (Sahay & Mukherjee, 2017). Supply driven perspectives introduce complex dependencies on resources, ignore the agency of users, the role of institutions, and many other demand-side conditions (Sahay & Mukherjee, 2017) and do not sufficiently focus on the resilient attributes of information systems (Heeks & Ospina, 2018) that are critical to offer sustainable services. This indicates that the concept of resilience has not received much attention in the ICT4D domain, where the focus has been more on one-way or two-way communications, digitizing existing flows and processes than reengineering and supporting multi-stakeholder networks (Heeks & Ospina, 2018). This approach is against the trends in agricultural research and development process which emphasize the importance of multi-stakeholder engagement and participatory approaches (Adekunle & Fatunbi, 2012).

The concept of resilience in IS is multi-dimensional implying a perfect reliability (that is free of failure) is impossible (Sakurai & Kokuryo, 2014). However, the situation can be improved by focusing on the need for resilient IS (Sakurai & Kokuryo, 2014) that can cope with disturbances at different stages (Müller et al., 2013). Thus, resilience should not be viewed as a static phenomenon but something to be improved and developed through time. IS research has also seen resilience from three important perspectives. The first views it from a technical perspective with a focus either on the post disaster property, such as recoverability, of a system (Wang et al., 2010; Zhan &
This paper follows conceptualization and framework of resilience for the ICT4D domain as the “ability of a system to withstand, recover from, and adapt to short-term shocks and longer-term change” and one that avoids continuing systemic inequalities (Heeks and Ospina, 2018, p6). Avoiding systemic inequalities is particularly relevant for poor farmers’ access to agriculture extension and information services. Heeks and Ospina’s (2018) resilience framework is composed of foundational and enabling attributes. The foundational attributes consist of robustness, self-organization, and learning and the enabling attributes are composed of redundancy, rapidity, scale, diversity and flexibility, and equity attributes. Heeks and Ospina (2018) also identify markers that characterize each of these attributes (Table 1).

<table>
<thead>
<tr>
<th>Resilience attributes</th>
<th>Description</th>
<th>Markers</th>
</tr>
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<tbody>
<tr>
<td><strong>Foundational Attributes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Robustness</td>
<td>Ability of the system to maintain its characteristics and performance in the face of contextual shocks and fluctuations</td>
<td>Physical preparedness; Institutional capacity; Loose functional coupling</td>
</tr>
<tr>
<td>Self-organization</td>
<td>Ability of the system to independently rearrange its functions and processes in the face of an external disturbance</td>
<td>Collaboration and consensus-building; social networks and trust; local leadership</td>
</tr>
<tr>
<td>Learning</td>
<td>The systems’ capacity to generate feedback to gain/ create knowledge, strengthen skills and capacities necessary to experiment and innovate</td>
<td>Capacity building; new and traditional knowledge; reflective thinking</td>
</tr>
<tr>
<td><strong>Enabling attributes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Redundancy</td>
<td>The extent to which components within a system are substitutable</td>
<td>Resource sparseness; resource substitutability; functional overlaps</td>
</tr>
<tr>
<td>Rapidity</td>
<td>Accessing and mobilizing assets quickly to achieve goals in an efficient manner to ensure the system’s ability to respond to external stressors timely</td>
<td>Rapid issue detection; rapid issue assessment; rapid issue response (resource mobilization)</td>
</tr>
<tr>
<td>Scale</td>
<td>The breadth of assets and structures a system can access to effectively overcome/bounce back from/adapt to the effects of disturbances</td>
<td>Scale of resource access; multilevel networks; intra-level networks</td>
</tr>
<tr>
<td>Diversity and flexibility</td>
<td>Availability of a variety of assets knowledge, institutions, and institutional functions that enable a range of response options to external stressors, both short- and long-term</td>
<td>Variety of courses of action; adaptable decision-making; innovation mechanism</td>
</tr>
<tr>
<td>Equality</td>
<td>The extent to which the system affords equal access to rights, resources and opportunities to its members</td>
<td>Equality of distribution of assets; inclusiveness and participation; openness and accountability</td>
</tr>
</tbody>
</table>

**Table 1: Framework of Resilience (adapted from Heeks & Ospina, 2018)**

The AEIS is a multi-stakeholder information service. It requires identifying key players (Haythornthwaite, 1996) who would champion the ICT initiatives (Renken & Heeks, 2018) to justify the continued existence of information (Haythornthwaite, 1996). Hence, based on Heeks and Ospina (2018) framework, this research will explore the current mechanisms of information service provision in the Ethiopian AEIS, the prevalent challenges and issues and the key transformations to improve the resilience of IS for AEIS.
3. RESEARCH METHOD

The study is based on a qualitative case study as such an approach gives an advantage to focus on the real-life experiences and contexts of the phenomenon (Yin, 2009; Eisenhardt & Graebner, 2007) in environments where users’ context of action is critically important (Benbasat et al., 1987). Data are collected as part of a wider project, partially presented in Atinaf et al (2020), from the stakeholders involved in the AEIS system.

As reported in Atinaf et al (2020, p 5) “qualitative data were collected through interviewing a range of stakeholders at one AEIS system locale from the “Amhara” Regional State of Ethiopia. Ethiopia is [administratively] divided into different administrative structures called regions, which are further divided into administrative zones. A zone has a number of “Woredas” in it. The “Woreda” administrative unit is composed of “Kebeles”, the lowest units in the administrative. The [AEIS] is led by the Federal Democratic Republic of Ethiopian (FDRE) Ministry of Agriculture and is typically composed of the Regional State Agriculture Bureau, Zonal Agriculture Office, “Woreda” Agricultural Extension Office, Development Agents (DAs), Farmers’ Associations, and Farmers.” Other organizations are involved in supporting the services, these include, “research centers, local cooperative offices, seed producing organizations, and Unions of Farmers Associations. The [AEIS] involves the above stakeholders operating at different levels where farmers are the primary beneficiaries of the services. Data collection took place in early 2017 by using theoretical sampling approach complemented with the snowballing technique to identify potential interviewees. The interviews started from the Director and Agricultural Extension Department Head of the “Amhara” Region Agricultural Research Institute to discuss the overall AEIS in the region.

In total, 20 individual and group interviews with 29 participants covering the Heads of local agriculture extension and woreda cooperative offices, development agents, farmers, and other key informants from farmers association, research centers and head of Information Technology unit at the Agricultural transformation Agency (ATA) are conducted. See Atinaf et al (2020, p 5) for profile of interviewees.

Data are first transcribed and then translated from Amharic language to English language. The translated data is checked against the transcription by a language expert to ensure meaning was not lost during translation. Data analysis starts with thematic coding technique (Saldaña, 2009) following the foundational and enabling attributes of resilience (Heeks & Ospina, 2018)

4. RESULTS

The findings are presented with three primary goals: to identify the mechanisms the AEIS community applies to ensure foundational and enabling resilience attributes, the challenges encountered, and the transformations needed to overcome these challenges. This is followed by a discussion of the resilience attributes and resilience markers.

4.1. Foundational Resilience Attributes

4.1.1. Robustness

Erratic weather conditions and pests are some of the shocks the AEIS stakeholders face. These shocks which are not planned a priori in the AEIS system are addressed by applying community information sharing practices. For instance, informants from Development Agents, the Research Center, and Research Institute mentioned that, even if the ATA pushes information from the center to the stakeholders, farmers have their own mechanisms of producing pesticides and have convincing arguments regarding their agricultural practices such as sowing seeds and farmland plowing to fight crop disease. Moreover, the farmers use their social structure and local knowledge to manage unplanned disturbances such as shortage of expert support. For instance, an expert from a Woreda office indicated
... it will take us two days to give support for smallholder farmers in a single rural kebele when most of them will be engaged in similar and seasonal activity. We will use farmers’ development group leaders as experts to give support to others and communicate the information to be applied by the smallholder farmers.

4.1.2. Self-organization
The AEIS system is organized as a self-helping community to respond to the problems that its members face. One of these is its structure and the defined roles that members have within this structure. The stakeholders include the farmers’, development agents, farmers’ associations, subject matter specialists, researchers, and farmers’ development groups. The roles of these stakeholders are presented in Table 2. The stakeholders participate in exchanging contextually relevant information tailored to individual fields, taking the divergent concerns of the stakeholders into context through discussions and supervision, continuous interactions, and via their growing actor networks. The stakeholders apply these defined roles to re-arrange themselves as self-support communities in order to put the functions of the agricultural extension information provision functions in place.

<table>
<thead>
<tr>
<th>Key Actor</th>
<th>Role in Agricultural Extension Information Service</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farmers</td>
<td>Use information; identify and communicate experiences, concerns, challenges, and issues and problems to adopt new technologies</td>
</tr>
<tr>
<td>Development agents</td>
<td>Information brokering and transferring development work programs to farmers, communicating concerns, challenges, issues, and technology priorities of farmers to SMS and researchers</td>
</tr>
<tr>
<td>Farmers’ association (FA)</td>
<td>Announcing market price information and marketing schedule to farmers; communicate availability of agricultural input and other machinery technologies to farmers</td>
</tr>
<tr>
<td>Subject matter specialists</td>
<td>Providing information to farmers and DAs; communicate solution information to problems and issues, communicate development work programs to DAs</td>
</tr>
<tr>
<td>Researchers</td>
<td>Identifying farmers’ technology needs and technology intake and creating awareness on the technologies, information to DAs and SMS via trainings</td>
</tr>
<tr>
<td>Development groups (DG)</td>
<td>Develop and communicate concerns, challenges, and issues of smallholder farmers via group leaders; assist and support farmers by providing information in the absence of DAs; disseminate input and other agricultural technology needs of farmers to DAs</td>
</tr>
</tbody>
</table>

Table 2. Actor in the agriculture extension service

4.1.3. Learning
The AEIS community has its own ways of capacity building mechanisms such as the use of the social structure of the farmers to enable learning from each other. There is horizontal and vertical information exchange across the structures that involve individuals, institutions, and groups/collectives to facilitate the learning via the community’s local languages. This is used as a strategy to empower members of the stakeholders in the AEIS system with skills and knowledge of agricultural practices. The mechanisms applied include direct observation, discussions, trainings, meetings, joint activities, supervision. A development agent in an interview indicated,

... we will attend meetings with the smallholder farmers whenever they assembled together for their own purpose and make discussions on issues related to their farming practices.

Stakeholders apply farmers’ field observations, group discussions to devise solutions for their own problems, organize trainings on selected issues, and perform activities in groups, and supervision of smallholder farmers and other stakeholders along the social and institutional hierarchy.
4.2. Enabling Resilient Attributes

4.2.1. Redundancy

Substitutability of access to agricultural extension information is ensured via applying various information delivery mechanisms. These mechanisms offer advantage of redundant access to agricultural extension information which at the same time provides inclusive access to the needed information by members. The information exchange mechanisms applied include word-of-mouth public announcements, service encounters, publications on paper and web portals, supervision, training, broadcasting over radio and television, discussions, and joint activities. The use of mobile phones and the ATAs’ Interactive Voice Response (IVR) system is a prime example to the substitutability of the AEIS. For instance, an expert at the Woreda office indicated the following:

*Many farmers have mobile phones with them or household members, and we use mobile phone calls to communicate urgent information with stakeholders.*

These information exchange mechanisms enable redundancy of information provision functions with different forms of presentation, access from different sources, and through different devices to improve availability or reliability of AEIS. The stakeholders in the AEIS system make scare resources abundant via these mechanisms to address problem of dependency on single source.

4.2.2. Rapidity

The speed of information access, assessment and mobilization of information is routed through mobile phone calls as well as the social and institutional structures. Stakeholders apply mobile phone calls to meet the urgent needs of information. An interviewee from the development Agent indicated that

*‘farmers usually call over our mobile phones when they need information urgently.’*

However, it doesn’t mean that every smallholder owns a mobile phone and has access to experts in the AEIS, a challenge in fulfilling rapidity. The social structures within the farmers’ villages are instrumental to these communities in routing agricultural extension information rapidly to members. The Development Groups in the rural Kebeles facilitate the flow of information within the AEIS system so that everyone has access to contextual information needed. This structure is organized based on gender and age into the men development groups, women development groups, and youth development groups. Smallholder farmers use this semi-social structure as a platform to circulate information rapidly in addition to using it as a learning mechanism in the AEIS system. Moreover, the farmers associations formed by farmer members are used to disseminate market related information to members. Board members and farmers who take leadership positions in the farmers associations and the rural Kebeles take the prime responsibilities in communicating such information.

4.2.3. Scale

Agricultural extension information is contributed and used by different stakeholders. The individual farmers, farmers’ development groups with its multi-level structure, the development agents, subject matter specialists at a higher administrative level, the researchers from research institutes, and the farmers associations are involved in the information exchanging process. Members within this social and institutional networks interact vertically (top-down and bottom-up) across structures and horizontally within a specified structure. The social and institutional structures can be easily scaled up and grow to form networked actors. This network is available to respond to stakeholder’s queries of help and support related to AEIS both to the members as well as to others across the structure. The stakeholders are connected each other to enable the network to grow or scale and functions at any scale within the administrative structure.
4.2.4. Diversity and Flexibility
Diversity and flexibility of agricultural extension information exchange is enabled through the application of different mechanisms. For instance, the ATAs' IVR-based system which delivers agricultural extension information via mobile devices, the social structures within the stakeholders which acts as a self-help group, and the use of other forms of extension information communication are prime examples. Other agricultural extension information provision mechanisms that mark flexibility and diversity include word-of-mouth public announcements, mobile phone call, service encounters, publication, supervision, training, broadcast media, discussions, and joint activities. For instance, a farmer indicated that:

... when I hear important information, I will announce it to the villagers. Board members of the farmers associations do the same thing to circulate information that should be addressed to other farmers.

However all forms of these diversity and flexibility markers is not suitable to all stakeholders. A project director at a university working to enhance knowledge of DAs asserted the situation as follows:

Information and knowledge exchange platforms, such as the Ethiopian agricultural web portal, is highly scientific operating at a national level in an environment where agricultural practice is affected by different ecological and social factors.

4.2.5. Equality
The extent of equal access to AEIS cannot be described based on the empirical data as there is a precise marker for it. However, there are markers in the AEIS system that shows equal access to information. Agricultural extension information is a needs-based service and offered based on stakeholders’ desires. The organization of the development groups at different levels, constructing service encounters at Kebele offices, and a volunteer-based farmer associations are markers for equal access to AEIS. Though it is a volunteer-based public service, there are challenging conditions facing smallholder farmers in accessing expert personnel when there is a need to.

4.3. Challenges and Issues in the AEIS System
The findings also show some persistent issues that challenge resilience of the AEIS including the current IS for AEIS. These are related to existing agricultural IS and IS development methodologies, access to basic AEIS, digital literacy, and access to market information.

4.3.1. Information Systems Development Methodologies
Challenges and issues in the current computer-based IS being used for AEIS are categorized into two. The first is related to lack of tools for guiding the design and development of the information systems. Supporting this respondent at the ATA told the following:

In our country, there is a culture of designing IS based on what comes to our mind all of a sudden; it is the same in this ATA project. The project doesn’t follow software development/software engineering principles, lacks documentation, and there are problems related to integration and scale up.

The second is reflected in the existing IS and the extent to which they incorporate information from stakeholders, facilitate automatic and effective information transfer, and are sufficiently stocked with relevant agriculture extension information. Information received by the smallholder farmers are hardly sourced from farmers themselves. For instance, although farmers have developed their own pesticides and arguably effective farming practices, existing IS designs are limited to include such information into current agricultural extension practices.

Poor information transfer is also manifested in the IS content stored in the ATAs’ system as it relates to meeting the stakeholders needs. Supporting this, a developer at ATA reported that, ‘content stored in the IS is updated every six months and provides too general recommendations’.

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Moreover, the system is criticized for lacking features to support the stakeholders’ roles in their day-to-day activities. The challenge of information transfer is also associated to transfer of insufficient information packages and recommendations related to farming technology. An informant from the Research Institute stated this as:

*For a specific technology, millet, applying the standard package of the technology in the research center produced 40 quintals per hectare. The same amount of produce was gained in the farm trial phase too. When the technology is distributed to the farmers, the total produce from the same size of land was reduced to 10 quintals. The reason was inappropriate application of the technology package.*

### 4.3.2. Lack of/Limited Access to Basic Agricultural Extension Services

Lack of/ or having limited access to basic AEIS is another challenge affecting the effort made to offer effective public AEIS. The proportion of service providing personnel and institutions to that of smallholder farmer’s population, geographic distance, and commitment of those personnel and organizations remain the main limiting factors creating a divide. The empirical data also revealed that the gap gets worse during high agricultural activity seasons (for instance during sowing natural resources protection). Moreover, our data shows, those who are geographically near to experts or institutions have better access than those located at a distant. A farmer noted the extent of geographical barrier as

“*the problem is serious for female DAs who cannot walk for long distance and cross dense forests for security reasons and also farmers who are near to them seek information frequently and those from a distance do not.*”

A DA also supported this claim saying “*we get farmers who are near on a day-to-day bases and visit in two or three weeks’ time those who are far*”.

### 4.3.3. Digital Literacy

For the AEIS users, what is equally important to that of delivering digital content is adapting it to the literacy levels of the stakeholders. The stakeholders in the AEIS are composed of actors characterized by a mix of high- and low-level functional literacy, information literacy, and use of digital devices. For instance, key informants indicated their doubts on the capabilities of farmers to assimilate the information received to the context of their problems unless they are assisted how to put the information received into practice. In support of this, an informant, a project director at Bahardar University, working on information and knowledge provision to the Development Agents indicated the challenges they observed while using digital content as follows:

*Development agents have limitations in searching and using information and knowledge presented on digital devices and electronic sources.*

This excerpt shows the existing gaps among the stakeholders where those at the lower structure have issues of digital literacy to successfully apply the IS and use of digital devices.

### 5. DISCUSSION

The findings show that the current practice of the AEIS system is enabled with certain levels of resilience attributes with various information communication mechanisms. There are also significant challenges. Table 3 presents a summary of the mechanisms, challenges related to the mechanisms and the key transformations required to put a resilient IS for AEIS in place.

<table>
<thead>
<tr>
<th>Resilience attributes</th>
<th>Current mechanism</th>
<th>Challenge</th>
<th>Key Transformations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Robustness</td>
<td>Use of stakeholders and the social structures; local knowledge available within members; the ATAs’ IVR-based IS</td>
<td>Lack of standard to apply local knowledge; too general information from the ATAs’ IS</td>
<td>Consider empowerment of stakeholders at different levels to better serve their community</td>
</tr>
</tbody>
</table>
Table 3. Summary of the current mechanisms, challenges, and key transformations

There is evidence of self-learning and development of capacity among the smallholder farmers and development agents to respond to their problems with no/little external support. The AEIS system is organized with identified roles to facilitate such learning. The social structure, namely the smallholder farmers’ development groups, is purposefully designed to fill the void that would happen due to lack of access to expert services in the AEIS. This supports the findings of Haythornthwaite (1996) who reported actors in the social system as the sources for both information/knowledge and social support/influence. Such self-learning within the social actors allows inclusive and sustainable learning through sharing and adoption of diverse and collective social practices among themselves and with others (Kapuire et al., 2017; Kendall & Dearden, 2017). This implies that actors in the AEIS are not passive users who pull information for consumption or use information pushed but active participants of the functioning of the service. Enabling this in the IS designs for AEIS would provide the advantage suggested by Kendall & Dearden (2017), i.e., the shift from packaging and transmitting information towards facilitating communication among actors.

The self-organization resilience property in the AEIS community is a much needed property as agricultural practice is context specific. Hence a solution can be sustainable if it is tailored to individual fields or regions and can adapt to local agronomy practices and social conditions (Leeuwis, 2004). It is necessary to take the divergent concerns of actors in designing and building an effective system and to have a sense of shared ownership (Monk and Howard, 1998). This is possible when such interaction and supervision dominated service system operated by interconnected actors with defined roles is enabled. Such a structure can be easily adaptable to actors’ networks and scalable to include new members and nodes. This is one of the markers of

<table>
<thead>
<tr>
<th>Self-organization</th>
<th>Stakeholders and members enabled to play roles in circulating contextually relevant information; discussions and supervision; continuous interaction</th>
<th>Role overlaps, limitation to support every farmer during seasons of intensive agricultural activity</th>
<th>Enabling actor networks and agency, and interaction of stakeholders</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning</td>
<td>Use of social structures to facilitate horizontal and vertical information exchange; facilitated via direct observation, discussions, trainings, meetings, joint activities, supervision</td>
<td>Difficult for some smallholder farmers to apply information received and apply the mechanisms to every smallholder farmer</td>
<td>Enable agency of stakeholders (individual, proxy, and collective agencies) to enable interaction and participation</td>
</tr>
<tr>
<td>Redundancy</td>
<td>word-of-mouth public announcements, service encounters, publications, supervision, training, broadcast via radio and television, discussions, and joint activities</td>
<td>Highly scientific content through portals, reachability issue due to missed broadcasts</td>
<td>consider implementation at any level of the administrative structure (lower-level, middle-level, or top-level)</td>
</tr>
<tr>
<td>Rapidity</td>
<td>Mobile phone calls, Social and institutional structures; farmers associations; Board members</td>
<td>Problems to get access to some stakeholders</td>
<td>Consider stakeholders as information contributors and resource integrators</td>
</tr>
<tr>
<td>Scale</td>
<td>The multi-level farmers structures; institutional structures at various administrative levels</td>
<td>Increased complexity in communication as networks grow</td>
<td>Consider implementation at any level of the administrative structure</td>
</tr>
<tr>
<td>Diversity and Flexibility</td>
<td>Public announcements via word-of-mouth mechanisms, face-to-face discussions, service encounters, publication, and radios and television</td>
<td>Different functions and formats of information</td>
<td>Consider stakeholders literacies, and access to devices</td>
</tr>
<tr>
<td>Equality</td>
<td>Needs-based and voluntary service; the farmers social structures that involve every smallholder farmers</td>
<td>Lack of motivation to continuously seek information or to visit service encounters</td>
<td>Enable inclusive designs to incorporate every stakeholder into the service as beneficiaries</td>
</tr>
</tbody>
</table>

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self-organization that can enable to find immediate solutions to problems. Actors’ networks and complex interactions foster technical, social and institutional change in agricultural innovation (Klerkx et al., 2012). The effort to put equity resilience property ensures inclusive AEIS provision through creating equal access to agricultural extension information within the AEIS community.

Information provision through different mechanisms enables the diversity resilience property of IS (Sakurai & Kokuryo, 2014). However, IS which are not applied in the daily-life of actors are less effective to put resilient systems in place (Sakurai & Kokuryo, 2014). Mobile applications installed on devices which stakeholders are familiarized with can be considered useful in this regard. Application of such common infrastructure enabled by universality and ubiquity provides advantage of uniqueness and unison goals to enable resilient IS (Sakurai & Kokuryo, 2014). The given diversity improves the redundancy and scale resilience properties of information provision. Agriculture in its nature is considered as a co-evolutionary process involving interactive development of technology, practices, markets and institutions of growing network of actors (Klerkx et al., 2012) as a marker of scale. The stakeholder networks in the AEIS can be created and applied at different levels of administrative structures. This enables implementing redundant systems at different administrative structures (Kebele, Woreda, Region or National level) that could be accessible to other locations during times of shock. Though the above mechanisms are valuable in offering some properties of resilience there are challenges hindering to put a successful ISs for AEIS. For instance, information published on portals gets obsolete as it may not be updated as frequently as possible (Leeuwis, 2004).

The challenges and issues affect the equality in accessing the public service AEIS and prevent stakeholders from accessing services equally and to build inclusive AEIS systems. The problems related to the lack of design guidelines for the practitioners and the other issues reflected in the IS itself contributed to the lack of resilience features in the current ISs for AEIS. The one, namely problems to incorporate content from stakeholders into existing systems, poor information transfer mechanisms, and lack/limited stock of services are critical to building resilient ISs for AEIS systems. The challenge of information transfer also include issues that made services inaccessible/unreachable to some sects of the community; the low commitment of the development agents and development group leaders, and other supporting institutions; and the travel distance that the service seeker or provider is expected to move or the geographical distance where the service centers are located. The social tie that a farmer has to key members in the social network and to experts in the organizational structure determines his/her access to AEIS. The low level of digital literacy explained by a combined low level of functional literacy, information literacy, and digital literacy complements the above challenges and the transformation towards a resilient IS for AEIS. These challenges attest the packaging and pushing of information from a center with an assumption of the receiver can change it to the desired outcomes do not hold true always. Because, information is expected to be processed or adapted by an actor in order to achieve the intended outcome (Wahid et al, 2017) and the mentioned challenges limit this capability. Transformations are required to advance the resilience of the IS for AEIS. Such transformation can be in the areas of designing the IS to enabling some capabilities and its implementation. The enabling aspect should consider empowerment of stakeholders at different levels, enabling actor-actor-networking and interaction, and enabling digital agency within the AEIS. Implementation of the design is required to consider some level of universality such as: possibility to implement the IS at any level of the AEIS structure, considering stakeholders as key content contributors and resource integrators, considering literacies levels of the target stakeholders and access to computing devices, and inclusion of the stakeholders to get access to basic public agricultural extension services.

6. Conclusion

This research applied the resilience framework to explore how the stakeholders of the Ethiopian AEIS system maintain resilience of information provision and the challenges and issues which
could be considered as short and long term shocks) they encounter. Some of the transformation required to withstand and adapt the challenges are also identified. The resilience of IS for AEIS could be enhanced if they can facilitate interaction and communication among networked actors using devices stakeholders are familiarized with and taking into account their literacies and other characteristics. Therefore, building resilient IS for an AEIS system requires understanding and transforming foundational and enabling resilience attributes. Specifically, it is important to identify actors and actor-network along with their roles to enable ownership, interaction and communication within/across the social and institutional structures, and agency of actors.

The study contributes to the conversation on the application of the IS resilience framework in analyzing local information provision practices. By so doing, it adds to the empirical base of the ICT4D resilience framework literature and can be used to encourage and compare findings from other studies that follow the same line of enquiry. The results of this study can also contribute to kernel theories to develop IS design theory for AEIS. To practice, it highlights the key transformation areas to improve the effectiveness and impact of AEIS.

REFERENCES AND CITATIONS


Towards a Resilient Information System for Agriculture Extension Information Service


APPROPRIATION, COLONIALITY, AND DIGITAL TECHNOLOGIES. OBSERVATIONS FROM WITHIN AN AFRICAN PLACE

Gertjan van Stam, Masvingo, Zimbabwe, gertjan@vanstam.net

Abstract: This paper provides an assessment of experiences and understanding of digital technologies from within an African place. It provides philosophical reflections upon the introduction and existence – appropriation – of digital technologies. Digital technologies are inherently linked to a colonialising power and, in general, unaligned with local, African ways of knowing. Imported technologies are set in modern, universalised doing and unsensitive to the importance of aligned being in African contexts. Sensitivities, it is argued, can be fostered by a decolonial turn, where focus shifts from the individual to the community.

Keywords: Africa, digital technology, decoloniality

1. PREAMBLE

This paper contributes on the theme of decolonisation in information systems. The paper approaches matters from transdisciplinary (Du Plessis, Sehume, & Martin, 2013) and critical ethnographic angles (Madison, 2012). The argument is built by linking Heidegger’s views on appropriation to the field of digital technologies and reflect from the author’s 20 years of longitudinal observations on digital technologies and academics in African places (van Stam, 2017b, 2019b). Experiences in the natural world and humanities were interrogated and reflected upon following the living research method (van Stam, 2019a). Research, analytics, and dissemination were primed in orality (Mawere & van Stam, 2017; van Stam, 2017a) and communities (Mawere & van Stam, 2020).

This work aligns with a dynamic and integrative epistemology, integrating differentiated experiences, embodied understandings, value judgements, and actions while residing in rural and urban areas in sub-Saharan Africa (Bigirimana, 2017). The work is embedded in a reflexive science where observations, experiences and learnings amalgamate through reflection and introspection, facilitated by theory (Burawoy, 2009). The aim is to recognise patterns and wrestle African understanding out from under a Eurocentric gaze, as acts of decolonisation (Hlabangane, 2018) and epistemic liberation (Buskens & van Reisen, 2016; Grosfoguel, 2011). As such, the work seeks centred, inclusive, multifaceted understandings, emancipation of polyvocality (the consideration of many voices), diversity and multiple perspectives, from an African positionality (Adamu, 2020).

2. INTRODUCTION

The philosopher and phenomenologist Martin Heidegger (1996), in his seminal work Being and Time, uncovers an important field of inquiry when assessing information and communication technology (ICT)-driven innovations, decolonial perspectives, and the experiences of people who hegemonic narratives keep at the margins of ICT development discourses. This field concerns the appropriation of being. Heidegger’s appropriation refers to how existence – what is – reveals itself, by itself, without being influenced by any specific categorisation (Mei, 2009).
Reflecting on how we know what exists is an important precursor when assessing the role of digital technology in indigenous contexts. It involves uncovering biases in how realities emerge and how they reveal themselves, a field where literature cognisant of African worldviews emerge (van Stam, 2017b, pp. 40–47). Negating such a reflection signals ignorance, or is an act of actively forgetting (Sheehan, 2015). In his efforts to gain an understanding of how reality reveals itself, Heidegger found he could not ignore the issue of appropriation. This resulted in, among other things, the emergence of his critical view of technology (Heidegger, 1977). The appropriation of ‘mobile’ telephony in Africa is well explained through constitutive appropriation, which is where systems and artefacts are imported and integrated into the lived experiences of individuals and communities (Odumosu, 2018). Here, the word constitutive is added to indicate the holistic and embedded nature of the act of appropriation of the technology, for instance, in Africa. Heidegger’s critical ontological positions seem to resonate with views on technology that emerge from Africa unframed by Western hegemony (Mavhunga, 2018). Like work done in Australia (Schultz, 2018), African studies reflecting on Heidegger’s establishment-challenging views on technology and those emerging from Africa, through conversations and embedded and decolonial thinking, can augment the indigenous journey to digital technologies that are plural and hospitable.

Reflections on the issue of the appropriation of technologies and practices is conspicuously absent in digital technologies, especially in situations of export of technologies. In many African cultures, the manner in which a person or action has been introduced defines subsequent engagements (du Toit, 2009). The introduction positions a new entity with an identity in the past and a current and future network of relationships. Therefore, the introduction has political implications. The introduction is the start of a continuum of shared being (having a relationship). The negation of how digital technologies have been introduced does, therefore, limit gaining understanding of its relational position and the way it is perceived to contribute to the social tapestry in African places. Unfortunately, global arrangements in digital technologies are universally characterised – limited – by widespread ‘techno-think’ and ‘techno-do’ (Sheehan, 2015). Positioning digital technologies as self-explanatory or as a silver bullet overlooks the fundamental mismatch of cultural views on its raison d’être. The omission of a careful introduction of digital technologies and failing to address the question ‘how do we think we know’ results in ambiguity on the position of digital technologies in African social structures and among African authorities. This insensitivity links in with a long history of the commodification of African humanity and a disrespect for political authorities and metaphysical perspectives in Africa (Banda, 2019). Therefore, the question of appropriation is crucial when digital developments are contemplated or proposed, as it influences whether or not such interventions can be successfully exported from one philosophical realm to another.

Understanding what digitalisation means necessitates assessing how it came about and which authority is vouching for – introducing – its appropriation. These are important issues with significant ramifications in digital practice in Africa, as digital technologies are more than mere tools. Digital technologies sustain an environment and structures a way of performing functions in societies (Akrich, 1997). These observations need careful assessment, as the failure to consider digital technologies’ social embedding is reminiscent of the introduction of technologies to aid colonial practices.

"[African p]hilosophy [...] is a critically aware explorative appropriation of our cultural, political, and historical existence. (Komo, 2017)"

Philosophy will necessarily have a political dimension. It is naïve to think that philosophy is politically neutral. So, the struggle for liberation becomes the main challenge of every African philosophy which pretends to be hermeneutics. It has to be the hermeneutics of this particular historical situation in Africa – colonialism and neocolonialism: “[...] unlike Heidegger, for us, the question of our existence, of our “to be”, is an inherently political question. (Serequeberhan, 1994)"
When considering the cross-cultural setting in which digital technologies and interventions based upon such technologies manifest, Heidegger’s abstract philosophical ruminations force the practical question that frames this paper: How are digital technologies affected by coloniality? And, subsequently aiming for usefulness: How can we decolonise digital technologies in Africa? These questions refer to, among other things, the transfer of the cultural consciousness into computer systems and computer human integration. In relation to this, digital services are viewed as a natural extension of the society they serve (Yacob, 2004). In this line of thinking, digital technologies are not just positioned as entities that fill a void (by their sheer existence reifying themselves) but positioned as an agency that aims to augment what is already in place. Of course, in Africa, digital services arrive in already populated spaces of specialists, structures, systems, and practices. Digital technologies do not liberate Africa from a condemned past, as per the rhetoric of development, driven by its need for change and innovation, but can be relationally positioned to improve on what is going well.

The African philosopher Achille Mbembe regards the contemporary technologising of the world as a means of spreading Western culture to the rest of the world (Mbembe, 2017). In his paper Bodies as Borders (Mbembe, 2019), he describes a computable speed regime, where society is organised around the forces and energy derived from computability. This self-perpetuating regime thrives on normative descriptions in a mathematical language, which are, in turn, transposed into algorithms for derivations. He links this focus on quantifiable information and governance through calculations to how technology is used to set up mobile, portable, omnipresent and ubiquitous delineations and borders. In this sense, technology functions as the means by which the West manages the Rest (Adamu, 2021; Mamdani, 2012). Mbembe’s observations of people being controlled through technology are not new. The Americans Paul Dourish and Scott Mainwaring (2012) point out how the thoughts underpinning ubiquitous computing are inherently colonial. They argue that this thinking metastasises technologies to act redemptively based on the following assumptions:

- The need to ‘civilise’: Centres of power (hubs, labs) are geared towards assisting places perceived as ‘lacking’.
- Superiority: Development is undertaken by people/entities that are assumed to be knowledgeable or powerful.
- Universality: What works here can be applied there, with same results.
- Reductive truth: Comparison, evaluation, understanding and prediction follow from quantification and statistics.
- Future making: Centres of power/the developed are the blueprint for progress in other regions, for the developing.

The risk in these assumptions is that those who assume that they possess power define what is true in terms of the thinking by those who are subdued (Mamdani, 2012). Such external truths cause a clash of paradigms, also in digital technologies (Mawere & van Stam, 2015).

Technologies carry expressed values, from the site of their conceptualisation to the place of deployment (Feenberg, 2005). This imposition of culture through technology is easy to understand when assessing drones or killer robots, but less obvious when implementing digital apparatus like mobile phones and Wi-Fi routers, or interacting with applications that exist by virtue of the dashboard. It is no wonder that the Cape Townian Shaun Pather and his Latin American co-author Ricardo Gomez (2012), in an evaluation of years of publications on information and communication technologies, were prompted to wonder: ‘Do we ask the right questions?’

Current philosophies of science and the resulting methodologies and mainstream academic practices seem not to recognise, or uniformly negate, inputs from African conceptions (Mawere & van Stam, 2015). Dominant science and technology theories are predominantly Western (Harding, 1998). From this exogenous gaze, in digital technologies, African communities are often approached as non-
agentic spectators. In such a view, of course, scientists and foreign specialists feel warranted to develop and implement solutions that they deem best. Although doing good is set in method and attitudes of benevolence, its judgement is set by intellectuals and professionals operating in frames derived from a knowledge system foreign to Africa. This knowledge solidifies in methods and policies on how one should think about the materialisation of the digital and use in African contexts. This orientalistic system obscures the fact that judgement of what is best is set by dominant, imperial powers in an Eurocentric thought positioned to explain others (van Stam, 2020). Such a patronising Eurosplaning does little, if anything, to align with analysis and judgement from African knowing and viewpoints (Adamu, 2019). The resulting digital solutions can only be sustained by (en)forced attention. Prime examples of forced attention are workshops in which attendants are being paid to attend and the setting of agendas on development, training, measurement and evaluation according to priorities and measures of success enforced from the outside.

African communities do harbour appropriate knowledge, embedded in and from the context. This knowledge outlasts any contribution by someone from the outside, who comes and is prone to leave at any time (soon). In contrast, when digitalisation emerges from within it is sustained through ownership by local communities (Bidwell, 2020).

African knowing is not only subalternised, it is generally not recognised, unwanted and seldom asked for (Jeater, 2018). When reviewing publications by non-African scientists, one hardly finds reference to the thinking and contributions of Africans. However, in academic works produced in Africa, one can see many references to non-Africans and explicit reference to contributions set in non-African philosophies. The disregard of African philosophies and practices by the dominant philosophies of science is discomforting when residing in Africa. It represents an epistemicide of African meaning making (Grosfoguel, 2010, 2013; Mawere, 2014; Nyamnjoh, 2012). Scholars such as Mexican Enrique Dussel (Dussel, 2000) and South African Mogobe Bernard Ramose (2016), among others, call for the resurrection of local ways of knowing and respect for the underlying worldviews. Such an orientation can withstand the uncritical import of Eurocentric paradigms in Africa. Mind boggling questions arise, such as: How can we decolonise digital technologies based on philosophies that have hardly, if any, African input? And, even when recognising this chicken-and-egg problem, how can we provide decolonised digital technologies in general?

3. AN AFRICAN NARRATIVE

The definition of colonialism is, like most definitions, set by the powerful. Although there are numerous definitions, the common denominator is that they are all proposed from the perspective of the coloniser. When assessing colonialism from the perspective of the colonised, it looks quite different. Colonialism, in this perspective, is a circular scheme of shaming, brainwashing, and conditionality, in other words: derogative judgment, demands for mimicry, and shackling (van Stam, 2017c). In Africa, contemporary dominating practices manifest as super-colonialism – a scaled-up version of old-style colonialism, perpetrated not only by countries sustaining a capitalist elite, but more so by corporations and international organisations acting as if they were sovereign (Mbare, 2019). The practices of super-colonialism can be seen in the workings of the global monetary system, international trade treaties, and the monopolisation of cyberspace. All of these systems strive to keep Africa subjugated and dancing to its tune (Mamdani, 2012). From this perspective, the importing of digital technologies and interventions from outside Africa is set in the continuation of the colonial narrative of bringing civilisation and modernity to a presumably dark and backwards Africa.

In addressing the issue of decolonisation in higher education, South Africa has been a torch bearer. Under the banner of the #RHODESMUSTFALL and #FEESMUSTFALL movements, students in South Africa have demanded decolonisation in higher education (Nyamnjoh, 2016). Although norms seem to be changing, it remains challenging to talk about conquests, the common praxis of ontological and epistemic violence, and, ultimately, an imperial academy with a long history of suppotng colonial acts. The significant benefits resulting from the continuing extraction of Africa’s resources, including data, provides no incentive to recognise the colonially-inspired structure of
contemporary information systems and their architectures (Mawere & van Stam, 2016a). A comparison between the old colonial shipping routes and the architecture of the Internet reveals an incredible similarity. The architecture of the Internet resembles the global information society as it was created in the 16th and 17th centuries, in which information was collected in African and brought in ships to knowledge centres in the West, where it was analysed and used (Mawere et al., 2019). Contemporary Internet infrastructure follows the shipping routes that colonial operatives used to extract this information.

Some describe the act of decolonisation as doing the right thing – whatever that may be. This is a questionable concept, as the causes of doing are set in character and how one conducts oneself. In turn, character is set in histories of experience, understanding, judgements and action. Addressing domination needs inspection, retrospection and introspection. Therefore, decolonisation requires an accurate and honest assessment of power, privilege, history and the present. Ethics dictate that, regarding digital technologies, we must:

[…] think through what it might mean to design and build computing systems with and for those situated at the peripheries of the world system, informed by the epistemologies located at such sites, with a view to underming the asymmetry of local-global power relationships and effecting the ‘decentering’ of Eurocentric/West-centric universals. (Ali, 2016)

This is not a task for the fainthearted. In fact, it can put one’s position in the (colonised) society on the line. There is a lot of resistance to positions that challenge dominant standpoints and the status-quo. There is no easy fix for social injustices like racism, discrimination, and (digital) inequality. Unfortunately, the process of judging often reifies the problem.

4. THE ACADEMY

Academia, especially in Africa, appears to thrive on copy and paste practices. For instance, the philosophies and methodologies valorised through hegemonic and universalising lenses are often uncritically transplanted and regurgitated as good science in Africa. The contemporary practices of parachute researchers crowd-out the work of academics in their local context (Bockarie, 2019; Mawere & van Stam, 2019).

The hegemonic, Eurocentric academy is regarded as a veritable institution – part of the system of good governance of knowledge, also in Africa. And yet, this academy has consistently failed to live up to this promise, as it invariably reinforces dominant narratives about a Eurocentric modernity (Koch & Weingart, 2016). As a result, universalised science does not hold true in most African contexts. In practice, it often serves as a vehicle for conquest and control (Mawere & van Stam, 2019). Subsequently, the academy is not understood by the majority of people in the so-called periphery. Being discarded to the margins, there are few ways of holding an imperial academic elite accountable for not respecting African ways of meaning-making.

Although there is much diversity in academy, it appears that many academics fear the label activist. They adhere to the dichotomy of theory and practice. Clearly, theoretical outcomes result in the rearranging of power in practice: technologies configure who can do what and where. This makes technology (e.g., cryptography and artificial intelligence, which are important technical components) political tools (Rogaway, 2015). Therefore, science must consider appropriation and the moral dimensions of its exploits (Murphy & Ellis, 1996). Unfortunately, Eurocentric structuring underpins ivory tower academics, a situation that is rarely questioned in Africa (Mawere & van Stam, 2019). A significant part of the academy believes that science is inherently good and value independent, although indications to the contrary are mounting. Apparently, many academics are unaware of the long and guilty history of upholding the Terrible Three: an othering orientalism, hegemonic imperialism and occupying colonialism (van Stam, 2017b), often in the name of the mythical concept of modernity (Dussel, 2000).
African study centres in Europe started off supporting colonial conquests. However, this history is overlooked in their external communications; apologies for their support for the colonial project have not been forthcoming. The brainwashing of “hegemonic education can exist only so long as true and accurate information is withheld” (Asante, 1991, p. 177). The battle for hegemony takes place in African education; here the adoption and regurgitation of Eurocentric, soulless, calculable reasoning and knowledge is being primed, because “…the curriculum [is] the terrain of the struggle for the transformation of the educational paradigm” (Ramose, 2003, p. 140). It is clear that decolonisation is relevant in every nook and cranny of society, and thus also in the digital realms, as its technologies replicates its underlying models of thinking.

5. TECHNOLOGY AND DECOLONIALITY

Most power structures, including those in academia, are the continuation of the colonial matrix of power, set in hegemonic epistemologies and systems (Ndlovu-Gatsheni, 2013). When assessing the powers-that-be from a colonial perspective, it appears that colonialism never ended (van Stam, 2017c). Africans are continually being shamed, brainwashed and usurped by hegemonic, foreign-inspired socio-economic narratives and structures. In addition, Africans are increasingly the subject of imported techno-social systems under the guise of securitisation. Digital platforms seek to analyse every African word and breathe to fuel the apparatus of their super-colonial masters. Corporate entities seeking to know it all are operating as de facto sovereignties and transnational institutes, or colluding with security forces from the centre (Greenwald, 2014). The means of appropriating resources are being perfected in a super-colonialism enabled by ubiquitous connectivity that surpasses the colonialism that relied upon the Westphalian concept of a nation state.

While it is important to challenge Eurocentric epistemologies in texts, it is not enough to do so if structural and physical factors of the colonial world help create and maintain the same epistemology that scholars are currently trying to decolonise. (Richardson, 2018)

Inherited from the colonial ethnology and maintained by ignorance and lack of interest, prejudices about Africa still run high (D’Almeida-Topor, 2006). The structure of many digital developments builds upon a one-sided view of economics, democracy – or information and computing for development for that matter – that emerged from imperialistic practices (Ndlovu-Gatsheni, 2013). Academic practice appears rather amnesic to its coloniality (Grosfoguel, 2011). The seeking of African understandings of the meaning and framing of the topic digital technologies in Africa – in language, philosophy and worldview – is subdued and, when proposed, subalternised (Louai, 2012). This discordant situation is fuelled by a lack of comprehension of – and even contempt for – indigenous perspectives and narratives, and a general lack to seek such a comprehension (Arendt, 1968; Mawere & van Stam, 2017). Consequently, for Africa, in general, the prospective benefits from foreign research and development and the resulting technical assistance processes are problematic (Mawere & van Stam, 2019).

From his study of Frantz Fanon as a psychiatrist who wrote about psychology, Nelson Maldonado-Torres (2017) argues that a decolonial turn puts attitude over method. This results in a transdisciplinary practice that mixes well with decolonial activism. Current digital practices, however, position method before attitude. Attitude is soft power in action, gained from an accumulation of experiences, understandings, and judgements. Attitude is an aspect of dynamic, integrative meaning making (Bigirimana, 2017). Such a meaning making involves the ongoing accumulation of insights and interlinks action with values and ethics. The content of these components varies per location. It is different in Africa than in other areas of world (van Stam, 2012). Therefore, African understanding of digital technologies will be different to the understanding of digital technologies elsewhere.

A decolonial turn is fundamental and all encompassing. It represents a paradigm switch, not a paradigm shift (van Stam, 2017b). In Africa, paradigm switching allows an oriental projected self, linked with universalism, to be replaced by a locally-grounded African authentic self, linked with...
diversity. The oriental self is composed of normative statements that measure, classify, and datafy African lives. This essentialising (re)territorialises and creates social silos and spatial identities, as well as relationships between space and bodies on the basis of abstract universals. In contrast, the African authentic self is based on value epistemologies like ubuntu or ifa, being the crystallisation of African philosophies and communal love (Mawere & van Stam, 2016b). African identities are embedded in, for lack of better words, indigenous wisdom traditions and local, regional and diverse narratives of (trans)modernity.

In the I-Paradigm, the individual is the unit of analysis. An individual is a human being independent of social groups or relationships. This, of course, is a theoretical concept, as each person is intrinsically connected, having emerged into the realm of the living through a woman’s womb and existing in an interdependent web of relationships. In this definition, the proto-individual is a human being that views him/herself (and others view him/her) independently from his/her relationships – a specific (and solitary) self in a world consisting of many other distinct (and solitary) selves (van Stam, 2021). This understanding of individualism aligns with assessments of how Western culture and so-called modernity “calls for the limiting of oneself in one’s private, egotistical ‘me’, with a tightly isolated circle where one can satisfy one’s own urges and consumer whims” (Kapuściński, 2008). Individualism and universality seem to be the dominant paradigms that guide contemporary renderings of digital technologies. Universality is claimed by a normative epistemology, in which knowledge is positioned as certain, indubitable, infallible and incorrigible, as well as objective. This knowledge is acquired by a knower who is a passive and neutral spectator of a detached reality. As a result, such knowledge is proposed as an accurate representation of the real world, ready to be boiled down into formulas for computation.

In Africa, the single human being is understood as a person, a human entity within a social network of relationships with companions, ancestors, the living, and the yet to be born, as well as non-humans. Initiation confirms that the person understands what it means to be in union with society and the more extensive social system – what one’s part and position is within it. Grounded in those understandings, one’s rights can be exercised, and duties performed in connection and set in systems of moral behaviour according to the espoused cultural values. A person continually evaluates and adjusts their personal conduct to the known or assumed expectations of those with whom he or she relates. In this way, the person shifts the focus of their conduct from an individualised-self to a communal-self, contributing to the development and upkeep of shared values. A community is a gathering of persons who subscribe to shared set of values; it provides belonging, is the embodiment of values and beliefs, is ethically grounded, and exists in a confined area in which justice can be sought (van Stam, 2021).

The We-Paradigm – the paradigm of interbeing – sees universalised, normative knowledge as external to the community, and is quick to link such knowledge to external belief systems, power and domination. Dynamic, integrative knowledge, however, is what the community knows in connection (Mawere & van Stam, 2017; van Stam, 2013). Exogenous digital technologies appear to have great difficulty recognising such a paradigm, in which community is paramount, where knowing is an accumulation of insights, gained through the active involvement of the knower by experiencing, understanding, judging and acting, involving interactions within the whole organisms, not in isolated minds – and in which creative expressions like art, dance, ritual, and sculpture are considered among the highest forms of knowledge.

Universalised views on digital technologies continue to be proposed for deployment in contemporary situations in Africa. As they are conceptualised in line with interests positioned outside of Africa, this hegemony serves colonial interests. Decoloniality is, thus, a proper topic for contemplation in relation to digital technologies in Africa. Colonialism exists because of concepts such as individualism, the concept of a social contract, and the capitalist economic system. Upon switching the paradigm of perception from individualism (the I-Paradigm) to community (the We-Paradigm) – with its social-personhood –issues of colonialism fall away. The We-paradigm is incompatible with notions of supremacy, hegemony, and domination. It is grounded in notions of
progress, movement and the raising of consciousness, connected with emotions, senses and embodied experiences. The communal paradigm is, therefore, incompatible with colonialism. Switching paradigms in digital technologies is, thus, a redemptive act of decolonisation. It is an ideological switch from digital technologies set in self-proclaimed universal truths to a digitisation embedded in context, cognisant of communities and diversity, conviviality, grace, and frontierness. This type of digitalisation transcends a focus on individual benefits and the concepts that give rise to colonialism to put morality, human beings, values, listening and feelings in their rightful place – at the locus of meaning-making and subjective insights (du Toit, 2007), the centre of the synthesisation of the rational and imaginative, the immeasurable and quantifiable, and the intellectual and emotional.

A paradigm switch to community sets digital developments on a pathway towards diversity to foster unity and synthesis, transcendence (in time and place), and the reconciliation of seemingly incommensurable views. It results in digital technologies that contribute to a contextually-aligned understanding of what life encompasses. This involves the letting go of a digitisation that is solely seen through a universal lens and based on Eurocentric valorisation, in a self-consciousness that regards authenticity and the individual (and, therefore, individualism) as the primary agent interacting in communities. Decolonisation addresses issues of method, aligning the method of research and development with the geographical context and manner in which knowledge is pursued in that place. In Africa, methods incorporate the management of relationships (especially in situations of conflict), and the harmoniousness of relationships between humans, nature, and the divine (Louis, 2007).

Just as the idea that a universalised view of digital technology needs to be challenged, likewise, the appropriation of data and displacement of information from Africa to non-African centres of computing must be recognised for what they are: colonial practices (Harris, 1998). These notions are gaining traction in post-colonial studies in the humanities (Smith, 1999), however, they are not readily accepted in the natural sciences.

Digitalisation and its technologies sit at the intersection of the natural sciences and the humanities. The consideration of social and environmental justice is crucial in a world that appears to be headed towards ecological destruction. A decolonised digital realm values ethnocentricity and the reciting of stories that constitute being; it seeks to allow the appropriation that Heidegger described. For instance, artificial intelligence, considered a promising aspect of digital technologies, is a misnomer, as, for instance, machines have no notion of mortality (Olivier, 2017). Prioritising the social aspects of digital technologies allows knowing to emerge and assesses experience from ethical standpoints – it values the journey. Above all, it questions the function of (imported) methods and theories in African places. It acknowledges that information has many facets that need to be assessed in the local context for it to be inclusively productive and integrally helpful (van Stam, 2013). The illusion of universalising science – which is a location-dependent (European), historically-determined, contingent ethno-science – suffocates the voices, visions, and contributions of a great variety of other genuine knowledge systems and epistemologies from the many cultures in Africa. Acknowledging that all knowledge is local knowledge decolonises and takes the sting out of modernity’s pretence at monolithic trajectories for digital technologies.

African ways of knowing and gaining knowledge are important, and the world needs them (Metz, 2020; Salami, 2020). For instance, an African way of seeking consensus was used during the Durban Conference on Climate Change in 2011. During tough times, under enormous pressure, the climate conference in Paris in 2015 was pulled out of the muck using indabas, which is a type of conference or consultation practised in South Africa (Rathi, 2015). Although the strength of the accord is yet to be seen, it is clear that without the introduction of this African conversation technique, there would never have been an accord at all.

Some say that communal practices have been lost, communities are gone, and uniformity is the norm. Such a demise might well be witnessed in many urbanised worlds. However, as mentioned before,
in Africa, most people do not live in urban areas. Long-established communities have been cut by colonial borders, imported notions of nation-state, and migration (Otieno, 2018). This destruction of communities is being replicated in cyberspace. In African environments, the sense of community is certainly not lost. This puts a decolonised digital narrative at odds with hegemonic, universalised views.

6. CONCLUSION
In Africa, digital technologies cannot be governed by systems and methods of intervention that Africans have had no part in conceptualising. Over centuries, Africa’s precious contributions and vital experiences have been neglected in a Eurocentric academy and its off springs from their research and development. Such indigenous contributions and experiences are known within, and from, a communal paradigm. This has deprived digital developments of precious and important information. Paradigm switching replaces colonially-framed knowledge with something that is already in place: communal understandings of reality. Switching the paradigm from I to We is necessary in movements to decolonise digital technologies. Such a decolonised digital realm builds upon the strength of sharing, care, respect, and maturity.

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THE ICT4D-BUEN VIVIR PARADOX: USING DIGITAL TOOLS TO DEFEND INDIGENOUS CULTURES

Lorena Pérez-García. Cross Cultural Bridges, perezgarcia@crossculturalbridges.org

Abstract: Arguably shaped by political economy perspectives from the Global North, ICT4D aims to reduce socioeconomic disparities across countries and regions through ICT implementations, as well as to open up opportunities for empowerment and human development. Despite these aims, ICT4D has been criticized because 1) although ICT and internet have positive effects on societies across the Global North, their positive impact on people’s lives in the Global South cannot be easily proved; 2) ICT4D’s primary focus seems to be on ICT’s series of artefacts rather than on ICT’s positive transformative potential of living conditions in the world; 3) the type of development ICT4D aims for could mask global hegemonic interests and seek neoliberal restructuring within less socioeconomically favoured communities within the Global South. For these reasons, claim scholars, ICT4D should be revised. By presenting ICT appropriations among Wixárika peoples in Mexico to protect their sacred land, this paper aims to 1) shed a light on the need for postcolonial critical frameworks on what ‘development’ associated with ICT should be and 2) to foster discussions on whether ICT can enable alternative voices from the Global South to be heard, despite tensions between traditional views and contemporary technologies.

Keywords: Wixárika, Buen Vivir, México, Development, ICT4D, indigenous cultures, ICT affordances, ICT appropriations.

1. INTRODUCTION

Technological advances achieved in microelectronics and telecommunications since the early 1990s resulted in the proliferation of information and communication technology (ICT). Furthermore, with the migration from Internet 1.0 to Internet 2.0, ICT became ubiquitous, as technology allowed more user involvement. While technological advances brought about technology-driven political changes and socioeconomic development, in some societies ‘development’ programmes resulted in a transfer of wealth away from low-income regions (Escobar, 1995). Thus, while ICT has become central to the global development agenda of economic growth and democracy (Wamala-Larsson et al., 2015), ICT has also contributed to socioeconomic and political inequality worldwide (Heeks, 2010) due to ICT’s uneven distribution in the world.

To address this paradox, ICT for Development (ICT4D) emerged as an academic discipline and an institutional policymaking rhetoric to address inequality in developing regions and to enable economic development in developing and underdeveloped countries through ICT (Zheng et al., 2018; Wamala-Larsson & Stark, 2019). However, opting for the use of ICT to improve people’s living conditions involves a paradox, according to Kleine (2010), as ICT and internet are highly regarded inventions that have had positive effects across the Global North, they are perceived as an adequate solution to many social problems. Yet when it comes to obtaining funding for ICT4D projects and programmes in the Global South mainly, it appears to be not that simple to prove their potentially positive impact on people’s lives. Thus, institutionally speaking, the impact that ICT has on people remains an elusive issue (ibid). Moreover, the association of ‘development’ and ICT within the rhetoric of ICT4D has been criticised for masking global hegemonic interests and seeking
neoliberal restructuring within less socioeconomically favoured communities (Svensson & Wamala-Larsson, 2015).

2. RESEARCH PROBLEM, CONTEXT AND METHODOLOGY

While there are institutional and governmental ICT4D projects successfully implemented worldwide, there are also institutional projects that fail to accomplish their goals (Pérez-García, 2020). Among the causes of failures of ICT4D projects, scholars stress that the type of development expected from ICT implementations seems to have a close relationship with economic improvement, and might be therefore rather restricted, as – although hardly imprinted in ICT4D projects and practices – development can be the result of the accomplishment of several material, personal and community expectations (Kleine, 2010; Sarjo et al., 2014; Tshivase et al., 2016).

When focusing in Mexico, although a few institutional ICT4D projects have succeeded in urban and reasonably urbanized areas, records show that most government ICT4D projects fail in rural areas. Among the accounted reasons for failure are 1) the economic and digital divide among the population of the country; 2) limited ICT access and ICT availability; 3) the difficulties to get ICT services in rural areas, due to geographic and natural conditions (i.e. mountains and biomass density). Linked to the effects these situations can have on ICT users’ involvement, ethnic identity, literacy rates, digital literacy, and language ought to be counted as failure factors of ICT4D projects as well (Pérez-García, 2020).

In relation to ethnicity, scholars suggest that models of technological implementations may smuggle in neo-liberal values and goals of private wealth accumulation (Jiménez & Roberts, 2019). Also, growth-oriented neo-liberal development policies and ecological planning can be in some cases neo-colonial as well as environmentally unsustainable (ibid). Thus, uncritically applying approaches from the Global North in the Global South may subordinate indigenous knowledge, different ways of knowing, and diverse cultural values. Moreover, growth-orientated neo-liberal development could oppose to indigenous values, such as shared enterprise, communal interests, reciprocity and interconnectedness—all central to indigenous worldviews in Latin America (Kothari et al., 2016).

Regarding indigenous population in Mexico, over 50 different indigenous groups correspond to about 12% of the total population of the country. Pre COVID-19 pandemic, more than 70% of indigenous people lived in poverty conditions (about 40% in poverty, 32% in extreme poverty) (CONEVAL, 2016). Despite the structural violence associated to the poverty rate in which indigenous live, indigenous peoples use ICT – when available, and to some extent. By doing so they cover a basic need to communicate. Moreover, indigenous populations in Mexico, like any indigenous peoples from around the world, collaborate across social media and attract international support for their digital activism campaigns (Myers et al., 2020). Such campaigns focus mostly on restoring cultural identity and preserving natural resources (Young, 2018). Also, some indigenous groups may use information systems in ways similar to dominant society groups (e.g., to run tribal affairs related to finance, accounting, and member engagement). Yet, we should also consider that Indigenous groups and Westerners may conceptualize and use information systems in vastly different ways, which the academic literature does not always account for (Myers et al., 2020).

Thus –within a broader pluricultural effort to generate knowledge, to further understand ICT as a means to foster culturally diverse views on development and to bridge the digital divide in socioeconomically marginalised communities like the above described – this paper sustains the need to rethink ICT4D from a postcolonial perspective. By doing so, this research aims to contribute to document praxis and epistemological gaps between institutionalized ICT4D and successful indigenous ICT’s use by replacing the expectations set on ICT for economic development with an indigenous post-colonial biocentric view.
To examine how ICT enables alternative voices and critical frameworks from the Global South to be heard, this paper will focus on ICT4D-Buen Vivir (BV) – good living– paradox that resulted from ICT appropriation among the Wixárika Indigenous community in Mexico. BV is a broad philosophical framework that stems from indigenous Quechua and Aymara traditions; being part of native Latin American populations’ traditions, most contemporaneous indigenous views find support in it (Hernández-Díaz, 2018). Away from shamanism, animism and anthropocentric views on development, BV is a heterodox and hybrid view – already legally introduced in some Latin American countries – that comprises both traditional indigenous views and a critique to modernity. BV is an alternative order based on the coexistence of human beings across the spectrum of diversity and in harmony with nature (Hernández & Laats, 2020). It calls for a deep change of knowledge, affectivity (moral-social values) and spirituality (ethical values) to understand the relationship between humans and non-humans, without fostering separation between society and nature (Chuji et al., 2019). Altogether, these ideas could represent further possibilities for a substantial change vis a vis the current crises attributed to Western views on development, growth, maximization of production, competition, disproportioned use of natural resources, eco-destructive activities, minimization of the common good, and anthropocentrism. (cf. Hopwood et al., 2005; Yashar, 2005; Walsh, 2010; Vanhulst, 2015; De Sousa, 2014; Hollender, 2014, Gudynas, 2014; Chuji et al. 2019).

Although there is no singular view of BV among indigenous cultures in Latin America, traditional expressions referring to a ‘good living’ can be found throughout indigenous groups in the continent. In Mexico, indigenous groups appeal for lekilaltik, the ‘good of us’, from the Tojolabal people; lekil kuxlejal, ‘the good life’, from Tseltal populations; or Maseual’s yeknemilis, ‘good life’ (Hernández-Díaz, 2018). Although in this paper a case study from Mexico will be presented, Buen Vivir will be considered and no Mexican expression that appeals for the same as – in its general form – BV has already been linked to the creation of legal frameworks for the rights of nature, such as Ecuador’s political constitution, the European debate on happiness, well-being, the critique of economic growth, and has also been used in economic development programmes in Mexico. As these principles could provide alternatives to current development and environmental crises (cf. Pérez-García, 2020; Hernández & Laats, 2020), finding the link between ICT4D and Buen Vivir could hold considerable elements for reflection when aiming to examine how ICT enables alternative voices and critical frameworks from the Global South to be heard. To accomplish this goal, a qualitative interdisciplinary research with plural methodology with a post-development paradigm has been carried out. As a result, this paper is divided into four sections, as follows: Firstly, the literature to date on development associated with ICT4D will be reviewed, looking specifically at how neoliberalism, globalisation, development, and ICT are being represented as a plausible solution socio-economic inequality. Although not yet broadly associated with ICT4D, Buen Vivir will be taken into consideration. Moreover, the indigenous pursuit of postcolonial and culturally inclusive notions of development through ICT will be introduced with ethnographic research carried out to document the use of ICT by Mexican Wixárika indigenous people. Drawing upon these sections, the findings of the paper will be then presented into two parts, particularising first the lessons learned from the presented case and, secondly, elaborating further the need to use ICT to enable alternative voices from the Global South to contribute with notions of development. Finally, overall conclusions will be presented.

3. DEVELOPMENT AND SUB-ORDINATION
Development as an amelioration has been present for centuries as societies strived for quality of life. As societies became more complex overt time, the triggers and range of development enlarged, rendering development into multidimensional ethos and praxis. However, in contexts where Western culture dominates, a form of colonisation takes place through social constructions of meaning around a rigid hierarchy in which the colonisers outrank the colonised (Ashcroft, Griffiths, & Tiffin, 1998).
Development’s origins as progress, rationalism and modernity are rooted to European thinking (Rist, 2002; Cowen & Shenton, 1996; Hopper, 2013). More contemporary views on development were forged in aftermaths of the World Wars, as victorious nations aimed for post-war reconstruction and economic stability (Hopper, 2013), bringing about change within societal structures, people and culture as well, expecting to replicate the values of the First World into the Global South (Sachs, 1992; Sheppard et al., 2009).

By the Cold War era, the aim for development reached technology, as another agent against communism. Governmental/military projects were developed – i.e. the ARPANET (Advanced Research Projects Agency Network) and satellite communications networks in collaboration with the UK and France – involving investment from several countries and expectations for diverse geographies, mainly within the First World (Naughton, 2016).

By the mid-70s, after both the oil crisis and the economic crisis broke, the light was shed on the fact that the economic models promoted during post-war development were unsustainable in the long run for not taking any account of the effect that production and oil extraction could have on the environment and, consequently on the society (Sheppard et al., 2009). Thus, as industrialization started to reach its limits within first world countries, new markets were sought.

Neoliberalism appeared as an alternative. With neo-liberal economy free trade in commodities, services, and the international movement of capital and labour, politicians and economists (mainly Anglo-Americans) expected that every person in the world, regardless of their socio-economic background, would cultivate the same intention for ‘development’ and opportunities to prosper. Development was thus understood within the Global North as a market-led personal prosperity plan (Sheppard et al., 2009). An appeal for globalisation came then into play. Under this scheme, individuals were expected to experience the maximal personal liberty that resulted from market possibilities and deregulation of the private sector. Freedom was thus understood as a benefit of market-led neo-liberal economy, as individuals would experience it, as long as the market and the economy of the area they lived in would allow it (ibid). With such powers endowed to globalisation, developed countries leaned towards believing that globalisation and neoliberalism would be able to solve the economic difficulties in developing and underdeveloped countries. In consequence, political and economic pro-globalisation forces aimed for establishing the neo-liberal globalisation model in the largest part of the world.

In spite of this, the consequences of market-led developed economies started to take a toll on developing and underdeveloped societies. Alternatives for market processes to alleviate poverty, underdevelopment, and to counter the subordination brought about by globalisation and its negative effects in developing and underdeveloped societies, sustainable development emerged (Sheppard et al., 2009). Within this framework, nature preservation, on the one hand, and social capital, on the other hand, started to be acknowledged.

While this was happening, ICT use and applications were displaying an accelerated growth in some parts of the world. To bridge the socioeconomic gap, global institutions aimed to address inequality issues in the world with ICT towards the arrival of the new millennium (Unwin, 2009). Efforts between the Organisation for Economic Co-operation and Development (OECD) and the United Nations (UN) eventually resulted in the Millennium Development Goals (MDGs), a set of eight goals to be accomplished by the target date of 2015.

Regarding sustainable development, in 2012, the UN invited stakeholders to make voluntary commitments on delivering concrete results for sustainable development. The Conference on Sustainable Development – Rio+20 – took place, drafting clear and practical measures for
sustainable development. Ventures for a paradigm shift from a human-centric society to an Earth-centred global ecosystem – derived from this conference – are imprinted in current socio-economic and political efforts from countries like Iceland, Scotland, New Zealand, France, Netherlands, and Wales, to achieve economic degrowth for ecological sustainability and social equity through:

1. alternatives to gross domestic product (GDP) as a measure of well-being,
2. radical questioning and proposals on common values of care, solidarity, cooperation and an understanding of Nature,
3. collaboration of national and regional governments to advance on the recognition of development as both human and ecological well-being (UN, 2020).

By 2014, the OECD and the UN realised that the MDGs were far from being attained. To address these shortcomings, the 2030 Agenda for Sustainable Development was agreed in September 2015, replacing the MDGs by the Sustainable Development Goals (SDGs). ICT was identified as a loyal ally “to ensure that ‘no one is left behind’ in the course of progress towards sustainable (economic) development” (ITU 2016, pp. 79). Despite this re-evaluation, still nowadays over 40% of the global population has no access to internet and ICT (Kemp, 2021), close to 46% of the world’s population lives on less than $5.50 USD a day, and close to 26% lives on less than $3.2 USD a day (WB, 2018).

This prevalent digital and social divide highlights that despite institutional efforts, ICT could not shift social structures of power and would not translate on social difference (De Sousa, 2006; Appadurai 2013). Thus, critical voices pointed out the proliferation of epistemological gaps. In this regard, claimed De Sousa (2006), globalisation and its associated practices disqualify people – artificially and epistemologically – to maintain the domination of neoliberalism, globalisation and their techno-scientific grounds based upon people’s alignment to alternative types knowledge – such as traditional indigenous knowledge. People with alternative knowledge are rendered “invisible, unintelligible or irreversibly discardable”, resulting in a creation of non-existent subjects and objects (De Sousa, 2006, p.16), being ethnically diverse populations among the most affected.

The socioeconomic and political discrimination rooted to globalisation-imposed subalternity and non-existence would keep ethnic diversity from being considered as starting point on the elaboration of comprehensive views of ‘development’ and as a trigger of ICT implementations to boost national economies (Navarrete 2016, 2017). While non-existence takes place, rough poverty, marginalization, their effects and consequences, would lead people to develop a culture of poverty (Appadurai, 2013). This ‘culture’ would act as a constant reminder among the poor of what they cannot attain and would aim for the acknowledgment of poverty to gain back a little of the dignity lost.

Under this rationale, indigenous have been rendered as subaltern and, as such, their culture and their cultural artefacts would also be considered non-existent within a globalisation paradigm. Given that most indigenous peoples are vulnerable due to the colonial oppression’s lingering effects, institutional ICT implementations relates to the ethics and politics of engagement in research, especially as colonialism has marginalized many indigenous people to the extent that still nowadays they continue to face threats to their sovereignty, wellbeing, and natural environment (Myers et al.,2020). Despite this situation, ethnic groups are not frozen in time, living a life without leisure or fun, and oppressed; they are as much members of the digital generation as persons living in the Global North (Gajjala, 2014). Thus, when available, ethnic populations are active ICT users, as shown by documented cases of ICT use among indigenous communities – triggered by themselves – in which through ICT appropriations, they have been able to pursue their own goals, show their resilience and stress the need to reassess ICT4D, to include postcolonial views on development and to favour the environment over economic gain (Pérez-García, 2020) and to reach an understanding of ethical ways to include indigenous peoples in ICT research process and consequent benefits without dictating the ways in which we include indigenous peoples (Myers et al.,2020).
4. THE WIXÁRIKA USE OF ICT TO SAVE SACRED LANDS

To approach indigenous ICT initiatives, qualitative research was carried out, focusing on the Wixárika (Huichol) ICT use and appropriation as a means to protect their sacred land from development projects (mining, agriculture, tourism) and their call for a fairer behaviour towards the environment. Between 2011 and 2019 diverse digital ethnography methods were carried out1 to document the activities carried out by the Wixárika people in Mexico (associations and individuals) to stop mining and touristic projects in their sacred lands. With the information gathered, the evolution and progress of indigenous and grassroots initiatives through their online presence was documented. Moreover, with consent of social media users (Facebook, Twitter, YouTube), the activities of 5 indigenous associations on their accounts and their websites were periodically monitored. Also 30 structured and semi-structured interviews to 15 NGO workers and indigenous peoples were carried out online, in Mexico and in the Netherlands. Some of the interviewees where interviewed more than once over time, without exceeding three times. Note that as the focus of this paper is on the movement to save Wirikuta, the information presented and analysed corresponds to the period between 2012-2016. Nevertheless, although not approached in this paper, the research on Wixárikas’ use of ICT continues to further document the ramifications of the movement, further achievements and their influence on other indigenous populations in Mexico.

Wixárika people – Huichols in Spanish or Wixaritari in Huichol language – hold nowadays the closest traditions to those of the Aztecs, hence their cultural importance (Liffman, 2011). One of the many particularities of this indigenous group is that, despite being active participants in the socioeconomic and politic life of the country, they have preserved their spiritual identity, continuing with their practices of animism – a cultural and religious tradition going back over 2,000 years (Alarcón-Cháires et al., 2013).

Wixárikas corresponding to about 4% of the total indigenous populations of the country (INEGI, 2010). Half of them is spread throughout their traditional lands in Nayarit, San Luis Potosi, Jalisco, Zacatecas and Durango. The other half is scattered throughout the rest of the country or in the USA (CHAC, 2011). The language spoken by them is Wixaritari, and several dialects derived from it. While the majority of them speak Spanish, some members remain mono-linguistic. Although Wixaritari is not a written language, Wixárikas are convinced that their traditional myths and traditions can only live on orally thus the passing on of the language is essential for the community’s survival and the development of the Wixaritari identity (Fernández, 2013).

One of their cultural pillars is a close spiritual relationship with their ancestors and their deities. To communicate with them, the Wixárikas make at least five pilgrimages through their sacred places – Wirikuta being the most important. By pilgriming, Wixárikas adhere to their beliefs on the creation of the world and connect with their deities to receive protection and guidance through life (Liffman, 2011).

In the Wixárika cosmovision, Wirikuta it is the place where the world was created, as it is one of the ecosystems with the highest number of endemic species in the world (ibid). Thus, from childhood every Wixárika is expected to make a pilgrimage to Wirikuta to re-enact the path their spiritual ancestors followed to communicate with their deities. Not performing these pilgrimages and not being in contact with nature in their sacred places “would separate the Wixaritari from their divine beings, resulting in a life without purpose” as in Wirikuta “the essence of terrenal [worldly] life is weaved and sustained” (Alarcón-Cháires et al., 2013).

1 Such as digital participant observation, online interviews, interaction observation on social media platforms and normalised web distance among related terms (see Pérez-García et al., 2016).
Despite the complex particularities of Wirikuta, as the 2008-2009 global economic crisis hit Mexico, the federal government decided to boost the country’s economy with mining projects in the land, granting in 2009 78 open-cast mining concessions to Canadian companies in the state of San Luis Potosí, affecting at least 70% of Wirikuta (ibid).

In response, Wixaritari authorities formed a Council for the Defence of Wirikuta, RWCDW in 2010. The Council, with the support of national and international NGOs, founded a Front in Defence of Wirikuta, FEDDW. The Front tried through different avenues to reach representatives of the mining companies in Canada and Mexican federal government officials. With little response and achievements, they hoped to get support from the UN, as the mining concessions were about to start their operations. The Front changed its strategy and focused instead on creating digital content to be available on social media so that the online community could “visualise and broadcast” — nationally and internationally — the needs of the Wixárikas and show solidarity for the defence of Wirikuta (Alarcón-Cháires et al., 2013). Throughout the online content made available – mostly recorded in Wirikuta –, Wixárikas presented the viewers and readers with information about their culture, their land, their pilgrimages and the way in which the mining concessions threatened their cultural heritage and the ecosystem. Information was recorded in Wixaritari by the indigenous people and translated into Spanish by the Frente. Soon, translations were also made available in English, as well as in French, German and Italian.

The spread of information via social media, the support from international personalities in the arts, literature, activism, and the response from national and international organisations led – in February 2012 – to the suspension of one of the mining projects that would have carved up 3% of Wirikuta (DOF, 20/02/2012). Three months later, in May, the federal authorities announced that Wirikuta was to be spared from the mining and returned to the indigenous communities (Presidencia de la República, 24/05/2012). Huichol indigenous authorities argued that half of the territory was still going to be exploited by the mining companies (Venado Mestizo, 25/05/2012).

Further pressure was exerted through social media releases and the further involvement of indigenous ICT users. In September 2013, the pressure applied by the online movement to Save Wirikuta was enough to force the federal government to suspend – not cancel for good – all the mining concessions in Wirikuta (DOF, 13/09/2013). With this resolution at least 500 direct jobs and 1,500 indirect jobs were cancelled, along with a planned investment of over 17 million MXP (approx. 1 million euros) (LGDP, 2014). Wirikuta was, nevertheless, temporarily spared from the ecological damage that mining would bring about and became a biosphere reserve for the time being, protecting not only the Wixárika traditions but the endemic species of the area.

5. FINDINGS

5.1 ICT and indigenous people
Despite the socioeconomic conditions of indigenous people in Mexico and the scarce ICT possibilities in the areas where the Wixárika initiative developed, the involvement of the population, the wide use of ICT to spread content, and the high impact of the initiative outweighed the odds against them. Through interviews to Wixárika Facebook users, light was shed on the fact that for the content to be uploaded and transferred, users committed to travel to mountains’ tops, up to areas where it is already known that there is better mobile signal reception. Although there were NGOs backing up the indigenous people with their initiative, indigenous people where actually generating digital content for websites and various social media accounts to achieve group’s recognition, cultural preservation, and to protect the ecosystem where they live.

The most valuable lessons learned from the presented case are:
1. While fulfilling a basic need to communicate with ICT, the Wixárika’s ICT appropriations contributed to the group’s quest for recognition, autonomy, ecological balance, cultural preservation and survival of their ethnic origins.

2. Despite the barriers and issues that Wixárikas encountered to use ICT, their ICT appropriation presented them with a means to achieve community goals that – while legally and ethically defendable – do not correspond to national governments and national and international institutions’ planning.

3. When populations living under structural violence interact with ICT – like Wixarikas in the presented case –, it is important to draw upon the experiences of these populations to understand what is – for them – to be pursued with ICT, whether appropriations and affordances could lead to strong ICT planning and implementations, and whether the latter could be a means for the fulfilment of their expectations on the relationships in their community and the relationship they develop with the environment.

4. Indigenous peoples seek to add their voices and aspirations to the debates on their future and their expected ‘development’ through ICT implementations in order to change how they are perceived by the world, to preserve their culture, to improve their living conditions while living within tradition.

5. The appropriations and affordances Wixárika population made of ICT exemplify how ICT can be used to achieve nature conscious improvements in living conditions, without relying on economic growth only.

5.2 ICT and bio-centric views on ‘development’ from the Global South

Most societies in the world live within a globalisation paradigm. However, the wealth and well-being that deregulated free trade would bring about for everyone involved, has not been homogenously distributed. Moreover, Western domination through globalisation has profoundly marginalised knowledge and wisdom that had been in existence in the Global South (De Sousa, 2014). Thus, to the eyes of populations of the Global South, development as seen in the Global North is a rigid idea that stacks nations – and people – into categories. It separates nature from humans and humans in gender, religion, class (Bassey, 2019). In contrast, indigenous traditions, claims Gudynas (2015), do not involve a linear idea of progress and history. Moreover, indigenous ontologies see the world as a plurality of simultaneous stories, with no single totalising narrative, where humankind is closely interrelated with nature (Jiménez & Roberts, 2019; Hernández & Laats 2020).

It would be overly ambitious to generally assert that ICT could help to change the ways the less dominant sociocultural groups are globally understood. Nevertheless, the paradox depicted in the presented Wixárika case, – along with other cases, such as Aymara Women’s use of ICT to preserve traditional knotting patterns (Jiménez-Quispe, 2021), Pastoralists use of ICT to lead their herds through paths with food and water (Bodgan-Martin, 2021) – shed light on the fact that ICT indigenous people’s appropriations, affordances, and use – far from only achieving economic ameliorations – are a means to expand people’s capacity to exercise their voice, to debate the economic conditions to which they are confined, to protect their culture, and to redefine the way they want to live their lives. Understanding the agents, actors, and tensions involved in this type of cases could help us to understand that the current development paradigm associated to ICT4D could be excluding not only segments of society but also efforts, – even if these are not fully valued or understood in the Global North, like the presented case – that aim for an improvement on people’s living conditions and preservation of the environment. Also, by understanding the ICT4D-Buen Vivir paradox and whether different views on ‘development’ as an amelioration could be associated with ICT4D could represent change possibilities to stir Western anthropocentrism views on development as production, use of natural resources and minimization of the common good, supported by ICT4D practices, and the effect these have had in contemporary societies. Moreover, it could minimise the effects of the logics of non-existence and the culture of poverty described by
De Sousa (2006) and Appadurai (2013) as BV rejects all forms of colonialism upholding a type of interculturality that values each tradition of knowledge, incorporating reciprocity, complementarity, communalism, redistribution (Chuji et al., 2019).

6. CONCLUSIONS

Reality, claim Jiménez & Roberts (2019), is constituted by many kinds of worlds, many ontologies, many ways of being in the world, many ways of knowing reality, and experimenting those many worlds. However, since colonial times, certain kinds of knowledges have been privileged as valid, consequently prioritising certain activities, while delegitimising and subordinating others with less economic and sociopolitical power (Tuhiwai-Smith, 1999; De Sousa, 2006, 2014).

When referring to ICT research, many new theories, claim Myers et al. (2020), are still grounded in colonial views. As a result, the research could lack sensitivity to indigenous peoples’ issues, and enforce a materialism that does not correspond necessarily with indigenous ethos.

To advance knowledge on indigenous ICT uses research, argue Tsibolane in Myers et al. (2020), researchers should engage with indigenous communities to re-centre indigenous voices, languages, concepts, worldviews, histories, experiences, knowledge, and beliefs to address ICT paradigms while also referring to the ethical interdependence between human beings, the natural environment, and ancestors.

Regarding Buen Vivir, the experiences of Ecuador and Bolivia’s nation-state constitutional projects demonstrated that BV can become co-opted as a discourse, without much change (Gudynas 2011; Williford 2018) and that there is a lack of structural preconditions for the implementation of BV at a nation level Beling et al. (2018). Other authors argue (Kothari et al., 2014; Merino,2015) that given that BV has been dialogically incorporated into government initiatives, its results and implications should be measured 1) by its contribution to destabilising dominant existing socio-cultural templates, and 2) by the possibilities it opens to explore alternatives to an economically neo-liberal way of living.

Although it can be claimed that BV is still a discursive ‘work-in-progress’, result from scholars and political leaders’ interpretation and articulation of traditional indigenous knowledges done to present an alternative to development (Jiménez & Roberts, 2019), BV’s strength resides in the fact that it does not aim to become a dominant hegemonic ideology. BV aims for the recognition of multiple perspectives coexisting and proposes to replace individualism values and economic growth at an environmental cost, with solidarity, reciprocity, complementarity, interdependence and harmony with nature. Considering such values could provide strong alternatives to perform ICT research that allow us to shift from a Eurocentric hegemonic ICT4D to a decolonial ICT4D that encourages plural ways to understand the world, while preserving nature.

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Pérez-García

The ICT4D-Buen Vivir Paradox


THE MODERATING EFFECT OF GENDER ON ADOPTING DIGITAL GOVERNMENT INNOVATIONS IN ETHIOPIA

Debas Senshaw, Sudan University of Science and Technology & University of Bahir Dar, debassenshaw@gmail.com
Hossana Twinomurinzi, Sudan University of Science and University of Johannesburg, hossanat@uj.ac.za

Abstracts: Digital government innovation is being recognised as a solution to many problems faced by governments in providing services to their citizens. It is especially important for low-income countries where there are resource constraints. This research was aimed at exploring the moderating effect of gender on the adoption of a digital government innovation in Ethiopia based on the UTAUT model (n=270) and using structural equation modeling (SEM). The results reveal that gender only moderates the relationship between facilitating conditions and usage behavior of government employees to adopt the digital government innovation which is inconsistent with other findings. Another key finding was that even though the innovation was regarded as not being easy to use, women identified that they would still use it because of the social influence from the peers and the bosses. This finding suggests that women government employees who obtain external support are more likely to use digital government innovations compared with men who are unlikely to use it even if they were facilitated. The paper recommends that governments of low-income countries like Ethiopia should design appropriate policies that encourage women in digital government.

Keywords: Digital Government, Digital Innovation, WoredaNet, UTAUT, Technology Adoption

1. INTRODUCTION

Digital technology now plays a significant role in governments to offer effective and efficient government services (Flórez-Aristizábal, Cano, Collazos, & Moreira, 2018; Janssen & Estevez, 2013). Digital technology can enhance the quality of government services by reducing the time and other resources that might be lost without the use of it. Digital technology in government can significantly enhance the ease of use as well as the accessibility of services to citizens and organisations to accomplish their goals (Montarnal, Delgado, & Astudillo, 2020; Norris & Reddick, 2013). Digital government has also the power to improve and facilitate the participation of citizens in the political processes and organisations in growing the economy (Chatzoglou, Chatzoudes, & Symeonidis, 2015; Norris & Reddick, 2013).

However, governments in low-income countries struggle to create innovations in digital government despite investing large amounts of capital usually obtained through loans and grant from developed countries and international bodies (Aladwani, 2016; Anthopoulos, Reddick, Giannakidou, & Mavridis, 2016). The development of most government digital innovations such as government websites is usually done by digital technology staff without the active participation of citizens or government employees to consider their needs and perceptions on the digital artefact (Abu-Shanab, 2017; Alshehri, Drew, Alhussain, & Alghamdi, 2012).

Another challenge is that many low-income countries do not engage with their local context before creating new digital government artefacts but rather simply adopt digital innovations that had been created elsewhere (Senshaw & Twinomurinzi, 2018). In other words, digital innovations in low-income countries that are based on the local context such as m-pesa (Kim, Zoo, Lee, & Kang, 2017)
have been shown to enjoy rapid adoption compared to innovations that have been adopted from other contexts.

The use of local digital government innovations that can provide accurate, useful, and context-based information for government employees is unquestionable especially during hard times of pandemic diseases like the current COVID-19 since they enable to access required information from home (Ahn, Park, Lee, & Hong, 2020).

This study focused on evaluating the influence of gender on adopting locally designed digital government innovations. In this research, gender was considered as a moderator variable due to its significance in technology acceptance models (Suki & Suki, 2017; Venkatesh, Morris, Davis, & Davis, 2003).

Previous research has indicated that men and women decide differently to accept and use digital innovations (Mandari & Chong, 2018; Williams, Roderick, Rana, & Clement, 2016). Gender plays a significant role in predicting usage behavior in information system research (Venkatesh & Davis, 2000; Venkatesh et al., 2003). For instance, the explanatory power of Technology Acceptance Model (TAM) is considerably enhanced after the consideration of gender as a moderating variable (Venkatesh et al., 2003). Particularly, gender has a moderating influence of performance expectancy, effort expectancy, social influence, and facilitating conditions on behavioral intention and use behavior (Venkatesh et al., 2003).

Most of the studies on digital technology adoption are carried out in developed countries (Im, Hong, & Kang, 2011; Liebenberg, Benade, & Ellis, 2018; Meso, Musa, & Mbarika, 2005; Rahman, Jamaludin, & Mahmud, 2011). On the other hand, there are only limited research works relating to the adoption of digital government innovations particularly in the African context.

The study therefore investigated the moderating effect of gender on the acceptance and adoption of digital government innovations. Specifically, the study investigated the moderating influence of gender on the adoption of a digital government innovation created for the WoredaNet in Ethiopia (Raman et al., 2014; Tai & Ku, 2013).

The reason why gender is selected as a moderating factor for this study is because Ethiopia is a patriarchal society along the lines of religion, tradition and culture, with patriarchy embedded in the laws and legislation (Kassa, 2015). This has resulted in disparities between men and women, in the division of labor, the share of benefits, in law and state, in how households are organised, and how these are interrelated (Kassa, 2015). For example, women are underrepresented in leadership and political decision making (Demeke & Gebru, 2015), education (Bayeh, 2016) and in all levels of formal government activities (Alghizzawi, Mahadin, Al-shibly, & Nawafleh, 2020; Naidoo, 2018; Nurhaeni, Yuliarti, & Nugroho, 2016; Özsungur, 2019). The paper, therefore, sought to answer the research question: How does gender moderate on the adoption of locally designed digital government innovations in the context of resource-constrained low-income countries?

The remainder of the paper is organised as follows: The next section explains the theoretical background of digital government, the influence of culture on digital government adoption, an overview of the digital government innovation followed by the Unified Theory of Acceptance and Use of Technology (UTAUT). Then, methodology section is presented followed by results and analysis section. Finally, the discussion of results is explained followed by conclusions and limitations of the research.
2. THEORETICAL BACKGROUND

2.1. Digital Government

Many different definitions of digital government are found in different literature based on the context it is used. A digital government is a government digital platform that aims to achieve improved governance (Mettler, 2019). Digital government is also defined as the use of digital technologies that can transform government initiatives and services by enhancing their quality (Misuraca & Pasi, 2019). Digital government plays a significant role in achieving better efficiency of government by changing citizens' behavior (Misuraca & Pasi, 2019; Norris & Reddick, 2013). However, the advantage of digital government can be achieved provided that it is accepted by the users of the digital government (Alshehri et al., 2012). Therefore, investigating the determinants of acceptance and adoption is very important to develop a relevant model.

2.2. The Influence of Culture on Digital Government Adoption

Women in Ethiopia are not treated as men (Bayeh, 2016) and therefore are not benefited from the economic opportunities of the country. Their participation in the economy is therefore limited like many other low-income countries in Africa (Demeke & Gebru, 2015). This is because the orientation of development projects is inclined to men and excludes women from formal employment. This has created an environment where women are engaged in unpaid, tedious household work that forces them to impoverished parts of society (Kassa, 2015). Secondly, they are deprived of access to training, modern technology and access to education though there is certain improvement done by the government of Ethiopia. This study therefore investigated the moderating effect of gender on the adoption of a digital government innovation that was based on the local context.

2.3. Overview of the Adaptive Capability Digital Artefact

The purpose of the app is to provide services particularly for Woredas of Ethiopia that are not using WoredaNet innovatively. Typically, government employees in Woredas are supposed to use the digital innovation to identify opportunities for public service innovations based on the local context. The app was created using design science research (Senshaw & Twinomurinzi, 2020). The need was identified from the low usage of the WoredaNet platform in Ethiopia. The WoredaNet is a digital government platform using fiber and satellite infrastructure across Ethiopia that was implemented by the government of Ethiopia to provide government services to the lowest administrative regions (Woredas). The name WoredaNet comes from “Woreda” which is Amharic. It has the equivalent meaning of a district. Among the services provided by the WoredaNet are video-conferencing, internet, electronic messaging, and voice over IP between federal, regional, and Woreda sites. There are 1,050 Woredas in Ethiopia, 976 of which (93%) have access to the WoredaNet. Despite the access, only a few Woredas actively use the WoredaNet (Miruts & Asfaw, 2014).

The findings of the adaptive capabilities of Woredas that are using WoredaNet innovatively were used to create the app. Adaptive capabilities are capabilities that can introduce a new service or a new way of creating a service (Ogunkoya, 2018; Wilden & Gudergan, 2015). A case study with a qualitative-interpretive approach was adopted to identify the adaptive capabilities of three innovative Woredas (the Amhara Regional State, Dangila town, and Woreta town). The selection of these three Woredas was made by the ICT management of the Amhara Regional State Science, Technology, Information and Communication Commission (STICC). Three public agencies namely, Judiciary (court) office, Human resource office and Finance office were selected from each the three innovative Woredas. The selection criteria were based on their active usage of the WoredaNet government digital platform. To obtain qualitative data, three executives and management (those who oversee similar tasks in government agencies), one from each government agency, one ICT support, and a district administrator (or a representative) from each of the three Woredas were chosen for the interview. A total of 15 interviewees were included. Thematic analysis was used to elicit adaptive capability codes and themes that were used as a requirement to design.
the digital innovation. Elaborated Action Design Research (EADR) approach (Mullarkey & Hevner, 2018) was followed to create the digital government adaptive capability artefact (Figure 1).

![Figure 1. Digital Government Adaptive Capability Web-based Application](image)

**Figure 1. Digital Government Adaptive Capability Web-based Application**

### 2.4. Unified Theory of Acceptance and Use of Technology (UTAUT)

The Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) is an enhanced model developed based on the previous technology acceptance models. UTAUT targets to examine the intention of users to use information systems and ultimately enhance their usage behavior through its robust features. UTAUT presents a more comprehensive picture of a technology acceptance process as compared to the previous individual models (Raman et al., 2014; Tai & Ku, 2013). UTAUT integrates the key features of the previous individual models that were used in the field of information systems. UTAUT was selected in this study compared to the newer UTAUT 2 since UTAUT is suited to explicate the attainment of learning tasks in the workplace (Ramírez-Correca, Rondán-Cataluña, Arenas-Gaitán, & Martín-Velicia, 2019). UTAUT is also an important tool for digital government managers to measure the possibility of adoption and acceptance of a new digital government innovation within an organisation, and it enables to examine aspects that help to drive the acceptance of new digital government innovation thereby designing suitable features to enhance the adoption and acceptance of new digital government innovation by the users (Gupta, Dasgupta, & Gupta, 2008).

UTAUT consists of four important constructs, namely, performance expectancy (PE), effort expectancy (EE), social influence (SI), and Facilitating conditions (FC) that are core determinants of behavioral intention (BI) to use technology (Venkatesh et al., 2003). Moreover, UTAUT also uses four variables (experience, gender, age, and voluntariness of use) that can moderate the impact of the four key constructs on behavioral intention and usage of technology.

In this research, a set of hypotheses has been developed and examined regarding the moderating effect of gender on the relationship of the four key constructs and that of the behavioral intention and use behavior of employees to adopt the new digital government innovation.

**Performance Expectancy (PE).** Performance expectancy refers to the extent to which a user believes that using digital technology enhances his/her job performance (Atttuquayefio, 2014). It plays a significant role in validating intention (Agarwal & Prasad, 1998). When users expect digital technology improves their job performance; they tend to accept the technology (Al Khasawneh, 2015; Bhatiasevi, 2016; Chiu, Bool, & Chiu, 2017). Moreover, gender affects the influence of
performance expectancy on the intention to use digital technologies (Mandari & Chong, 2018). Therefore, the following hypothesis is tested:

**H1**: Performance expectancy positively influences the behavioral intention of government employees to use the app, moderated by gender.

**Effort Expectancy (EE)**. Effort expectancy refers to the extent of ease related to the use of digital technologies (Davis, Bagozzi, & Warshaw, 1989; Lim, Su, & Phang, 2019; Venkatesh et al., 2003). The amount of effort the user puts in affects the behavioral intention of users to accept or adopt digital technologies (Venkatesh et al., 2003). Moreover, gender affects the influence of effort expectancy on the intention to use digital technologies (Venkatesh et al., 2003). Therefore, the following hypothesis is tested:

**H2**: Effort expectancy positively influences the behavioral intention of government employees to use the app, moderated by gender.

**Social Influence (SI)**. Social influence refers to the extent to which an individual thinks his/her boss or colleagues believe he or she should use the new digital technology (Venkatesh et al., 2003). Social communication affects users’ intention to use digital technologies (Hung, Hsieh, & Huang, 2018). Moreover, gender influences the effect of social influence on behavioral intention to use digital technologies (Venkatesh & Davis, 2000; Venkatesh et al., 2003). Therefore, the following hypothesis is tested:

**H3**: Social influence positively influences the behavioral intention of government employees to use the app, moderated by gender.

**Facilitating Conditions (FC)**. Facilitating condition refers to the availability of facilities to use new digital technology (Venkatesh et al., 2003). Unpredictable support of facilities results in lower pressure on the behavioral intention of using digital technologies, whereas predictable support of facilities positively influences use behavior (Attuquayefio, 2014). Moreover, gender influences the effect of facilitating conditions on use behavior (Venkatesh, Thong, & Xu, 2012). This is because men are task-oriented while women are easily affected by the surrounding environment to use digital technologies (Mandari & Chong, 2018). Therefore, the following hypothesis is tested:

**H4**: Facilitating condition positively influences government employee’s use behavior of the app, moderated by gender.

3. **METHODOLOGY**

3.1. **Data Collection and Evaluation**

Non-probability sampling technique was implemented to select ten Woredas that have access to the WoredaNet to evaluate the web-based app including the three Woredas that participated in qualitative data analysis. The Amhara Regional State Science, Technology, and Information Communication Commission (STICC) supported the principal researcher mainly for distributing the questionnaire online using Google Forms and deploying the web-based app in the organisation’s server at the time of evaluation so that evaluators can easily access the web-based app. It also assisted in assigning the WoredaNet experts in each of the Woredas to facilitate the evaluation response rate. The web-based app was evaluated by government employees consisting of Woreda administrators/representatives, process owners (those who administer similar tasks in public agencies) and experts from ten Woredas’ government organisations. The researcher’s email and smartphone were used to send the responses.
The questionnaire consisted of a 5-point Likert-scale from strongly disagree to strongly agree and demographic questions. Following the suggestions by (Owoseni & Twinomurinzi, 2018), the twenty items were modified from previous literature to ascertain scale validity as shown in Appendix A. A survey of 400 questionnaires was administered in the beginning. This sample size was decided taking into account the use of covariance SEM to test the hypotheses with at least 200 sample size (Livote & Wyka, 2009); only 270 complete responses were obtained in 25 days between Dec. 3 to 27, 2019.

The statistical tools SPSS 26 and Amos 26 were used to capture and process the data (Adil, Owais, & Qamar, 2018; Fan et al., 2016; Owoseni & Twinomurinzi, 2018). The data's normality was tested to see whether it met the general linear regression model. The constructs' skewness and kurtosis were determined for each item. The majority of the items were between the acceptable range of -2 and +2 (Abdullah, Chong, Widjaja, & Shahrill, 2017; DeLemos, J. L., Brugge, D., Cajero, M., Downs, M., Durant, J. L., George, Henio-Adeky, S., Nez, T., Manning, T., Rock, T., Seschillie, B., Shuey, & Lewis, 2009), except few items where kurtosis are greater than 2.0 as presented in Appendix B. Overall, the results showed that the skewness and kurtosis values were satisfactory.

From the data the number of women participated in the survey is much fewer than that of the men but adequate to carryout analysis. This was due to a similar sex distribution amongst those who received the questionnaire. Table 1 presents the heterogeneous demographics.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>185</td>
<td>68.5</td>
</tr>
<tr>
<td>Women</td>
<td>85</td>
<td>31.5</td>
</tr>
<tr>
<td>Experience</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years and below</td>
<td>29</td>
<td>10.7</td>
</tr>
<tr>
<td>6-10 years</td>
<td>123</td>
<td>45.6</td>
</tr>
<tr>
<td>11-15</td>
<td>101</td>
<td>37.4</td>
</tr>
<tr>
<td>16-20</td>
<td>17</td>
<td>6.3</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 and below</td>
<td>43</td>
<td>15.9</td>
</tr>
<tr>
<td>31-35</td>
<td>121</td>
<td>44.8</td>
</tr>
<tr>
<td>36-40</td>
<td>86</td>
<td>31.9</td>
</tr>
<tr>
<td>41 and above</td>
<td>20</td>
<td>7.4</td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diploma</td>
<td>35</td>
<td>13</td>
</tr>
<tr>
<td>Bachelor</td>
<td>186</td>
<td>68.9</td>
</tr>
<tr>
<td>Masters</td>
<td>49</td>
<td>18.1</td>
</tr>
</tbody>
</table>

Table 1. Respondents’ Demographic Data

4. RESULT AND ANALYSIS

According to statistical rules, kurtosis and skewness values between -2 and +2 demonstrate a normal univariate distribution (George & Mallery, 2010). Kurtosis is the degree of peakedness of a frequency curve, while skewness is the deviation from symmetry. All skewness values in this analysis are within acceptable limits, and four of the kurtosis values are between +2 and +4 which are satisfactory, indicating the assumption of normality has been met.
For this study, covariance-based structural equation modeling (SEM) using Amos 26 was used to assist with analyzing the data. Covariance-based SEM technique is suitable for exploring models and testing hypotheses based on large sample size (Owoseni & Twinomurinzi, 2018). This is the reason for using it for this study.

The analysis of covariance-based SEM is divided into measurement model analysis and structural model analysis (Owoseni & Twinomurinzi, 2018; Riskinanto, Kelana, & Hilmawan, 2017). The first deals with confirmatory factor analysis (CFA) to examine the reliability and validity of the latent variables while the second would test the hypotheses by examining path coefficients.

### 4.1. Measurement Model

Measurement model analysis focuses on assessment of reliability, convergent validity and discriminant validity (Riskinanto et al., 2017). To assess the model, it is necessary to first scrutinize the value of loading factors of the model’s variables if it satisfies the minimum requirement. This was carried out through running Amos 26 software. As shown in Table 2, the constructs’ reliability was measured by examining the values of Cronbach’s $\alpha$. The results indicated that the value ranges from 0.745 (for BI) to 0.844 (for SI) which met the minimum requirement of 0.7 (Liao, Fei, & Liu, 2008). The model’s reliability was also checked by examining the value of composite reliability. The result indicated that all constructs met the minimum requirement of 0.7 (Rahi, Ngah, & Ghani, 2018). Moreover the reliability of individual items was assessed by investigating the factor loading of all variables with their corresponding constructs. The result indicated that the value of all variables range from 0.522 (for EE4) to 0.870 (for FC3) which met the minimum requirement of 0.5. Thus, the results confirmed that the reliability of the research model was acceptable.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Item</th>
<th>Factor loading</th>
<th>P-value</th>
<th>Cronbach’s $\alpha$</th>
<th>CR</th>
<th>AVE</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE: Performance Expectancy</td>
<td>PE1</td>
<td>0.660</td>
<td>***</td>
<td>0.836</td>
<td>0.844</td>
<td>0.578</td>
</tr>
<tr>
<td></td>
<td>PE2</td>
<td>0.839</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE3</td>
<td>0.847</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>PE4</td>
<td>0.674</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE: Effort Expectancy</td>
<td>EE1</td>
<td>0.804</td>
<td>***</td>
<td>0.779</td>
<td>0.805</td>
<td>0.514</td>
</tr>
<tr>
<td></td>
<td>EE2</td>
<td>0.760</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE3</td>
<td>0.747</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>EE4</td>
<td>0.522</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI: Social Influence</td>
<td>SI1</td>
<td>0.753</td>
<td>***</td>
<td>0.844</td>
<td>0.850</td>
<td>0.655</td>
</tr>
<tr>
<td></td>
<td>SI2</td>
<td>0.905</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>SI3</td>
<td>0.761</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FC: Facilitating Conditions</td>
<td>FC1</td>
<td>0.550</td>
<td>***</td>
<td>0.830</td>
<td>0.817</td>
<td>0.535</td>
</tr>
<tr>
<td></td>
<td>FC2</td>
<td>0.638</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FC3</td>
<td>0.870</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FC4</td>
<td>0.821</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BI: Behavioral Intention</td>
<td>BI1</td>
<td>0.671</td>
<td>***</td>
<td>0.745</td>
<td>0.754</td>
<td>0.505</td>
</tr>
<tr>
<td></td>
<td>BI2</td>
<td>0.756</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>BI3</td>
<td>0.703</td>
<td>***</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Reliability and Validity Assessment

<table>
<thead>
<tr>
<th>Construct</th>
<th>UB</th>
<th>PE</th>
<th>EE</th>
<th>FC</th>
<th>SI</th>
<th>BI</th>
</tr>
</thead>
<tbody>
<tr>
<td>UB</td>
<td>0.825</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PE</td>
<td>0.384</td>
<td>0.760</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EE</td>
<td>0.440</td>
<td>0.732</td>
<td>0.717</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FC</td>
<td>0.297</td>
<td>0.274</td>
<td>0.264</td>
<td>0.731</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SI</td>
<td>0.213</td>
<td>0.448</td>
<td>0.368</td>
<td>0.171</td>
<td>0.809</td>
<td></td>
</tr>
<tr>
<td>BI</td>
<td>0.357</td>
<td>0.056</td>
<td>0.134</td>
<td>0.058</td>
<td>0.184</td>
<td>0.711</td>
</tr>
</tbody>
</table>

Table 3. Correlation and Square Root of AVEs Matrix

Due to the acceptable results by CFA, the structural model was developed.

4.2. Structural Model

Maximum likelihood, using Amos 26 was applied to measure the structural model. As a result, acceptable fit indices ($\chi^2$/df=1.848, GFI=0.902, TLI=0.928, CFI=0.940, NFI=0.880, RMSEA=0.056) were displayed. Results of regression weights as indicated in the structural model are represented in Table 4. The structural model with chi-square ($\chi^2$) value of 293.786, degree of freedom (df) value of 159, and p-value of 0.000 was displayed. This revealed that the model fitted the data adequately. As a result, it is possible to conclude the research hypotheses using the structural model (shown in Figure 2).
The independent and dependent variables will have a significant relationship if the p-value is less than 0.05. It will be insignificant otherwise (see Table 4).

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Relation</th>
<th>Dependent variable</th>
<th>Estimate (β-values)</th>
<th>P-value</th>
<th>Hypothesis conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Performance expectancy</td>
<td>⇨</td>
<td>Behavioral intention</td>
<td>-0.151</td>
<td>0.256</td>
<td>Rejected</td>
</tr>
<tr>
<td>Social influence</td>
<td>⇨</td>
<td>Behavioral intention</td>
<td>0.184</td>
<td>0.033</td>
<td>Accepted</td>
</tr>
<tr>
<td>Effort expectancy</td>
<td>⇨</td>
<td>Behavioral intention</td>
<td>0.213</td>
<td>0.105</td>
<td>Rejected</td>
</tr>
<tr>
<td>Behavioral intention</td>
<td>⇨</td>
<td>Use behavior</td>
<td>0.360</td>
<td>0.000</td>
<td>Accepted</td>
</tr>
<tr>
<td>Facilitating condition</td>
<td>⇨</td>
<td>Use behavior</td>
<td>0.301</td>
<td>0.000</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

Table 4. Regression Weights

As can be seen from Table 4, the results indicate that performance expectancy (β=-0.151, p-value>0.05) does not have a significant influence on behavioral intention to accept and use the new digital government innovation. This result is inconsistent with UTAUT (Venkatesh et al., 2003) that examined performance expectancy positively influences behavioral intention to accept and use information systems. The result deviates from the norm as most of the research on technology acceptance is done in developed countries (Im et al., 2011; Rahman et al., 2011). One possible explanation for the inconsistency of the two results is the difference in culture (Al-Gahtani, Hubona, & Wang, 2007; Leidner & Kayworth, 2006), where the two studies are done. UTAUT model was undergone in North America which is culturally different from Ethiopia. Performance expectancy...
will have less impact on intention specifically on a more collectivism and high power distance culture like Ethiopia where users conform to the expectation of others in higher social roles (Im et al., 2011).

Moreover, the results also reveal that effort expectancy ($\beta=0.213$, $p$-value $>0.05$) does not have a significant influence on behavioral intention to accept and use the new government digital innovation. This result is also inconsistent with UTAUT (Venkatesh & Davis, 2000; Venkatesh et al., 2003) that examined effort expectancy is a significant predictor of intention. The possible explanation for this inconsistency is the difference in culture where the two studies are carried out (Al-Gahtani et al., 2007; Leidner & Kayworth, 2006). Similarly, it can be explained that the influence of effort expectancy will be weaker in a more collectivism and high power distance culture like Ethiopia where users decision to accept and use new technology is significantly affected by other factors such as social norms (Im et al., 2011).

On the other hand, social influence ($\beta=0.184$, $p$-value $<0.05$) has a positive impact on the intention to accept and use the new digital government innovation. This means that when employees are encouraged by their boss or colleagues, users will tend to use the new digital government innovation. This is also consistent with UTAUT (Venkatesh et al., 2003) that examined social influence positively influences intention.

The results also show that behavioral intention ($\beta=0.360$, $p$-value $<0.05$) has a positive influence on the usage of the new digital government innovation. This means that when employees have more intention to use digital innovation, they regularly use it. This result is consistent with UTAUT (Venkatesh et al., 2003) that examined behavioral intention has a significant influence on the usage of information systems.

The results show that facilitating conditions ($\beta=0.301$, $p$-value $<0.05$) positively influences the usage of the new digital government innovation. When employees are supported with appropriate resources to use digital innovation, they frequently use it. The result is consistent with UTAUT (Venkatesh et al., 2003) that explored facilitating conditions positively influences the usage of information systems.

### 4.3. Moderating Effect

Maximum likelihood using Amos 26 was used to test the influence of gender on the relationship between performance expectancy and behavioral intention, effort expectancy and behavioral intention, social influence and behavioral intention, and facilitating condition and use behavior of government employees to accept and use the digital government innovation. The moderating variable helps to demonstrate if it could affect the direction of the relation or the strength of the relationship between the dependent and independent variables (Hung et al., 2018). To evaluate the moderating effect, cross-multiplication of the observed variables, and moderating variable, gender was carried out. As a result, the standard regression coefficients ($\beta$-values) were obtained as indicated in Table 5 below. The results reveal that the regression coefficients were insignificant except that of the interaction of gender and facilitating conditions ($\beta=0.160$, $p=0.026$).

The result reveals that gender is a moderating variable for the relationship between facilitating condition and use behavior. External support to use the digital innovation makes a significant difference among men and women government employees. On the other hand, gender does not have a significance influence on the relationship between performance expectancy and behavioral intention ($\beta=-0.002$, $p=0.976$). This means that there is no difference in the behavioral intention of men and women government employees towards the usefulness of the new digital innovation. The result is inconsistent with UTAUT (Venkatesh et al., 2003). This inconsistency could be created due to the influence of culture as indicated by Baker, Al-Gahtani & Hubona (2007). Also, gender
does not have influence on the relationship of effort expectancy and behavioral intention (β=0.035, p=0.647). This shows that there is no significant difference among men and women government employees on the ease of use of the web app. This contradicts the result of UTAUT (Venkatesh et al., 2003) that explored gender as a moderating factor in the relationship between effort expectancy and behavioral intention. The explanation may be men and women in this study have almost similar educational background and work experience that could not make a difference in using the web app. Moreover, gender does not have influence on the relationship between social influence and behavioral intention (β=0.077, p=0.289). This means that social influence does not create a significant difference in the behavioral intention among men and women government employees to use the web app. This is inconsistent with the result of UTAUT (Venkatesh et al., 2003). One explanation may be in a more collectivistic culture like Ethiopia, technology adoption is highly affected by the social influences irrespective of gender (Faqih & Jaradat, 2015).

### Table 5: Moderator Analysis Results

<table>
<thead>
<tr>
<th>Hypothesis</th>
<th>Relationship</th>
<th>Std. Beta</th>
<th>p-value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1</td>
<td>PE x Gender BI</td>
<td>-0.002</td>
<td>0.976</td>
<td>Rejected</td>
</tr>
<tr>
<td>H2</td>
<td>EE x Gender BI</td>
<td>0.035</td>
<td>0.647</td>
<td>Rejected</td>
</tr>
<tr>
<td>H3</td>
<td>SI x Gender BI</td>
<td>0.077</td>
<td>0.289</td>
<td>Rejected</td>
</tr>
<tr>
<td>H4</td>
<td>FC x Gender UB</td>
<td>0.160</td>
<td>0.026*</td>
<td>Accepted</td>
</tr>
</tbody>
</table>

*: Significance at 0.05 levels

This research further explored which group of gender (men or women) produced the highest impact. A multi-group analysis based on gender was implemented to examine the influence of each group on the moderation effect. As a result, the standardized regression coefficients (β-values) of the two groups are presented in Table 6 below. The result implies that the men group has a dampening effect (β=-0.199, P=0.016) on the relationship between facilitating conditions and use behavior since β-value is negative. While the positive moderation effect of the women group was found to be significant on the relationship between facilitating conditions and use behavior with positive β-value (β=0.429, p=0.025). The interpretation is indicated in the discussion section below.

### Table 6: The Effect of Gender on the Moderation Effect

<table>
<thead>
<tr>
<th>Gender</th>
<th>Relationship</th>
<th>β -value</th>
<th>p-value</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>FC x UB</td>
<td>-0.199</td>
<td>0.016*</td>
<td>Dampening effect</td>
</tr>
<tr>
<td>Women</td>
<td>FC x UB</td>
<td>0.429</td>
<td>0.025*</td>
<td>Positive moderating effect</td>
</tr>
</tbody>
</table>

*: Significance at 0.05 levels

### 5. DISCUSSION OF RESULTS

The impact of government employees’ gender on the four main constructs of the UTAUT model for accepting and using government web app was investigated.

Overall, the digital government innovation was regarded as not being easy to use, mainly because no training was offered. It was therefore understandable that the users did not believe the web app could assist them to perform their jobs better. Nonetheless, they identified that they would still use it because of the social influence from the peers and the bosses.

The results show that gender has a moderating effect on the relationship between facilitating conditions and use behavior of government employees to use and accept the new digital government.
innovation. The women group was found to have a positive moderation effect on the relationship between facilitating conditions and use behavior with positive β-value (β = 0.429, p = 0.025). This means that when women government employees obtain more external support to use digital innovation, they are more likely to adopt it compared with men who were unlikely to adopt the digital innovation even if they were facilitated, and would actually use it less.

The result is consistent with the finding of Faqih & Jaradat (2015). One explanation presented is the psychological differences among women and men where external supportive factors are more important to women than they are to men.

The results of this study imply that governments of low-income countries such as Ethiopia should design appropriate policy issues that can encourage women in using local digital government innovations.

The paper contributes to practice and policy in revealing how governments of low-income countries should consider external supports and facilities while implementing locally designed digital government innovations.

6. CONCLUSION

The purpose of the study was to explore the moderating effect of gender on the acceptance and use of a digital government innovation. UTAUT model was used to examine the influence of gender on the relationship between the independent and dependent constructs. Moreover, structural equation modeling (SEM) using Amos 26 was adopted to examine the moderating effect of gender. The results reveal that gender has a moderating effect on the relationship between facilitating condition and use behavior of government employees to accept and use the government web-based app, while it does not affect the other relationships. Multi-group analysis was used to examine the moderating effect of gender on the relationship between facilitating condition and use behavior of government employees that use the digital government innovation. The result shows that the women group has a positive influence on moderating the relationship between facilitating condition and use behavior.

6.1. Limitation and Future Research

The research was limited to using only gender as a moderating factor on a small sample of Woredas in the Amhara Regional States of Ethiopia. Future studies should also consider increasing the sample Woredas from different regional states and different stakeholders across Woredas.

REFERENCES


Proceedings of the 1st Virtual Conference on Implications of Information and Digital Technologies for Development, 2021


Appendix A

<table>
<thead>
<tr>
<th>Construct</th>
<th>Question items</th>
</tr>
</thead>
<tbody>
<tr>
<td>PE</td>
<td>PE1 I find the web-based app useful to learn about what others are doing.</td>
</tr>
<tr>
<td></td>
<td>PE2 Using the web-based app increases my chances of getting important information.</td>
</tr>
</tbody>
</table>
Using the web-based app helps me obtain important information more quickly. 
Using the web-based app increases my productivity at work. 

Learning how to use the web-based app is easy for me.
My interaction with the web-based app is clear and understandable.
I find the web-based app easy to use.
It is easy for me to become skillful at using the web-based app.

People who are important to me think that I should use the web-based app.
People who influence my behavior think that I should use the web-based app.
People whose opinions that I value prefer that I use the web-based app.

I have the resources necessary to use the web-based app.
I have the knowledge necessary to use the web-based app.
The web-based app is compatible with other technologies I use.
I can get help from others when I have difficulties using the web-based app.

I intend to continue using the web-based app in the future.
I will always try to use the web-based app in my daily life.
I plan to continue to use the web-based app frequently.

I have ever used a web-based app.
I often use web-based apps.

Note: PE=performance expectancy, EE=effort expectancy, SI=social influence, FC=facilitating condition, BI=behavioral intention, UB=use behavior

Table 7. Question Items of the Survey Adapted from (Tan, 2013)

Appendix B
<table>
<thead>
<tr>
<th>Variable</th>
<th>PE4</th>
<th>0.672</th>
<th>1.261</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effort Expectancy</td>
<td>EE1</td>
<td>-0.326</td>
<td>0.013</td>
</tr>
<tr>
<td></td>
<td>EE2</td>
<td>-0.372</td>
<td>-0.007</td>
</tr>
<tr>
<td></td>
<td>EE3</td>
<td>-0.756</td>
<td>2.732*</td>
</tr>
<tr>
<td></td>
<td>EE4</td>
<td>-0.930</td>
<td>2.213*</td>
</tr>
<tr>
<td>Social Influence</td>
<td>SI1</td>
<td>-0.932</td>
<td>0.849</td>
</tr>
<tr>
<td></td>
<td>SI2</td>
<td>-0.811</td>
<td>0.372</td>
</tr>
<tr>
<td></td>
<td>SI3</td>
<td>-0.862</td>
<td>0.362</td>
</tr>
<tr>
<td>Facilitating Conditions</td>
<td>FC1</td>
<td>-0.494</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>FC2</td>
<td>-0.385</td>
<td>-0.036</td>
</tr>
<tr>
<td></td>
<td>FC3</td>
<td>-0.740</td>
<td>0.840</td>
</tr>
<tr>
<td></td>
<td>FC4</td>
<td>-0.603</td>
<td>0.056</td>
</tr>
<tr>
<td>Behavioral Intention</td>
<td>BI1</td>
<td>-0.555</td>
<td>0.123</td>
</tr>
<tr>
<td></td>
<td>BI2</td>
<td>-0.807</td>
<td>0.925</td>
</tr>
<tr>
<td></td>
<td>BI3</td>
<td>-0.730</td>
<td>0.512</td>
</tr>
<tr>
<td>Use Behavior</td>
<td>UB1</td>
<td>-0.654</td>
<td>0.741</td>
</tr>
<tr>
<td></td>
<td>UB2</td>
<td>-0.647</td>
<td>0.751</td>
</tr>
</tbody>
</table>

* Kurtosis out of -2 to +2 range

Table 8. Normality Assessment
PATTERNS OF ICT USAGE IN DISASTER IN SAMOA

Ioana Chan Mow, National University of Samoa, i.chanmow@nus.edu.ws
Agnes Wong Soon, National University of Samoa, a.wongsoon@nus.edu.ws
Elisapeta Maua’i, National University of Samoa, e.mauai@nus.edu.ws
Ainsley Anesone, National University of Samoa, a.anesone@nus.edu.ws

Abstract: The study discussed in this paper focuses on ICT use during disasters in Samoa and is a replicate of a study carried out in 2015. The study used a survey to explore how Samoan citizens use technology, act on different types of information, and how the information source or media affects decisions to act during a disaster. Findings revealed that traditional broadcasting were still the most prominent, most important, and still predominate in early warning and disaster response. However, there were now increasing usage of mobile and social media in disaster communications. Findings also revealed that people trust official reporters the most as source of information in times of crisis. The intent is that findings from this study can contribute to a people-centred approach to early warning and disaster providing empowerment to affected individuals to act in a timely and appropriate manner to ensure survival in times of disaster.

Keywords: disaster, crisis, early warning, collective action, trust, ICT, people-centred

1. INTRODUCTION

While technology access has expanded worldwide, there is still limited research about how people use the technology available to them during crisis, and what the effects of varying socio-political and economic contexts are on the level of trust people place on information from different sources and technical mediums. The study discussed in this paper focuses on ICT use during disasters in Samoa at the individual level and is a replicate of the original study carried out in 2015 (Mow, Shields, Sasa, & Fitu, 2017).

The objectives of the research were to resolve the following questions:

How can Samoans use their mobile and internet devices during times of crises and natural disasters?

How do Samoan citizens act on different types of information and how does the source of information affect their decisions to act?

Attempts were also made to compare the findings to the 2015 study. The aim of the second study was to determine if any significant changes had occurred in the last 5 years as well as the added interest of early warning systems in the light of the current pandemic. In Samoa disasters such as cyclones and flooding are common occurrences particularly during the wet season. Timely warning of approaching cyclones and the imminence of floods saves lives and the use of technology coupled with timely action based on trusted sources of information are critical factors and hence the motivation for this research. The intent is that findings from this study can contribute to a people-centred approach to early warning and disaster providing empowerment to affected individuals to act in a timely and appropriate manner to ensure survival in times of disaster. Early warning is defined as ‘the provision of timely and effective information, through identified institutions, that
allows individuals exposed to a hazard to take action to avoid or reduce their risk and prepare for effective response’ (UNISDR, 2004). A people-centred early warning system comprises of four interacting elements (i) risk knowledge, (ii) monitoring and warning service, (iii) dissemination and communication and (iv) response capability (UNISDR, 2004). As pointed out by Twigg (2002), the human factor in early warning systems is highly significant and failures attributed mainly to the communication and preparedness elements (Basher, 2006). At the root of all this is the need for the provision to communities of information which can empower them to make the right decisions to protect themselves and respond accordingly. Factors such as risk awareness, personal trust to the government and mass media, involvement in the community and social networks can influence their preferred warning information source (Lindell & Perry, 2012; Rahayu, Comfort, Haigh, Amaratunga & Khoirunnisa, 2020).

The main area of interest in this research is to understand how citizens can use their mobile and internet devices during crises and natural disasters. Since communication infrastructure is a “magnifier of human intent,” there is a relationship between social capital, good governance, and how people act on different streams of information. Such a study is also timely in the light of the current pandemic with its heavy reliance on technology and also the need to investigate how information can be transmitted vertically and laterally in times of such a crisis.

2. LITERATURE REVIEW

While technology access has expanded worldwide, there is still limited research about how people use the technology available to them during crisis, as well as what the effects of varying socio-political and economic contexts are on the level of trust people place on information from different sources and technical mediums. While the commercial and economic benefits of increased mobile phone and data connectivity have been evident to agencies such as the World Bank and the telecommunications industry since the early 2000s, the benefits of these technologies with regards to governance and crisis response have only started to emerge in the last eight to ten years (Eggleston, Jensen & Zeckhauser 2002; Kirkman, Cornelius, Sachs, & Schwab 2002).

In discussing ICTs and development it is important to differentiate between social and technological research. A great deal of research and development has gone into software and hardware for development and crisis response. Instances include the Qatar Computer Research Institute (QCRI) which is leading efforts to automate the tracking and coding of Tweets from disaster zones (Meier, 2013) and Ushahidi who has developed a brick-sized device that acts as a remote internet hotspot (Rotich, 2017). Furthermore, data science continues to expand our understanding of how to use the vast amounts of data generated via ICTs (Crawford, 2013).

The current study focuses on the human side of technology use during crises, using surveys to ascertain what information technologies people choose to use when making a decision to act during a crisis.

Letouze, Meier and Vinck (2013) argued that big data (and by extension the technologies that allow people to contribute to big datasets) can be packaged and used in such a way that it empowers communities to develop their own local-level responses to crisis, since larger government and governance organizations often cannot react quickly to emerging risks. This concept is mirrored in an earlier paper by Meier (2008), critiquing the problems with traditional conflict early-warning systems; the methods that are used for early warning are too aggregate to provide information to policy makers and first responders quickly enough to prevent violence.

Crises present a variety of collective action and decision-making problems, involving high risk and low information. In crises two factors are key in collective action problems: one is group size and the other is group cohesion (Olson, 1965). ICTs help alleviate both of these problems, because they can broadcast to a very large audience with little difference in cost (Lupia & Sin, 2003). The transmission costs of an individual text message versus a text message sent to hundreds of recipients is negligible. In a social networking platform like Twitter, thousands of people can receive and
rebroadcast a message within minutes at no cost to the original sender (except for the overhead of having an internet connection). ICTs, because of their technical attributes, take care of the problems related to population size, cost, and regularity of information transmission. Information is a critical resource in times of disaster allowing responders to effectively manage a disaster and those affected to best adapt to the threat (Steelman, McCaffrey, Velez & Briefel, 2015). It is in these situations where ICTs become useful, since they can be used to share large amounts of data laterally and vertically very quickly.

This leaves the socio-political question of what information mediums and sources people trust and will act on. As Gurstein (2014) pointed out, “...what is particularly important here is the significance not simply of the availability of information but also of the capacity to identify what information is important, who the information would be important to, and how to bring that information to the attention of those for whom it will be important and useful”.

But ICTs do not cause people to act; people take action when they trust the information they receive, and trust is a socio-political outcome not a technology-driven one. Trust is a key element which influences the response of a receiver of information in times of disaster (Renn & Levine, 1991; Kasperson & Stallen, 1991).

Until recently scant attention has been paid to what sources of information recipients turn to, find useful or trust in times of disaster (Steelman et al., 2015). An understanding of what sources and media of information people trust and regard as useful and important will result in more effective communication in early warning and disaster. These are the aspects of disaster response which are evaluated in this research. The research investigates what sources and medium of information responders or people trust in times of disaster; what sources and media they will act upon and consider important.

In Samoa, technology is used in disaster and relief management in various ways. Alerts forwarded from the Tsunami centre in Hawaii and early warning from the Emergency Managers Weather Information Network (EMWIN) are received by Disaster management organisation (DMO), Meteorology section via mobile, email and by fax. These alerts are then disseminated to selected citizens in every village via a range of modern and traditional media such as pre-programmed SMS, radio, tv and email. These will then give rise to warning signals such as use of church bells, school bells and also continuous sound of sirens to warn the public of imminent and approaching disaster.

3. METHODOLOGY

The proposed study is quantitative in nature. A survey was used to collect data. The survey instrument in the form a questionnaire consisted of the following sections:

i. Respondent details
ii. Ownership of phones and accessibility to selected social sites
iii. News and information
iv. Emergency information-(e.g.,) cyclone, earthquake, tsunami
v. Taking action during an emergency (e.g.,) cyclone, earthquake, tsunami
vi. Importance of information sources

(Please refer to the English and Samoan version of the questionnaire attached.)

3.1 Sample

Sample selection was based on both population size and geographical location to ensure representativeness. The proposed study used the geographical subregions based on the Samoa Bureau of Statistics (SBS) census divisions, where Samoa is divided into 4 subregions: i) Savaii, ii) Urban Upolu, iii) Northwest Upolu and iv) the Rest of Upolu. The survey was conducted on a sample of 400 households based on 1 participant interviewed per household. To ensure a representative sample indicative of population density and geography, proportionate sampling was used at the level
of subregions based on SBS 2016 Census data. Hence the sample of 400 comprised of 89 from Savaii, 76 from Urban Upolu, 142 from North West Upolu and 93 from the Rest of Upolu. Within each subregion, convenience sampling was used to obtain the necessary samples within districts and villages.

<table>
<thead>
<tr>
<th>Subregion</th>
<th>Total population SBS 2016 Census</th>
<th>%</th>
<th>Weighted Sample by subregion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samoa</td>
<td>195,979</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apia Urban Area</td>
<td>37,391</td>
<td>19.1</td>
<td>76</td>
</tr>
<tr>
<td>North West Upolu</td>
<td>69,376</td>
<td>35.4</td>
<td>142</td>
</tr>
<tr>
<td>Rest of Upolu</td>
<td>45,652</td>
<td>23.3</td>
<td>93</td>
</tr>
<tr>
<td>Savaii</td>
<td>43,560</td>
<td>22.2</td>
<td>89</td>
</tr>
</tbody>
</table>

Table 1. Weighted sample of 400 based on 4 subregions of Samoa

3.2 Procedures
The survey team administered the survey to respondents in the 4 subregions. Eligible respondents for the survey were members of the surveyed household in the age range 18 to 40. The survey and the consent form were made available in both English and Samoan. For each subregion the survey team used convenience sampling and surveyed people in key convenience locations such as shops and community centres. After signing the consent form, each participant was questioned by a member of the survey team and responses recorded on the survey form.

3.3 Data Analysis
Data included information on trust and use of information from different sources and technical mediums (e.g. mobile phone, social media, etc.). Statistical analysis was conducted using SPSS with the data primarily being descriptive statistics.

4. RESULTS AND DISCUSSION
The results of the analysis are reported in the sections in the order within which they are located in the questionnaire. In the case of multiple response items, the findings are reported as percentages or proportion of the total sample (400).

4.1. Nature of Study Participants
There were 400 respondents for this survey from the 4 subregions of Samoa with proportions reflecting 2016 Census proportions by subregion. The sample was selected across 38 districts and 141 villages. Respondents were in the age range 18 to 75 with an average age of about 31. Sample were predominantly female and consisted of 36.2% male and 63.8% female. In terms of marital status 54% were single, 41.5% married, 3% divorced/separated and 1.5% widowed. In terms of employment status, sample were predominantly employed (42.5%), 32% students, 10% domestic duties, 10% self-employed, 0.5 % special needs.

4.2. Ownership of phones and accessibility to selected social sites
Results of the survey indicated that 94% of the respondents owned a mobile phone. This figure is about the same as the World Bank national statistic (2020) on mobile ownership of 90%. Of these mobile phone owners, 82.5% owned smart phones. The findings indicate that mobile phone ownership remain relatively high and similar to the 2015 figure of 91% but a massive increase in ownership of smartphones from 34% in the 2015 survey to 82.5% in the 2020 survey. This implies that any emergency services can now target smartphones. A possible cause of this is the affordability and accessibility of mobile phones. With the high rate of mobile ownership and smartphones, this
also implies that use of SMS and cell broadcasting and other mobile apps can be viable and cost-effective forms of dissemination of emergency warnings and notices.

**Figure 1. Ownership of mobile phones**

In terms of mobile providers, results indicated that Digicel was the dominant provider at 52% followed by Vodafone 32% and with 15% (23%) indicating service from both providers. Compared to the 2015 survey, Digicel was still the dominant provider but Vodafone (previously Bluesky) had now doubled its market share compared to 15% in 2015. This finding has valuable implications on decisions on SMS and cell broadcasting services.

**Figure 2. Telephone providers**

About 89% of the respondents with cell phones indicated that they use their cell phone for Internet access compared to 56% in the 2015 study. An evaluation of how people access Internet from home indicated that 89% access through mobile phone, 24% use home computers and only 8% use tablets. Again, the findings indicate a sizable increase in access by mobile phone from 52% in 2015 to 89% in 2020.

An evaluation of the use of applications revealed that about 88% use IPchat applications, 90% use Facebook and only 11% use Twitter. These figures indicate a huge increase (almost triple) in the use of IPchat applications from 26% in 2015 to 88%, as well as 65% in 2015 to 90% in 2020 for Facebook usage. The large proportion of IPchat application users and Facebook users indicate that
these types of social media may be used for dissemination of disaster warnings and response information.

Figure 3. Means of Internet Access

4.2.1. Who People Trust in an Emergency
In trying to understand collective action problems, one focus of this study was to determine who people trust during an emergency. Results indicated that 95% trusted government and 84% trusted that the Matai or council of chiefs will provide them with the necessary emergency relief. These figures indicate an increase in trust in both government and matai from the 2015 survey but also that people continue to place a high level of trust in government to provide them with the necessary emergency relief during disasters, as well as the village leaders (Matai).

4.2.2. Who do People Turn to for help
When asked as to whom they turn to for help, respondents gave a range of responses. The most common responses were family (31%) followed by government (13%) and then the Disaster Management Office (DMO) (10%). When asked for reasons given for their choice of who to turn to, majority indicated “trust” (18%),” those that act fast” (14%) and that their choice was due to that” it was their job to act” (13%). Such responses are useful in guiding decisions on key agents for disaster and emergency relief response. It is also interesting to note that participant responses to this item, were shaped and conceptualized in the light of recent emergency events such as the measles epidemic and the current COVID pandemic.

4.3. News and Information
This section of the survey aimed to determine sources of news and information used by people. When asked from whom they get their news from, most respondents indicated professional reporters (83%), friends (50%), family matai (46%), government (39%) and mayor (Pulenuu) (20%), as the main source of news and information. Professional reporters refer to official media personnel such as radio, television and newspaper reporters. There was an overall increase compared to 2015 across all categories with professional reporters still the most popular source of news.
4.3.1. Sources People get News from

In terms of what sources people get news from, findings indicated a predominance of TV with 84% indicating TV1 as their news source, 44% TV3, 20% EFKS TV. In terms of radio 62% source news from Talofa FM, 51% from Radio 2AP, 21% from Magik FM. There was also an increase in Mobile SMS as a news source to 57%, Internet at 40% and newspaper at 21%. These findings indicate a shift of predominance to both TV and radio as well as increased prominence of the use of mobile SMS and the Internet as sources for news. These findings are similar to studies by Becker (2004), Taylor et al., (2007) and Cretikos et al., (2008) which indicated the predominance of mass media such as radio and television as a source of information.

4.4. Emergency Information

4.4.1. Whose information People trust in an emergency

Respondents were asked about whose information they trust during an emergency. Responses indicated 45% trusted information from professional reporters, 33% trust information from government, 28% trust information from the family matai\(^1\) and 13% trust friends as the main source of information they trust in an emergency. Only 10% of the respondents indicated the village Pulenuu as a trusted source of information. These findings suggest a change from 2015 where professional reporters and family matai were the main sources of trusted information. It also suggests an increase in trust in government for providing information during an emergency.

---

\(^1\) Family chief or head of the family
4.4.2. What sources of media do people trust in an emergency

In terms of what sources of media were trusted in times of emergency, there were a range of responses. Findings indicate the 5 main sources people trust are TV1 (49%), Talofa FM radio (35%), Radio 2AP (34%) Internet (30%) and Mobile SMS (29%). These findings seem to suggest a shift towards both radio and TV and also increasingly now the Internet and Mobile SMS in terms of sources people trust in an emergency.

4.5. Taking Action during an Emergency

4.5.1. Whose information people act upon during an emergency

In emergency situations it is not sufficient for people to just receive information but also to act upon information given in a timely manner in order to save lives and prevent hazardous impacts of disaster. Results of the survey indicated that during an emergency people act primarily upon information from professional reporters (37%), family chief (matai) (34%) followed by government (33%), the village pulenuu\(^2\) at 14% and friends (9%). These findings are similar to the 2015 findings.

\(^2\) Village mayor
Furthermore, a graph of whose information people trust and act upon (Figure 9), indicate that proportions of these two are very similar, thus indicating that people will act upon information from sources that they trust.

4.6. Importance of Information Sources

4.6.1. What sources of information people act upon

Investigation of what sources of information people act upon during an emergency using percentages of total sample indicated that findings follow closely the proportions of what sources of information people trust during an emergency. People acted upon information from sources of media that they trust. Hence, as indicated earlier, findings indicate the 5 main sources people trust and act upon are TV1 (44%), Talofa FM radio (33%), Radio 2AP (32%) Internet (24%) and Mobile SMS (25%). These findings seem to suggest predominance of both radio and tv and also increasingly now the Internet and Mobile SMS in terms of sources people trust and act upon in an emergency. This suggests that people will act upon information from sources of media that they trust.
4.6.2. Whose information is most important/least important

The survey also rated whose information and what sources were the most and the least important. Results indicated that on the subject of whose information was rated the most important in an emergency, 47% indicated professional reporters followed by government at 31% and family matai (18%). It is interesting to note that information from friends was rated very low. This is confirmed by the probe on whose information is rated as the least important where there was a range of responses but 72% rated information from friends as being the least important. These ratings are very similar to those of the 2015 survey.

4.6.3. What source of Information is most important/least important

The probe on what source of information was rated as the most important, indicated that radio collectively, was rated as the most important category, particularly the government owned 2AP (39%) and Talofa FM radio station (16%) followed by TV1 television (30%). On the probe on what source was the least important, Newspapers (42%) and Internet (29%) were rated as the least important source of information in an emergency.
4.7. Summary of Findings and Recommendations

The results summarised below provide answers to the two research questions which are the focus for this research.

The first list of findings attempts to address the first research question: **How can Samoans use their mobile and internet devices during times of crises and natural disasters?**

1. The predominance and pervasiveness of mobile phones at 94% indicate its potential for use in any disaster response and relief interventions and according to the first model can be used for lateral dissemination of information in an emergency.

2. With 82.5% of mobile phones being Smart phones – disaster preparedness, early warning and response interventions can now use not just text based but also smart apps. Mobile phones can be used by citizens to disseminate early warning, keep informed of any disaster and response updates in times of need.

3. The low usage of Twitter (11%) indicates that currently it is not the most effective media for disaster response management and lateral dissemination. However, with the huge increase in usage of IPChat applications (88%) as well as 90% Facebook usage, such social media should be considered as viable avenues for lateral dissemination for early warning and disaster response.

The rest of the findings attempts to address the second research question: **How do Samoan citizens act on different types of information and how does the source of information affect their decisions to act?**

1. People continue to place a high level of trust in both government (95%) and village leaders (84%) (matai) to provide them with the necessary emergency relief during disasters.

2. Professional reporters are regarded by the majority as the most predominantly used, the most trusted people whose information was most likely to be acted upon, and the most important source of information and news during an emergency. Professional reporters refer to official media personnel such as radio, television and newspaper reporters thus implying that radio and television are not only the most trusted sources, but also the most trusted media of information. In addition to professional reporters, people also trust and act upon information from government and family matai or chiefs. Hence this has implications on what effective sources of information need to be used for disseminating information during an emergency. Professional reporters as well as family chiefs (matai) are then reliable third party that can be used for dissemination of information in times of disaster.
emergency. This supports the claim that any disaster warnings need to be issued through 'credible' sources (Ronan and Johnston 2005).

3. People will act upon information from people sources they trust as well as media sources that they trust.

4. The predominance of radio and TV as an important, trusted source of information which people use and most likely to act upon, indicate their important role in any emergency response interventions. As well there is also increasing usage and trust in Mobile SMS and Internet. Since these media are trusted sources they should be used extensively for dissemination of information for preparedness, early warning and disaster response.

5. An interesting finding is the low level of importance people place on the Internet and newspapers. This may be due to people’s perceptions of the lack of reliability of the Internet and newspapers, which are possibly due to these being perceived as sources of “fake news” and “delayed updates”.

As mentioned earlier, the motivation to replicate the study was to evaluate whether there were any significant changes to the findings of the 2015 study. Specifically, the focus was to determine any changes in what technology devices can people use in times of disaster as well as sources and media people trust and use in emergency and disaster. A summary of the comparisons between the two studies appear below:

1. Findings indicate that mobile phone ownership remain relatively high and similar to the 2015 figure of 91% but a massive increase in ownership of smartphones from 34% in the 2015 survey to 82.5% in the 2020 survey. Digicel was still the dominant provider but Vodafone (previously Bluesky) had now doubled its market share compared to 15% in 2015. Findings indicate a sizable increase in Internet access by mobile phone from 52% in 2015 to 89% in 2020.

2. A huge increase (almost triple) was evident in the use of IPchat applications from 26% in 2015 to 88%, as well as 65% in 2015 to 90% in 2020 for Facebook usage. The large proportion of IPchat application users and Facebook users indicate that these types of social media can be used for dissemination of disaster warnings and response information.

3. In terms of who to trust in times of emergency, findings indicate an increase in level of trust in both government (95%) and matai (84%) from the 2015 survey but also that people continue to place a high level of trust in government to provide them with the necessary emergency relief during disasters, as well as the village leaders (Matai). When asked as to whom they turn to for help, the most common responses were family (31%) followed by government (13%). In terms of whose information can be trusted in emergencies, findings were similar to the 2015 study in terms of trust in information from professional reporters and matai but there also was now increasing trust in government. In terms of sources people trust and act upon in an emergency, findings indicate predominance of both radio and TV as of the 2015 study, but also increasingly now the Internet and Mobile SMS. This suggests that people will act upon information from sources of media that they trust.

But how do these findings contribute towards early warning and disaster response and relief management? One way to answer this is by reviewing work by Meier (2013) which indicate that in the field of disaster management, traditional centralized and external modes of early warning and response are becoming less and less effective owing to the increasing complexity of humanitarian emergencies. This has led in a shift to people centred early warning and disaster response. The 2006 UN Global Survey of (disaster) Early Warning Systems (UNISDR, 2006) defined the purpose of people-centred early warning as “to empower individuals and communities threatened by hazards to act in sufficient time and in an appropriate manner so as to reduce the possibility of personal injury, loss of life, damage to property and the environment, and loss of livelihoods”. In the context of people centred early warning and disaster response, the findings from this survey have indicated which information sources are important, what information sources people trust and act upon. An
example of “people centredness” is the use of mobile phones by citizens to find shelters, avoid hazardous areas, call for rescue so people can act in timely manner to avoid losses. Such information would also enable policy makers to establish a people centred early warning systems and disaster response which will empower individuals to act in sufficient time and appropriate manner in times of emergency and disaster.

Secondly, two areas from Mancur Olson’s work (1965) on collective action problems which are key in a crisis situation are group size and group cohesion. ICTs such as radio, television and mobile because of their technical attributes, take care of the problems related to population size, cost, and regularity of information transmission. The findings of this survey have identified which technologies or ICTs are predominant in terms of sources people trust and will act upon. From the findings of this survey the key ICT technologies people trust and act upon are radio and television but the predominance of mobile technology in Samoa also needs to be factored in, into any early warning and disaster response systems.

In conclusion, findings from this research need to be made available to Ministry of ICT, National Emergency Operations Centre (NEOC), Telecom and Internet providers and the Disaster Management office (DMO) to inform policy making and planning. Regular updates of this information are also essential to inform optimal methods of implementing early warning and disaster response systems.

Data and findings from this study is theoretically valuable for researchers working on e-governance, while also being practically useful for external agencies such as UNDP and UNOCHA since it demonstrates the level of information the citizenry has about communication technology-supported crisis response programming, which can be an indicator of their willingness to participate and make technology-aided e-governance programs sustainable.

Such a study is also timely in the light of the current pandemic with its heavy reliance on technology and also the need to investigate how information can be transmitted vertically and laterally in times of such a disaster. It can be argued that these same types of people or community based early warning systems can be developed for pandemics and diseases such as malaria (Macherera & Chimbari, 2016).

5. REFERENCES AND CITATIONS


FROM DIGITAL DIVIDE TO DIGITAL JUSTICE IN THE GLOBAL SOUTH:
CONCEPTUALISING ADVERSE DIGITAL INCORPORATION

Richard Heeks, Centre for Digital Development, Global Development Institute, University of Manchester, UK, richard.heeks@manchester.ac.uk

Abstract: The connection between digital and inequality has traditionally been understood in terms of the digital divide or of forms of digital inequality whose core conceptualisation is exclusion. This paper argues that, as the global South moves into a digital development paradigm of growing breadth and depth of digital engagement, an exclusion worldview is no longer sufficient. Drawing from ideas in the development studies literature on chronic poverty, the paper argues the need for a new concept: “adverse digital incorporation”, meaning inclusion in a digital system that enables a more-advantaged group to extract disproportionate value from the work or resources of another, less-advantaged group. This explains why inequality persists – even grows – in a digital development paradigm. To help ground future research and practice on this issue, the paper inductively builds a conceptual model of adverse digital incorporation with three main component sets: the processes, the drivers, and the causes of adverse digital incorporation. The paper concludes with thoughts on a future research and practice agenda that seeks to deliver digital justice in the global South: a necessary reconfiguration of the broader components of power that currently shape the inclusionary connection between digital and inequality.

Keywords: adverse digital incorporation, digital divide, inequality, digital justice, digital development, ICT4D 3.0

1. INTRODUCTION

Inequality is one of the major challenges facing the world and there are significant concerns about the contribution of digital technology to inequality (UN 2020). The dominant lens for understanding the relation between digital and inequality has historically been that of the digital divide: of nations, regions, groups, individuals, etc. absolutely or relatively excluded from the benefits of digital technology (van Dijk 2020).

But we are now said to be moving towards a new phase or paradigm of the relation between digital and international development: “ICT4D 3.0” or “digital development” in which digital changes from being “a specific development tool to a general development platform” (Heeks 2020). What are the implications of this much broader, deeper role of digital in development for our understanding of the relation between digital and inequality?

Drawing from the development studies literature on chronic poverty, this paper argues that an increasing cause of inequality in the global South is not exclusion from digital systems but “adverse digital incorporation”: inclusion in a digital system that enables a more-advantaged group to extract disproportionate value from the work or resources of another, less-advantaged group. To understand this process, the main task of this paper is to build a conceptual model of adverse digital incorporation given no such model – nor, even, of adverse incorporation generally – yet exists.

It does this through inductive review of the literature on adverse incorporation and the illustration of key components of adverse incorporation through their application to digital systems – platforms particularly – in the global South. The paper concludes with a graphic representation of adverse digital incorporation and consideration of the implications of this as a basis for digital justice.
2. BACKGROUND

“When it is all said and done the telephone is not an affair of the millions. It is a convenience for the well-to-do and a trade appliance for persons who can very well afford to pay for it.” (The Times of 1902 cited in Mann 2010)

The telephone at the turn of the twentieth century may not have been a digital device but the quote above prefigures the concerns that arose with the growing diffusion of information and communication technologies (ICTs) during the last century. These crystallised in the mid-1990s with advent and growing use of the term “digital divide”; an idea which was soon applied on a global scale and became part of the parlance of international development (James 2003).

The digital divide was initially understood in Manichean terms: a dualism of “haves” vs. “have nots” that related to technology access; be it devices like PCs or services like Internet connectivity. Over time, the notion of the digital divide evolved and expanded in at least two ways (Ragnedda & Muschert 2013, van Dijk 2020):

a) Forwards along the information value chain: particularly expanding from technology access to consider divides in technology use – for example, deriving from differences in user skills and knowledge.

b) Backwards and outwards from the information value chain: particularly encompassing social inequalities (gender, race, disability, income, etc) that were seen as precursors to or even causes of the digital divide.

This broader and more contextualised view of the digital divide was sufficiently different from its origins that some sought to attach new labels, such as “digital inequality” (Robinson et al 2015, van Deursen 2017). Whichever the terminology, however, the foundational concept was exclusion and the underlying narrative was that particular groups or geographies were being prevented from accessing the benefits of digital technologies.

For those focusing on ICTs and development, such a worldview was generally sustainable in the first years of the twenty-first century as the majority of those in the global South were unable to access or use mobile phones or the Internet. The worldview remains relevant today to the hundreds of millions still without a mobile phone, the nearly three billion estimated to not use the Internet (ITU 2020), and all those unable to benefit from advanced digital applications like robotics or artificial intelligence. However, the worldview of exclusion is challenged in a world in which a significant majority of the global South’s population have a mobile phone, and a majority have Internet access (ibid.). They are now included in, not excluded from, digital systems.

This tide of change – not just growth in access to digital infrastructure in the global South but far greater levels of usage and increasing depth of digitalisation and platformisation – is such that we have come to talk of a new “digital development” or “ICT4D 3.0” paradigm (Heeks 2020). One could still argue for the singular relevance of exclusion within this emerging phase of ICTs and development if the relationship between digital and inequality could be shown to relate solely to the declining category of those excluded from use of digital systems. Yet evidence suggests this is not the case; that, instead, inequality is increasingly related to use of digital technologies in the global South (Murphy & Carmody 2015, Gurumurthy et al 2019, Heeks & Shekhar 2021). Our understanding of digital and inequality must therefore encompass not just problems of exclusion but also problems of inclusion.

This shifting perspective mirrors earlier debates around poverty and development. Initial views saw poverty from the perspective of social exclusion: "the process through which individuals or groups are wholly or partially excluded from the society in which they live" (Hickey & Du Toit 2007:2).
The economic prescription flowing from this was to integrate the poor into markets. Yet, poverty and inequality persisted following globalisation and marketisation of developing economies. As a result, a new perspective arose: that of adverse incorporation which argued that some groups could be differentially disadvantaged through their inclusion in markets, states and civil society (ibid.).

The concept of adverse incorporation has achieved a niche presence within development studies; its use perhaps constrained by the lack of any clear and systematic framework for its application. However, it seems a relevant foundation on which to base investigation into the relationship between inclusion in digital systems and inequality; what, for some, will represent adverse digital incorporation. This investigation now follows – an inductive and iterative exploration of key concepts from the adverse incorporation literature and their illustration from digital development case studies. The adverse incorporation literature is not extensive and the analysis was undertaken based principally on three seminal sources that provide core insights into the concept: Bracking (2003), Hickey & Du Toit (2007) and Phillips (2013).

From this, as already indicated, adverse digital incorporation can be defined as inclusion in a digital system that enables a more-advantaged group to extract disproportionate value from the work or resources of another, less-advantaged group (adapted from Phillips 2013). Initial high-level thematic analysis of this adverse incorporation literature was also undertaken, which identified three core conceptual categories: systemic processes of unequal incorporation, drivers to incorporation, and causes of adverse incorporation. Each of these will be analysed in turn as elements in the development of a conceptual framework.

3. ADVERSE DIGITAL INCORPORATION CONCEPTS

3.1 Process Patterns of Unequal Incorporation

Drawing from the definition, then central to adverse digital incorporation is exploitation in the sense of the extraction of value by one group from the efforts of others (Phillips 2013). This can be seen at the level of individual workers and their labour. A digital development illustration would be the gig economy digital platforms that extract value from the labour of their workers, leaving too little value for the workers themselves2. Thus, for example, some of those working for gig economy platforms in South Africa find themselves earning below minimum wage and almost all find themselves earning below the living wage: the minimum amount deemed necessary to fulfil basic needs (Fairwork 2020a). Exploitation can also be seen at the level of enterprises. For example, small enterprises like hotels and travel agencies in Africa increasingly seek to participate in the global tourism markets run by digital platforms, in the hope of reaching direct to tourists particularly from the global North. However, the main beneficiaries are the platforms: “the promise of disintermediation remains unrealized for many as new kinds of foreign, internet-enabled intermediaries have emerged (e.g. TripAdvisor) to concentrate market power, control information about destinations, and achieve significant levels of capital accumulation outside Africa” (Murphy & Carmody 2015:203).

One part of this pattern of exploitation would be commodification in which something previously untraded is turned into a traded item; thus incorporating the owner or producer into a market. An extreme example would be the women – and children – from countries such as the Philippines who participate in webcam sex (Kuhlmann & Auren 2015, Mathews 2017). Their bodies are commodified for the benefit of Internet-connected others in distant places and, certainly in the case of children, often with long-term traumatic results for themselves.

Also related is criminal exploitation where individuals are drawn into participation in online activities in which value and resources are illegally extracted from them. While the stereotype of

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2 This relates to paid labour but exploitation can also be seen with unpaid labour. The most obvious example would be the actions of social media platforms which capture value from the unpaid labour of users sharing their thoughts, feelings, photographs, videos, etc.
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one type of this – “419ers”, “Sakawa Boys” – has focused on those in global South countries as the perpetrators of fraud, they are also the victims. The Wangiri phone scam – after one ring, the call is cut and, when the recipient calls back, they are connected to a very high-cost premium-rate international call – has snared victims in Indonesia, Kenya, Pakistan and many other low-/middle-income locations (Priezkalns 2020).

These examples focus on extraction of value from labour or money but a further pattern of adverse digital incorporation is legibility: data about the existence or characteristics of a less-powerful group being captured in a digital system and thereby rendered visible to a more-powerful entity which then uses that data to enhance its power and control relative to the less-powerful group. Digital state surveillance systems throughout the world exhibit this pattern. China’s Social Credit System is the current apotheosis of this, integrating data about citizens and their online behaviour from public and private digital systems that has “exponentially increased [state] capabilities to monitor the populace” (Liang et al. 2018:434) and constitutes a form of “data-driven authoritarianism” (Lee 2019:953).

While legibility’s tropes of surveillance and control are particularly associated with the state, they are increasingly seen to affect workers in global South countries, as digital systems make them more legible to managers. Factory managers in China, for example, have required that workers all have mobile phones; that workers must respond immediately when called, even outside normal working hours, under threat of punishment for failure to do so; and that all messages are available for surveillance. As a result this digital device has become “a ‘wireless leash’ that shop-floor management can use as a nearly complete control and surveillance system over employees” (Qiu 2009:188).

If it were the digital equivalent of its physical predecessor, then enclosure would refer to the transfer into a privately- or state-owned digital system of what had previously been communal data or knowledge assets. Misappropriation of traditional community knowledge relating to plants and animals – so-called “biopiracy” – is a relatively well-known example. For instance, a USAID-funded project captured from the Shuar indigenous community in Ecuador the details of hundreds of local plants and their medicinal uses (Nagan et al. 2010). This was then passed on to the US government National Cancer Institute which placed this knowledge into a closed-access information system for use by large pharmaceutical companies.

3.2 Structural Components of Adverse Digital Incorporation

Drivers to Incorporation

Why do individuals join digital systems that have adverse consequences for them?

In some cases, this arises from ignorance: a lack of knowledge of those adverse consequences and a belief that incorporation will be beneficial. We can see this at work in criminal exploitation. Scams targeting South Asian victims use Middle-East country codes; deceiving the recipients into thinking they have a call from relatives working in those countries (Javaid 2020). In this example, there is no benefit from incorporation into the scam but in other examples of adverse digital incorporation, the ignorance is more nuanced: the benefits do exist, even if not quite in the form or to the extent anticipated, and the ignorance is either of the existence of adverse consequences or of their likelihood and extent. For example, gig workers in Africa join digital platforms in the expectation of certain levels of income and without a clear understanding of the risks involved (Anwar & Graham 2021).

This highlights an important point about adverse digital incorporation: it may well not be solely adverse; i.e. solely negative in its consequences. Those participating in China’s Social Credit

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3 Digital enclosure has also been rather more broadly applied to the capture of individual data (Andrejevic 2008). As with exploitation of unpaid labour, the most obvious example would be the actions of social media platforms which gain licence to distribute and use the thoughts, feelings, photographs, videos, etc. of individual users.
System receive benefits “such as deposit-free sharing economy services, fast-tracked check-ins for hotels, and mobile payment options” (Kostka 2018). Those working on gig economy platforms receive some level of income and some form of livelihood (Fairwork 2020a). Lack of benefit is not the essence of adverse digital incorporation. The essence, as noted above, is differential disadvantage – that a more-advantaged group disproportionately extracts value from the digitally-mediated actions or resources of the less-advantaged group; denying that latter group the value that should accrue to it and thus increasing relative inequality.

In other cases, the driver to joining an adverse digital system is direct compulsion: a requirement of powerful others to join. Many state surveillance systems would fall into this category, for example where linked to a digitally-mediated identity that is then required in order to access public services. In India, there has been much criticism of the national identity database, Aadhaar, including its role as a state surveillance tool, and a capture of benefits by private interests, both legitimate and – in the case of privacy breaches – illegitimate (Khera 2019a). But “what started as a voluntary ID gradually became compulsory” (Khera 2019b:4): a “coercive application” of digital technology that leaves citizens with no choice but to participate (Basu & Malik 2017).

Neither of these drivers, though, satisfactorily explains many examples of adverse digital incorporation into economic digital systems where individuals join because of a lack of choice: an exclusion from better alternatives. Why is it, for example, that migrant workers join gig economy platforms even though they may well earn less than minimum wage? In the case of South Africa, a number of those interviewed for the Fairwork project did so because they were excluded from other employment opportunities either by legal requirements or lack of social capital or by discriminatory hiring norms. Likewise for parents prostituting their children online in the Philippines, “the first factor is poverty … they tend to engage in that so that they can have enough food to eat” (Kuhlmann & Auren 2015:38). These families live physically, socially and economically on the margins of cities and they are excluded from systems of formal employment and welfare.

Exclusion and adverse incorporation are thus not mutually-exclusive perspectives in understanding digital inequality but can be closely connected (see also Hickey & Du Toit 2007). Historical and contextual patterns of exclusion from particular economic, social and political systems can significantly increase the likelihood that marginalised individuals and groups will participate in digital systems that are disadvantageous. Any understanding of adverse digital incorporation must therefore encompass temporality and contextuality – the historical and contextual processes by which those incorporated have come to be excluded from alternative systems.

**Causes of Exploitation**

Once incorporated into a digital system, why is it that the value of actions and/or resources is differentially distributed? The literature on adverse incorporation is repetitively clear that the root cause for this is power and control: the way in which a more-advantaged group controls the system into which the less-advantaged group is incorporated (Bracking 2003, Hickey & Du Toit 2007). That control allows the former to extract and capture the value generated by the latter.

In a very direct sense, inequitable outcomes emerge from digital systems because the more-advantaged group has control of design of the system: a design inequality compared to the exploited users. This was the case in almost all of the instances given above: that states or platform companies are able to design the processes and governance of digital systems in such a way that resources flow unequally. This is often most visible when alternative designs exist which indicate there is nothing inherent in the inequalities that are found. For example, some mapping systems are extractive: using outsiders to take data from low-income communities and then present it online for the use and benefit of others. But alongside such designs are participative others planned by or with the community. These use community members to undertake the mapping, and make specific efforts – through low-tech interfaces, paper-based maps, presentations at community meetings – to enable communities to make use of that data (Heeks & Shekhar 2019).
Resource inequality can lie behind unequal outcomes of using digital systems. Users with lower access to financial, human, social, physical and informational capital will be differentially incorporated into digital systems compared to those with higher endowments. In the biopiracy case, for instance, it is the global North actors who know the economic value of local plants when the Shuar do not, and it is the former who have financial resources, socio-economic contacts and physical machinery necessary to monetise the plants into pharmaceutical products (Nagan & Hammer 2013).

Institutional inequality can play a role, where formal laws and regulation and informal norms and values favour the more-advantaged group. For example, East African small enterprises digitally integrating into global value chains often struggle; suffering greater volatility and risk with the potential for profits to be reduced (Foster et al 2018). The beneficiaries are the lead firms in the global supply chains; those which determine the specifications and standards that African small enterprise must adhere to, and which use the flows of digital information to more tightly-control their suppliers and to switch from less- to more-adherent suppliers.

Relational inequality can be understood in terms of the relative dependencies between the actors within a digital system. In the economic sphere, the substantial reserve army of labour in many South countries creates asymmetrical dependency. For example, physical gig platforms employing drivers and deliverers can readily replace any individual worker (Gomez-Morantes et al 2019). The platforms therefore do not depend on the worker and are able to treat them adversely. On the other side, individual workers may depend significantly on the platform; particularly if – based on the expectation of a certain, stable income – they have taken out loans. It has been shown that, the greater the dependency of the worker on the platform, the more willing they are to allow themselves to be exploited (Schor et al. 2020). The asymmetry of dependency in this relationship is exacerbated by the atomisation of gig workers in the general absence of trade unions or worker associations (Graham et al 2017). The structural relationship of platform to workers is thus many individual one-to-one relations rather than a one-to-many relation mediated by a worker association; the former being considerably weaker and more open to exploitation.

3.3 Conceptual Framework

Having drawn out the key components of adverse digital incorporation, we can put them together

![Figure 1. Conceptual Framework of Adverse Digital Incorporation](source: author)
into a single overall conceptual framework, as shown in Figure 1. This centres the digital system and the patterns of adverse digital incorporation described in the first sub-section above. Drivers to incorporation are identified on the left and the main outcome of unequal extraction of value is identified on the right side. Around the system are the other structural components that facilitate adverse digital incorporation, including the historical perspective of temporality.

4. CONCLUSIONS

The era of digital development will be marked by many developmental benefits of digital systems. Equally, the problems associated with such systems will not be confined to inequality: the growing carbon footprint of digital systems is but one example. However, digitally-related inequality is likely to be a major challenge throughout the century for those involved in digital development.

The concept of digital divide and related ideas such as digital inequality have moved beyond their initial simplistic origins. However, they have to date remained rooted in a worldview of exclusion from the benefits of digital systems. In this paper I argue that, as we move into a digital development paradigm, this worldview remains important but it is no longer sufficient. We need as well to account for the inequalities that arise in the global South when less-advantaged individuals and groups are included in rather than simply excluded from digital systems. Drawing from development studies, this paper argues that the concept of “adverse digital incorporation” can help to understand the emerging relation between digital and inequality. To help operationalise this new concept, the paper then built a model of it.

Having created the adverse digital incorporation model inductively, a next step for digital development research will be to apply the model deductively as the basis for analysing case studies in which use of digital systems is associated with unequal outcomes. Case examples have already been suggested above but others are likely to increasingly emerge. In terms of research paradigm, the emphasis on causal mechanisms linking structural precursors to processes of exploitation suggests that critical realism may be an appropriate frame. Methodologically, and given the need to understand context, relations, differential extraction of value, etc., then qualitative methods are likely to be of most relevance for such research.

The era of digital development seems likely to be being marked with a growth in adverse digital incorporation. Is this simply a reproduction of existing processes of adverse incorporation in a digital milieu? Or is there something inherent in the functionalities and affordances of digital systems that makes them more likely to facilitate, or even to create, unequal outcomes? Put another way, where is the digital in adverse digital incorporation: is Figure 1 in fact just a model of adverse incorporation?

Answering such questions must be part of the future research agenda but we can start to identify some of the paths for exploration of this issue. Research on the institutional work of digital platforms suggests that they enable an aggregation of market institutional functions that were previously distributed and dissipated (Heeks et al 2021). This enables an aggregation of power well beyond that feasible in traditional markets, and hence a greater asymmetry of power between platform owner and platform users. In turn this greater asymmetry enables a disproportionate extraction of value. Digital has also – via machine learning and algorithms – made systemic processes such as decision-making or distribution of value more opaque (Burrell 2016). Such opacity hides and thus facilitates disproportionate extraction of value.

The focus here has been on the victims of adverse digital incorporation but research will also be needed on the beneficiaries. What drives them to design and implement exploitative digital systems? Can we find some systematic difference between those creating systems that increase inequality and those creating systems that decrease inequality?

This last question moves us into the realm of practice. In practical terms, countering adverse digital incorporation would mean identifying digital systems that unequally include already-disadvantaged
groups and seeking to address the drivers, causes or processes of adverse digital incorporation. An example here would be the Fairwork project, which seeks to address inequalities between capital and labour that emerge as gig workers are adversely incorporated into digital labour platforms (Fairwork 2020b). It does this by intervening in resource inequality – providing workers with open information about pay and conditions on platforms; and by intervening in institutional inequality – encouraging standards and norms for decent gig work and for ethical consumption and investment in the gig economy.

A danger of contextual models such as the one developed here is that they lapse into structural determinism: assuming that only external structural interventions can improve the impact of adverse digital systems, and failing to recognise the agency of those who have been adversely incorporated. Taking again the example of gig platform workers, we can see many examples around the world of them self-organising and taking protest or legal action to reduce the unequal distribution of value that derives from their labour (e.g. Wood et al 2018, Joyce et al 2020). The potential for agency of disadvantaged groups must therefore be part of the agenda for development practice.

Recognition and conceptualisation of adverse digital incorporation offers a basis for alternative digital development design strategies. “Neutral digital incorporation” would design digital systems in which value was evenly rather than unevenly distributed between system actors. “Advantageous digital incorporation” would design digital interventions that specifically sought to reduce existing inequalities. Based on the understanding developed above, the key insight is that advantageous digital incorporation can only occur if digital interventions in some way address underlying inequalities, both historical and contextual.

As summarised in Figure 2, a key argument in the domain of inequality is that only justice – rather than equality or equity – will truly address inequality in the long term because it addresses the underlying causes of that inequality rather than just dealing with its manifestations. Using this terminology suggests we must therefore move beyond the digital divide, and beyond digital inequality, to “digital justice”: seeking to address not just the proximal processes of adverse digital incorporation but also their underlying causes.

![Figure 2. Equality, Equity and Justice](image)

Source: Tony Ruth from Maeda (2019)
As the Figure 1 model demonstrates, this takes the focus away from the practices and procedures of digital development systems and towards the need to impact the wider institutions, structural relations, design processes and resource distributions that surround such systems. Only by impacting those can we move from adverse to advantageous digital incorporation, and deliver digital justice in the global South.

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5. REFERENCES


THE COMMODIFICATION OF OPEN EDUCATIONAL RESOURCES FOR TEACHING AND LEARNING BY ACADEMICS IN AN OPEN DISTANCE E-LEARNING INSTITUTION

Lancelord Siphamandla Mncube, University of South Africa, ncubels@unisa.ac.za
Maureen Tanner, University of Cape Town, mc.tanner@uct.ac.za
Wallace Chigona, University of Cape Town, wallace.chigona@uct.ac.za

Abstract: The use of open educational resources (OER) is gaining momentum in higher education institutions. This study sought to establish academics' perceptions and knowledge of OER for teaching and learning in an open distance e-learning (ODeL) university. The study also sought to establish how perceptions are formed. The inductive approach followed the lens of commodification to answer the research questions. The commodification phase allowed for a better understanding of the academics' prior knowledge, informers, academics behaviour about OER, and how they perceived OER to be useful for teaching and learning. The study employed a qualitative method, with semi-structured interviews to collect data. The study found that academics with prior experience and knowledge of OER are more successful in the use of these resources for teaching, learning, and research. OER is also perceived as a useful tool to promote African knowledge, showcase the contributions of African academics, improve academic research capabilities, improve student’s success rate, particularly for financially vulnerable students. Based on the acquired perceptions, the study able to propose a new guideline to formulate user perceptions. However, this can only be achieved through a solid OER policy with the support of government and tertiary institution top management. The findings may inform higher education institutions when they consider the development of OER strategies and policies, especially in response to the Covid-19 emergency online learning transition.

Keywords: Commodification; Open educational resources; Academics’ perceptions; Teaching and learning; Open distance e-learning institution, Covid-19.

1. INTRODUCTION

Globally, in the diverse higher education institutions there has been an emergence of adoption and development of open educational resources (OER). Institutions comprehend these educational resources as useful and the idea of OER is sold and marketed into academics as facilitators and knowledge producers in academic spaces (Nusbaum, Cuttler & Swindell, 2019; Anderson & Cuttler, 2020). This relates to the commodification process as referred to something which converted to a commodity or a creation of a market for things so that are bought and sold (Fleissner, 2009; Pankova & Khaldeeva, 2017). The commodification process is popular in the investigation of information technology adoption (Silverstone, Hirsch & Morley, 1992), lately in the delivery of teaching and learning. Commodification has contributed to research and has contributed to the growth of social inequality (Adair, 2010). In the event of commodification, this might also create obstacles for academics as are expected to develop and adopt OER, yet it is not known if they are all comfortable with the initiative.

OER are described as open digital educational resources that are accessible from online platforms (Cobo, 2013). Also, OER are lauded for reducing the cost of teaching and learning resources in
higher education institutions (Blaschke, Müskens & Zawacki-Richter, 2020). They showed to have a positive impact on cost reduction as they are free of charge, are simple to use (McGowan, 2020). These OER are created and guided by creative commons which are open licensing built within the framework of intellectual property rights of open copyright licenses. These permit to retain, reuse, revise, remix and redistribute OER (McGowan, 2020). Open educational resources are available in different formats such as open textbooks, open-source software, videos, pictures and many more (Cobo, 2013).

In many developed countries, higher education institutions are well equipped with electricity, information communication technology (ICT) infrastructure, connectivity and financial stability (McGowan, 2020). However, despite the availability of such relevant resources, the adoption of OER has not gained wider popularity across faculties and disciplines (Genc & Kocdar, 2020). This might be due to the nascent stage of OER in higher education institutions, resulting in academics not having identified appropriate strategies to adopt OER in their disciplines (McGowan, 2020). That is exacerbated in developing countries where various factors hinder the adoption and utilisation of OER by academics in higher education institutions. Barriers to OER adoption in developing countries include the poor ICT infrastructure as well as low and unaffordable internet connectivity (Hodgkinson-Williams, Arinto, Cartmill & King, 2017). Besides, there are social as well as OER-related challenges including “lack of interest, pedagogical challenges, social norms, lack of relevance, lack of institutional support, lack of capacity, lack of legal clarity, and copyright issue” (Cox & Trotter, 2017; Wolfenden & Adinolfi, 2019). These circumstances result may contribute to a low OER development and adoption rate. It is evidenced by OER portals report that the OER adoption in sub-Saharan Africa was meagre 2% (Hilton III, Bliss, Robinson & Wiley, 2013).

It is, therefore, important to explore further how academics perceive the use of OER for teaching and learning as well as their knowledge on the matter, to contribute to the commodification rate. OER are an essential initiative within the online and distance learning sphere and in other institutions. Until recently, most universities assumed a face-to-face teaching model. However, due to the Covid-19 pandemic, the tertiary education landscape has seen a rapid and unprecedented shift towards an online teaching model (World Economic Forum, 2021). Open educational resources could play an essential role in this transition. This further confirms the urgent need to understand academics’ perceptions and knowledge as related to the commodification of OER to improve the effectiveness of existing teaching, learning, and research approach in an online context.

The latest open distance e-learning (ODeL) approach relies on ICT and information systems to deliver and administer teaching and learning including research. At the same time, an ODeL approach is more like a business model (University of South Africa (UNISA) Annual report, 2013). ODeL as a business model embraces only online learning provision (UNISA Annual report, 2013). An ODeL institution, therefore, expects its academics to be versed with modern ICT to provide teaching and guide students within the information systems. Teaching in an ODeL is achieved using multimedia technologies such as videos, virtual platforms, social media, video conferencing, instant communications, OER and many more ICT services. That poses challenges to ODeL academics and institutions because not all academics possess the required skills for tuition provision. Hence, the shift may pose a serious operational risk (UNISA Annual report, 2013). In an ODeL environment, everything resides in an online system and no physical human interaction occurs. Also, students are not grouped into lecture halls for lessons. Instead, they are scattered all over the world and can catch up with lessons at any given time regardless of access devices and contexts. All academics employed for teaching and learning in an ODeL institution are compelled to be innovative in the provision of subject lessons. Thus, in an evolving ICT-driven context such as ODeL, academics are expected to rely on OER instead of prescribed textbooks (de Hart, Chetty & Archer, 2015).

Given the research problems, the study sought to understand academics perceptions and knowledge of the development and adoption of OER in the context of an ODeL university which is the UNISA
because in such context academics are providing teaching and learning (tuition) in an online mode and are expected to consider the variety of online teaching resources. The study posed the following key research questions:

- What are the academics’ perceptions about OER for teaching and learning?
- How are the perceptions formulated?

The study employed a qualitative case study approach. The commodification process was deemed to be the most appropriate theoretical lens as discussed in the literature review. The study findings might help ODeL institution and any other higher education institution when making decisions in the strengthening or development of OER policies that will be adopted during the Covid-19 era and in the future. Besides all positive and negative factors attribute to the adoption of OER. Due to the coronavirus (Covid-19) pandemic which started from China in the city of Wuhan in 2019 (Chinazzi, Davis, Ajelli, Gioannini, Litvinova, Merler, Piontti, Mu, Rossi, Sun & Viboud, 2020). Consequently, this pandemic has claimed the lives of several people not only in China but worldwide. Based on the covid-19, various many countries initiate lockdowns trying to eliminate the spread of the virus (Bhattacharyya, Bhowmik, Mukherjee, 2020; Dharma, Sharun, Tiwari, Dedar, Malik, Singh & Chaicumpa, 2020). This lead to stop operations in many institutions such as schools, universities, travel agencies, entertainment centers, and services in the countries. Therefore, the ODeL institution might be in a better position to fight against the spread of covid-19. This can be achieved because in an ODeL institution there are fewer physical human social interactions as students and academics interact through virtual spaces of teaching and learning (Mncube, Dube & Ngulube, 2017). This influenced the investigation on how academics in an ODeL institution commodifying OER for tuition and research before and during the Covid-19 era.

2. LITERATURE REVIEW

The study reviewed literature aligned to the research question and the commodification process which is concerned about the user’s previous phenomenon knowledge, and perceptions of IT artifacts (Berker, Hartmann, Punie & Ward, 2006). In inquiring about user’s prior knowledge, it is deemed to be necessary to interrogate literature starting from the origins of OER and overview of OER. That enables the study to generalise about academics’ prior knowledge. Also, that lays a foundation before starting to acquire about academics’ perceptions concerning OER.

2.1 Commodification process

Commodification refers to how a commodity is designed and marketed to consumers (Berker, et al., 2006; Chigona, Chigona, Kayongo & Kausa, 2010). Therefore, commodification can be considered as a theoretical lens that enables the exploration of an emerging IT artifact while seeking the users’ perceptions in the adoption of OER for teaching, learning, and research. According to Habib and Sønneland (2010), the commodification process “encompasses the various activities that transform new or unfamiliar commodities into objects that have the potential to raise interest in the mind of their potential users”. That relates to the ODeL institution as a role player in the promotion of OER to academics, so they become aware and wildly used for tuition and research. Furthermore, it is a process through which material and symbolic artifacts are created and opened to the influence of the consumers (Chigona, et al., 2010). In the study context, OER ideas are sold to influence academicians to recognise them as an important commodity to perform their daily duties.

The commodification assisting to discover the way users experience technologies, what technologies mean to them, and how technologies play a role in their daily lives (Silverstone, Hirsch & Morley, 1992). The relevance of the commodification process might determine how academics perceive an emerging OER to be useful in their academic spaces. In the current case, commodification might provide an insight on how to promote the development and use of OER in ODeL institutions. Since many academic institutions are now obligated to make provisions for online teaching, learning and research whilst relying on ODeL modes, findings from this study are opportune. Based on this
understanding, there is a link to the perceptions and knowledge of OER by the means of ‘commodification’. Therefore, commodification refers to the adoption and knowledge of OER by academics where technologies initiatives, like OER, are marked with a specific function and identity within the ODeL environment.

2.2 The origins of OER
OER was established to address the myriad of challenges of many higher education institutions in the developing world. The common challenges these institutions were facing included access limitations, lack of adequate bandwidth, poor ICT infrastructure, inadequate local telecommunication infrastructure, and regulatory policies to govern OER as a means of access to knowledge (UNESCO, 2002). These challenges impacted student learning and success, the quality and assessment of student learning, and their affordability for higher education (León, Tejero, Dévora & Pau, 2020). The use of OER positively impacts institutional financial sustainability through increased student retention (Fine & Read, 2020).

There is confusion in the use of the terms “open electronic resources” and “open educational resources”. The former is considered as library materials obtained from databases, magazines, archives, theses, conference papers, government papers, scripts, and monographs in an electronic form (Hawthorne, 2008). The term open electronic resources have existed for quite some time as it was developed in the late 1960s and was made available to the public in 1972 to enable remote online access to database services (Bates, 1998). On the other hand, the term ‘open educational resources’ was coined in 2002 (UNESCO, 2002). OER refers to ‘internet resources’, this implies an online resource that provides educational information free of charge with ease of access, due mainly to the free software and public access systems (Tucker, 2020). These terms convey the same message. Interestingly, all the content of open electronic resources informs the open educational resources. The assumption may be that the term ‘Open educational resources’ is more related to content and educational matters. Serious attention is needed from the higher education institutions to initiate policies related to OER, to avoid any confusion that can occur, particularly with unpacking ‘open educational resources in their relevant context.

2.3 Overview of OER in academia
In higher education institutions academics are developing and adopting OER. Academics are expected to facilitate tuition and research and for that purpose, they may adopt and generate several teaching resources (Tsakonas & Papatheodorou, 2006). Some of the resources are OER that are produced in different formats such as but not limited to texts, images, videos, simulation, and courses (Hilton, 2016). Academics may also utilise OER that are considered as freely accessible to academic content like open access books, open sources, articles, and any subject-specific source (Hawthorne, 2008). Free access to academic content aims to enhance the use of information, electronic data management, mobile data collection, scholarly publication, and education (Tucker, 2020).

Globally, it is noted that not all academics are exposed or knowledgeable about OER (Anderson & Cuttler, 2020). The lack of knowledge might have been caused by various factors such as lack of infrastructure, inequalities in access to education (Cox & Trotter, 2017) and the fact that OER is emerging technology (Anderson & Cuttler, 2020). Furthermore, the use of OER as a possible tool for research and supervision has not yet been fully exploited to widen access to knowledge in certain aspects of research training (South African Department of Education, 2003).

2.4 Academics’ perceptions concerning OER
Perceptions are known as cognitive and psychological processes initiated by Fiske and Taylor (1991). Lately, perceptions are considered as a process of selecting, organising, and interpreting information (Miller & Poston, 2020). In this context, the perceptions are acquired from academics concerning OER. Since the initiation of OER in 2002, there has been a shift in academics’
perceptions concerning the use of OER in education. OER is increasingly perceived to be on par with traditional textbooks from a quality perspective (Blaschke, Müskens & Zawacki-Richter, 2020). OER is also perceived to be able to widen access to, reduce the costs of, and improve the quality of education (Creative commons, nd). In a recent study that investigated both traditional textbooks and OER, academics were found to have positive perceptions about OER (Maboe, 2019). Academics are positive because students who use OER can score better grades and have lower failure rates than those using traditional textbooks. Students’ attitude towards the subject matter also improves when they use OER (Serrano, Dea‐Ayuela, Gonzalez‐Burgos, Serrano‐Gil & Lalatsa, 2019).

Negative perceptions emerge when academics must search, select, edit, and apply OER as this process can be challenging (Blaschke, Müskens & Zawacki-Richter, 2020). As such, adequate guidelines to that effect may improve the academics’ perceptions towards OER (Serrano, et. al., 2019). Therefore, there is a need to further explore academics’ perceptions concerning OER in a developing country context is more present, given the prevailing covid-19 pandemic. As many institutions are expected to rely on an online teaching model, OER could be increasingly prioritised by academics.

3. THE CONTEXTUAL SETTING OF THE STUDY

The study context is the University of South Africa (Unisa). The institution consists of various campuses across nine South African provinces and beyond the country. The institution was established in 1873 (Unisa website, 2021). In the year 2000 undertook a restructuring of tertiary education; this process led to the establishment of a single distance education institution. This was approved by the minister of higher education in 2003 (South African Department of Education 2003). The institution offered distance learning through virtual platforms and little physical interaction with students and mostly relied on a blended mode of facilitation (Unisa website 2021). This became the largest open distance learning institution in Africa and the longest standing dedicated distance education university in the world (Unisa website 2021). It enrolled nearly one-third of all South African students as it relied on online and a blended mode of service delivery (Unisa website 2021). In 2013 the university began shifting from ODL to ODeL (UNISA Annual report, 2013). ODeL allows students to pursue their studies by fully relying on an online learning mode (UNISA Annual report, 2013).

The use of OER aligns with the requirements of ODeL institutions. These OER are also supported by ICT and any other information systems (Goodman, Melkers & Pallais, 2019). This is in line with ODeL institutions that rely on online information systems such as learning management systems. This means students can enroll wherever they are using online platforms for learning. Therefore, the ODeL together with OER might be the best option to increase the opportunities for people to access education (Davis & Cartwright, 2020).

Besides enabling the increase of enrolment, ODeL has also been praised for reducing enrolment costs (Blaschke, Müskens & Zawacki-Richter, 2020) and improve equity in higher education. Online and distance learning has risen in popularity in the last two decades as it is an effective approach for accommodating an increasingly diverse student population in higher education and enriching the learning environment by incorporating online teaching resources (Serrano, et al., 2019). The crisis remains because in investigations of OER development by faculties there is little knowledge produced, although studies of OER development structures have been undertaken in international settings (Hodgkinson-Williams, Arinto, Cartmill & King, 2017). The institution amended its curriculum policy to allow the usage of OER and a reduction of prescribed textbooks to support students who may not afford the books (de Hart, Chetty & Archer, 2015).
4. METHODOLOGY
The study opted for a case study as a research design. The study focused on a single case study which is the Unisa. This study is interpretative and employed for a qualitative approach. A qualitative inquiry was appropriate for studying commodification (Silverstone, 2005). The researchers wanted to establish academics perceptions concerning the commodification of OER. The qualitative approaches are based on the ontological assumption in which reality is understood as subjective. This means that studying perceptions and experiences that may be different for each person and change over time and context (Eriksson & Kovalainen, 2008).

The study followed a guideline in Figure 1. After inquiring and gathering findings based on the three aspects of the commodification process which are academic knowledge, informants about commodity, and user behaviour, there was a need to establish how perceptions were formed. The process started from acquiring academic knowledge (either prior or current) about the phenomenon. From there it was necessary to know how they are behaving towards the OER. Lastly, the study gathered academic behaviour toward the OER. The investigation into the three aspects helped to suggest the appropriate strategy of showing the formulation process of perceptions in an Information System organisation.

4.1. Sample and sampling
The study used purposive and snowball sampling. The sample was drawn from a broad heterogeneous ODeL context as consisted of eight colleges (Unisa website, 2021). Initially, the e-mails were sent to all colleges in the academics’ departments to request permission to conduct semi-structured interviews. The first respondents in the respective colleges assisted to identify other relevant respondents who were involved in the adoption and development of OER. Those academics who were considered as users, adopters and developers of OER then were approached for interviews. Respondents were academics from all ranks such as junior lecturer, lecturer, senior lecturer, and professors. To qualify for participation, these academics had to be involved in teaching and learning or teaching any subject within the ODeL context. This was done because they are in a better position to commodifying OER. A total of 19 academics participated in the study.

4.2. Data collection and analysis
The data were collected using semi-structured interviews. This allowed the respondents to talk about and explain issues that they felt were important in their own words (Longhurst, 2010). The research instrument was based on the commodification process. The data was collected in 2019 -2020. The data collection was done in face-to-face interviews and online interviews using virtual platforms such as MS Teams. The interviews typically took place on different campuses of ODeL in the academics’ offices. The interviews lasted 30 – 60 minutes. During the data collection, the data were recorded and were later transcribed into a text format. The transcribed data were coded into NVIVO for analysis. The study used thematic analysis.

4.3. Ethical considerations
This study is part of a PhD study that is registered at the University of Cape Town (UCT). ethical clearance for the study was obtained from the university (UCT, 2021). Further, the researchers
obtained permission from the ODeL university to research within their institutions following their policy (UNISA, 2013). Permission to conduct interviews was obtained on condition that all ethical procedures be adhered to such as, anonymity including the protection of respondents, rights to participate, and their right to withdraw at any time if they felt like doing so.

5. **EMPIRICAL FINDINGS**

5.1. **Demographic information of respondents**

Table 1 presents the demographic information of the respondents.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Respondents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Academics gender:</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>14</td>
</tr>
<tr>
<td>Female</td>
<td>5</td>
</tr>
<tr>
<td>Academic title:</td>
<td></td>
</tr>
<tr>
<td>Mr</td>
<td>6</td>
</tr>
<tr>
<td>Mrs</td>
<td>4</td>
</tr>
<tr>
<td>Dr</td>
<td>6</td>
</tr>
<tr>
<td>Prof</td>
<td>3</td>
</tr>
<tr>
<td>Qualifications:</td>
<td></td>
</tr>
<tr>
<td>Honours</td>
<td>4</td>
</tr>
<tr>
<td>Masters</td>
<td>9</td>
</tr>
<tr>
<td>PhD</td>
<td>6</td>
</tr>
<tr>
<td>Work experience (years):</td>
<td></td>
</tr>
<tr>
<td>1 – 3</td>
<td>5</td>
</tr>
<tr>
<td>4 – 5</td>
<td>5</td>
</tr>
<tr>
<td>6 – 10</td>
<td>5</td>
</tr>
<tr>
<td>11 – 15</td>
<td>1</td>
</tr>
<tr>
<td>16 – 20</td>
<td>2</td>
</tr>
<tr>
<td>21 – 25</td>
<td>0</td>
</tr>
<tr>
<td>26 – 30</td>
<td>1</td>
</tr>
<tr>
<td>Position:</td>
<td></td>
</tr>
<tr>
<td>Junior Lecturer</td>
<td>4</td>
</tr>
<tr>
<td>Lecturer</td>
<td>6</td>
</tr>
<tr>
<td>Senior Lecturer</td>
<td>6</td>
</tr>
<tr>
<td>Professor</td>
<td>3</td>
</tr>
<tr>
<td>Colleges:</td>
<td></td>
</tr>
<tr>
<td>Accounting Sciences</td>
<td>4</td>
</tr>
<tr>
<td>Agriculture and environment sciences</td>
<td>2</td>
</tr>
<tr>
<td>Economics and management sciences</td>
<td>3</td>
</tr>
<tr>
<td>Education</td>
<td>2</td>
</tr>
<tr>
<td>Human sciences</td>
<td>4</td>
</tr>
<tr>
<td>Science engineering and technology</td>
<td>2</td>
</tr>
<tr>
<td>Graduate studies</td>
<td>2</td>
</tr>
<tr>
<td>Total</td>
<td>19</td>
</tr>
</tbody>
</table>

5.2. **Academics’ previous knowledge about open educational resources**

The majority of the respondents had previous knowledge of OER. However, the majority of the respondents did not have a clear common understanding of the OER. Some viewed OER as any other electronic or internet resource relevant to education. Some thought that there is no difference between open electronic resources and open educational resources.

“This is my ignorance I thought that they were open electronic resources, and I didn’t know there were open educational resources” (L5).
“...OER is all about having free access to academic content for academics and students can utilise in their academic space” (SL2).

This finding concurs with literature as the OER terminology has not yet been clarified (Hawthorne, 2008; Pete, Mulder, Neto & Omollo, 2018). This might raise concerns about the term ‘OER’, as respondents understood OER is being relevant but were confused by what they referred to. Besides, two junior lecturers had no previous views about the OER phenomenon. This might be attributed to their work experience because many junior lecturers are new in academia.

“No, I experienced the OER in 2018 luckily when I arrived here in [ODeL institution], I was involved in a team that was responsible for developing OER so that familiarized me with the knowledge of OER” (JL2).

5.3. Sources from which academics learned about OER

The respondents learned about OER from various sources both within the ODeL institution and other institutions. Table 2 indicates some sources of OER knowledge for academics.

<table>
<thead>
<tr>
<th>Sources of knowledge about OER</th>
<th>Some related responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>ODeL institution</td>
<td>“I heard about OER from [ODeL institution] when the institution was advocating for OER. It was also through presentations, especially among colleagues in the health studies. They make use of OER frequently” (L2).</td>
</tr>
<tr>
<td></td>
<td>“I read from ODeL OER strategy about OER, and I don’t have any problems” (SL1)</td>
</tr>
<tr>
<td>Alumni institutions</td>
<td>“When I was doing my Masters of ICT in education, exposed me further on OER and its value to education” (L2).</td>
</tr>
<tr>
<td>Open and online universities</td>
<td>“..., on the internet, when I went into the internet, I saw those adverts that you can study online...without having a teacher in front of you, so that’s how I learned about them [OER]” (SL2).</td>
</tr>
</tbody>
</table>

Most respondents (World Economic Forum, 2021.) heard about the OER from the university through either chair of departments, departments, other academics, and word of mouth within their work environments. Some academics heard about it when they were redeveloping their modules and were encouraged by the institution to adopt or develop OER for their module contents. Other academics heard about OER from the university OER strategy (short guidance proposed by the institution for OER) which was approved by the institution.

Some respondents were exposed to the technology through the institutions where they previously studied. L2 learned about OER during his previous studies when he was enrolled for a qualification in the field of Education. Some academics heard about OER through internet pop-ups or wikis that advertise OER in open universities. Open universities use the system for core student activities that require the provision of OER. The respondents heard from institutions that are well established in the development of OER and that are advertised on the internet.

5.4. Academics perceptions about OER for tuition and research

Most respondents had positive perceptions about OER. Table 3 summarises some of the perceptions of academics.

<table>
<thead>
<tr>
<th>Emergent perceptions</th>
<th>Some related responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective in improving the pass rate</td>
<td>“I began using OER after realizing through a colleague that they are very useful so I had to adapt it into my portal so that I can get the very same results that my colleague got, I mean my colleague’s students were passing very well through the use of OER” (JL1).</td>
</tr>
<tr>
<td>Tool for decolonising</td>
<td>“Firstly, as an activist scholar I want to change that South African academic are using African knowledge...by promoting our languages and cultures...all OER I produced are written in IsiZulu” (SL1).</td>
</tr>
</tbody>
</table>
“So, for me, the potential of OER is that we can create African knowledge, African ways of doing things” (P2).

An enabler in the development of study material

“…when we re-developed our studying material, we were made aware that we should make use of OER and we should make use of it in our study materials because of the value it can provide in the enrichment” (L3).

“It is when I started using OER when I was developing online modules” (L7).

Useful in attracting students to virtual platforms

“It was the module media studies, I was teaching, where I used Facebook as a platform of teaching” (L1).

Useful for research and supervision

“Say when you are doing supervision and you get something on research proposal writing, you just copied and forward it to your students” (Professor 1).

Response to Covid-19 pandemic requirements

“We’ve got no choice and now that there’s Covid-19 we don’t have any choice we have to use OER” (Professor 6).

Some respondents viewed OER as a special initiative for teaching. They considered OER as a great resource for improving the pass rate because such resources provide students with access to a broad range of knowledge. Even if students cannot afford textbooks, they could have OER as a substitute or complement to the compendium of teaching and learning resources. Some academics began to use OER as part of the open sources for teaching information systems modules. They opined that this was done to enhance access to teaching resources because of the high costs of subscribing to textbooks. Some academics perceived OER as a good initiative to promote scholarship. Besides, some academics began to develop OER because they wanted to increase and promote African knowledge which is written in indigenous languages. For example, one academic had already started to produce OER in IsiZulu (one of the widely spoken languages in South Africa).

The majority of respondents begun using OER when they were involved in the processes of developing study material for their courses. As some started using OER when they were updating and revising the content and they had no option but to use OER. As part of development, academics use OER when they were initiating the process of developing tutorial letters and developing their subject matter on module content. Tutorial letters refer to those documents prepared for each module offered in an ODeL institution for communicating with registered students on issues to do with teaching, learning, and assessment (Unisa website 2021). Some academics adopted OER because they wanted to encourage students to develop an interest in online learning. After all, some students were computer literacy and preferred virtualization of content. They opined that the decision to use OER was spurred by the need to attract students to use the online platforms for learning that the ODeL institution subscribed to. The respondents hinted that teaching using online platforms encourages students to utilize OER. With regards to the promotion of virtual content, some of the academics have done something by embedding OER in social media and learning platforms. Some respondents adopted OER for their research because of the convenience of such resources in providing answers on methodologies underpinning scientific research processes. This indicates that OER enables a successful research process in any undertaken research. The academics encouraged the use of OER among their postgraduate students so that they could strengthen their research capacity. OER were noted as an appropriate initiative to ease the burden of supervising postgraduate students.

6. DISCUSSION

The study sought to find out how academics in an ODeL institution commodify OER for teaching and learning. The study noted that OER is an emerging phenomenon in an ODeL institution. OER
is a new initiative and considered pivotal in providing free access to teaching and learning resources (Tucker, 2020). These OERs are capable of providing a variety of subject content for diverse disciplines through online databases. Some academics lack ICT knowledge and find it difficult to adapt and create OER for their teaching modules because they are newly employed in the virtual institution. Literature also affirms that the lack of experience and knowledge of OER negatively affected the adoption and development of OER (Goodman, Melkers & Pallais, 2019). Academics who have been employed for less than two years appear to not have more knowledge of OER in contrast to those who have been in the institution for more than five years. This might be that academics who have more than five years’ experience had more OER training than those who are two years’ experience. Therefore, an assertion can be made that the academics with more work experienced are successful in the adoption and development of OER for teaching, learning, and research.

Many academics in developing countries do not have the experience to develop and adopt OER (Hodgkinson-Williams, et al., 2017; Cox & Trotter, 2017; UNESCO, 2002). And yet, the recent emergence of OER is described as one of the main solutions to help institutions deliver quality learning resources for free (Anderson & Cuttlar, 2020; Blaschke, Müskens & Zawacki-Richter, 2020). OER is essential in the improvement of success rate in teaching because such resources provide academics with access to a range of information (Serrano, et.al, 2019; Wiley, et al., 2017). It is, therefore, essential to devise mechanisms to inform academics from traditional face-to-face tertiary institutions in developing countries of the benefits of OER and how best to utilise these resources to rapidly improve the quality of teaching, learning and research endeavors. Without such mechanisms, the benefits of OER cannot be realised.

Also, the institution needs to be committed to driving the OER initiative with support from both government and institutional top management through an approved OER strategy. The findings confirmed that when the university is encouraging academics to create and use OER for tuition and research, this commodification of OER initiative can be successful.

The development of study material must transform since online and e-learning have gained popularity over the last two decades. This will enable the institution to operate fully online and phase out the hardcopy resources. This is seen as an effective approach for accommodating an increasingly diverse student population and enriching the learning environment through the incorporation of online teaching resources (Hilton, 2016). Hence, there is a significant need to redevelop taught modules that promote the infusion of OER into all subjects in higher education institutions. However, this can only be achieved through a clearly defined OER policy rather than an OER strategy at the institutional level. These findings give rise to the following proposition:

**Proposition 1:** ODeL and any other higher education institutions should implement a solid OER policy with the support of government and top management to ensure the success of the OER initiatives for teaching, learning and research.

The findings also showed that when OER becomes more prevalent in academic spaces, the higher their impact in creating a knowledge society i.e., people or individuals who have access to desired information to make informed decisions. Their prevalence might also mitigate the exclusion of students from accessing information due to high costs. For example, academics perceived OER as an enabler for the promotion of African knowledge. Such use of OER brings freedom to academics to shift their mind and be able to decolonise the education system, particularly in the South African context. It is noted that the majority of available OER were developed in the Global North (Cox & Trotter, 2017). This affirms that the Global South consumes and relies on the knowledge which is developed from the Global North (Chavez & Kovarik, 2019). The emergence of OER in the African context puts academics in a better position to showcase their academic contributions to the world by excelling in the development of African OER. This gives rise to the following proposition:
Proposition 2: The use of OER is a valuable tool to promote African knowledge and content and showcase the contributions of African academics for teaching, learning and research.

The study found that OER is perceived as an enabler in the development of free online study material. The respondents opined that some students find it expensive to purchase scholarly resources and for them, OER provided alternative support to learning. Furthermore, OER is considered effective to improve pass rate because such resources provide students with free access to a broad range of knowledge. One can, therefore, conclude that freely available OER can bring a shift in the teaching-learning space especially for financially vulnerable students who could then be afforded the possibility to freely access relevant information sources in support of their learning.

Literature also discovered that those academics who develop and employ OER contribute to students' retention and success rate (Serrano, et al. 2019; Wiley, et al., 2017). The existence of OER enables access to educational material for free in contrast to other printed materials whose prices are increasing significantly globally (Goodman, Melkers & Pallais, 2019). This finding further asserts the relevance of OER in this economic climate following the covid-19 pandemic. During the covid-19 pandemic, academic institutions and many countries of the world were forced to stop their businesses and close academic institutions (UNESCO, 2020). In that context, the OER initiative got global attention since it could allow learning to proceed without compromising on social distancing (Owolabi, 2020). This is particularly relevant to the covid-19 situation, where academics are required to design online learning material rapidly to safeguard the academic program and ensure students’ success during the lockdown and emergency online mode of teaching and learning.

The findings are in line with literature as suggested that institutions and education departments should start to be innovative and recommended “including open pedagogy, open collaboration, and open assessment should be implemented to keep the learners motivated and engaged during this long period of online learning” (Mncube, Dube & Ngulube, 2017:5). Such reconstruction of education also comes with challenges related to infrastructure, pedagogy, resources, assessment, quality assurance, student support system, technology, culture, and best practices (Owolabi, 2020). This indicates that the Covid-19 pandemic forced educators, academics, United Nations, policymakers, and governments to rethink and immediately act on new educational strategies. In so doing, OER gained popularity because literature affirms that OER initiatives must be implemented during the pandemic’s era and beyond (Van Allen & Katz, 2020). In this regard, research concludes with the following emerging proposition:

Proposition 3: OER are perceived as a possible solution to drive social distancing and enforces e-learning for tuition and research whenever natural disasters and transmitted diseases emerged in the world.

7. CONCLUSION

This study examined the perceptions of academics of OER in an ODeL university and how the perceptions are formed. The study used the lens of commodification. The study found that academics with prior experience and knowledge of OER are more successful in the use of these resources for teaching, learning, and research. Such prior knowledge can be acquired through many years of experience in the tertiary institution, online exposure, or through alumni institutions. OER is also perceived as a useful tool to promote African knowledge written in indigenous languages and that can help African academics showcase their contributions to the rest of the world. That might show that African academics are in the process of developing OER which are suitable for their contexts. Academics also perceived OER to be useful in supporting research capabilities and the improvement of pass rates. Given the fact that OER is freely available, it was found to be useful in assisting financially vulnerable students. The fact that the institution relies on its internal learning management system for OER, that become a hindering factor for people who are outside the ODeL
ecosystem. The issue of openness is not yet well achieved because some of the documents that are supposed to be openly available to university portals, were hard to retrieve. Lastly, the study findings showed that OER is perceived as a role player in the provision of a safe teaching and learning approach in the Covid-19 era. It was noted to be one of the best practices in adhering to social distancing and promote e-learning.

The study concludes with two main contributions. Firstly, it enabled the identification of gaps in the literature that have led to the suggestion of three propositions which are considered as main study contributions. The second contribution is related to how the three perceptions were formulated in the commodification process. In the circles of commodification, the study concludes that the perceptions can be formed in an organisation by considering the following factors: prior-knowledge, informers about the commodity, and user (academic) behaviour towards commodity

To deviate from other processes of formulating perceptions by Fiske and Taylor (1991). The study realise that it might be relevant to any information systems studies that want to establish user perceptions about ICT-related phenomena to apply proposed guidelines in Figure 1. Besides the perceptions of academics, it was noted that the ODeL institution had an OER strategy. The findings suggest that the strategy can be strengthened by the development of a solid OER policy and with the support of government and tertiary institution management to govern OER. Therefore, the study recommends the appropriate higher education OER model and the implementation of an OER policy to guide academics about the adoption and development of OER.

8. ACKNOWLEDGMENT

This research is part of a PhD study which was registered at the University of Cape Town with the title “The domestication of open educational resources by academics in an open distance e-learning university of South Africa”. This project is funded by the National Institute for the Humanities and Social Sciences (NIHSS) and collaborates annually with the South African Humanities Deans Association (SAHUDA).

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Open Educational Practices and OER in the Global South: Meta-synthesis of the ROER4D project.


BIG DATA ANALYTICS IN HUMANITARIAN AND DISASTER OPERATIONS: A SYSTEMATIC REVIEW

Abhilash Kondraganti, University of Liverpool, abhilash.kondraganti@liverpool.ac.uk

Abstract: By the outset of this review, 168 million people needed humanitarian aid, and the number grew to 235 million by the end of the completion of this review. There is no time to lose, definitely no data to lose. Humanitarian relief is crucial not just to contend with a pandemic once a century but also to provide help during civil conflicts, ever-increasing natural disasters, and other forms of crisis. Reliance on technology has never been so relevant and critical than now. The creation of more data and advancements in data analytics provides an opportunity to the humanitarian field. This review aimed at providing a holistic understanding of big data analytics in a humanitarian and disaster setting. A systematic literature review method is used to examine the field and the results of this review explain research gaps, and opportunities available for future research. This study has shown a significant research imbalance in the disaster phase, highlighting how the emphasis is on responsive measures than preventive measures. Such reactionary measures would only exacerbate the disaster, as is the case in many nations with COVID-19. Overall this research details the current state of big data analytics in a humanitarian and disaster setting.

Keywords: humanitarian, disaster, big data, analytics, systematic literature review

1. INTRODUCTION

The humanitarian crisis has become one of the most urgent issues to be addressed in recent times, especially in 2020. One humanitarian crisis can undo years of growth, with economic consequences exacerbated by the rise in unemployment and implications such as poverty. Human suffering is ever-increasing and once in a century crisis like COVID-19 will make it more difficult for humanitarian organizations to reach the affected people. According to the United Nations Office for the Coordination of Humanitarian Affairs (UN OCHA), we are looking at 235 million people across the globe who need humanitarian assistance in 2021, a sharp increase of 40% compared to last year (UN OCHA, 2020a). Human suffering at large is caused by either natural or human-induced disasters, but these overwhelming numbers are usually due to natural disasters. There were 7,348 natural disasters in the period 2000-2019 which is more than one reported natural disaster per day over the last twenty years, while this number for the period between 1980-1999 was just above 0.5 disasters per day (UNDRR, 2020).

Humanitarian actors such as local and international NGOs are working closely with governments and United Nation agencies such as OCHA to reach people affected by these disasters. The pooling of funds for relief efforts is always going to be an issue as it is uncertain, but more importantly, it is a challenge to use the raised funds efficiently. In 2019, OCHA required $21.9 billion to alleviate the suffering (UN OCHA, 2019) and it has successfully received $18 billion as contributions from the donors (UN OCHA, 2020b). This suggests that the funding deficit is declining relative to previous years, however, considering the unpredictable nature of donations, humanitarian actors must concentrate on cost-effectiveness in operations to prevent excessive reliance solely on funding. Also, disaster relief is mainly made up of logistical operations, as per Van Wassenhove (2006), it is about 80%. After 15 years of this assertion, one of the findings of an applied research project reaffirmed...
that the representation of humanitarian logistics is in the range of between 60% - 80% of overall expenditure on humanitarian relief (Lacourt and Radosta, 2019). Further, 35% - 40% of these logistical funds are wasted due to a lack of analysis on spend and duplication of efforts (Day et al., 2012; Kwapong Baffoe and Luo, 2020). Being unable to raise funds may be attributable to economic or diplomatic causes, but poor utilisation of the funds is down to logistical and operational failure needing serious attention.

A key approach to resolve efficiency and effectiveness issues in logistical operations has been the application of new technologies. Rapid advances in technology and the use of Big Data Analytics (BDA) has created new opportunities for many industries (McKinsey & Company, 2018). Swaminathan’s (2018) opinion is that traditional humanitarian organisations may also experience improvements with the integration of BDA and are better placed along with profit-driven corporations to make use of this technology. On the other hand, Sharma and Joshi (2019) argue that data does not reflect the actual situation of the field, and over-reliance on big data technologies could impact humanitarian operations. It might also cost one of the basic humanitarian principles, being humane (UN OCHA, 2012) which might be difficult to accomplish in a non-human data-driven engagement. Experts involved in disaster response however seem to favour the use of data analytics or a system that may be less challenging for them in areas such as analysing the credibility of data, or enhancement in identifying the disaster location (Thom et al., 2016). This is justified due to the critical, inherently unpredictable, and complex nature of operations on the field needing quick decision making (Knox Clarke and Campbell, 2020). More importantly, the humanitarian and disaster operations (HDO) field is becoming more diversified with the inclusion of individuals such as volunteers, people working in crowd sourcing who are outside of humanitarian organizations and are not equipped with enough training.

Review of the existing literature shows a considerable gap between the business and humanitarian sectors in attention to and use of BDA. While the business sector has made significant advances in shifting from descriptive analytics to predictive analytics, and more recently introduction of sophisticated prescriptive analytics (Lepenioti et al., 2020) (e.g. UPS (Delen, 2019) and PopSugar (van Rijmenam, 2019)), such applications in humanitarian and disaster sector has been rare (Centre for Humanitarian Data, 2019).

The disparity in the academic research towards BDA in HDO needs to be thoroughly reviewed. Therefore, this study aims to investigate the role of BDA in HDO, deliver a holistic understanding, and see where the research can be strengthened. The objective of this research is to review and analyse how BDA has been used in various disasters, disaster phases, and categories in the humanitarian field. The three research questions for this study are stated below:

RQ1: How has the research on the application of BDA for HDO evolved over time?

RQ2: What is the status of the BDA application across different disaster categories, disaster phases, disaster locations, and what different types of big data have been used?

RQ3: What are the key theoretical lenses applied to examine BDA application in HDO?

First, this review provides the methodology adopted to conduct the research, which is explained in the next section with the help of the review protocol, search strategy, and assessing the quality of articles. In the following sections, the results are presented and discussed the key aspects of the review. Finally, this review provides the directions for future research to advance the use of BDA in the HDO field, and reflect on the limitations of the review.

2. METHODOLOGY

A systematic literature review (SLR) is employed as a research method to collect and critically assess the existing knowledge in the research field to respond to the research questions. The selection of SLR is based on four compelling reasons; Firstly, it aims to add clarity to the entire process with the support of review protocol, and a strategically designed search strategy (Booth et al., 2012).
Secondly, the researcher aspires to avoid any bias including selection and publication bias in conducting the review and the principles of SLR can minimize this and facilitates in generating more reliable outcomes (Becheikh et al., 2006). Thirdly, the ability to be transparent in the whole review process (Booth et al., 2012) and finally, it could be reproducible for other scholars interested in further exploring this research (Booth et al., 2012). This review has broadly followed the guidelines of Tranfield et al. (2003) and Denyer and Tranfield (2009), two widely used SLR methods in the management discipline.

![Figure 1 Systematic literature review process](image)

### Stage I: Literature Review Planning
- 1. Research Rationale
- 2. Research Objectives
- 3. Review Protocol
- 4. Database Search
- 5. Selecting Suitable Papers
- 6. Assessing the Quality
- 7. Review Results
- 8. Reporting

### Stage II: Conducting a Literature Review
- Search String
- Inclusion Criteria
- Abstract Review
- Articles Review
- Full-text review

### Stage III: Reporting and Dissemination
- Content Analysis

### 2.1. Review Protocol

The research protocol helps in performing the second stage of the review ‘conducting a literature review’ which is the core part of this study in the SLR process shown in figure 1. The purpose of this protocol is to avoid any researcher bias (Tranfield et al., 2003), hence the search strategy is in place with a formal set of rules put in place to identify the suitable articles for this study. So, the quest for extant literature is enabled by the selection of a more fitting citation database, and Scopus is chosen for this study. Scopus is considered the largest multidisciplinary database and has more coverage of journals than Web of Science (Aghaei Chadegani et al., 2013). Also, the search results are integrated from other databases including Springer Link, Science Direct, Wiley Online Library, Emerald Insight, etc. (Roy et al., 2018).
2.2. Search Strategy

The efficacy of SLR is dependent on the search strategy that is used to shortlist the scholarly papers by implementing inclusion and exclusion criteria (Snyder, 2019). In Scopus, a search string was generated with the aid of the Boolean operators, which reflects both BDA and HDO in the search results. Here, the researcher is mindful of using more keywords as it could narrow down the search significantly and possibly omit any relevant documents; therefore, the search string is not tight and left as generic as possible. This is a nascent field, and as a measure, the author is very cautious in selecting the search keywords. BDA is divided into two keywords: ‘big data’ and ‘analytics’, since some articles may use either name in the title, abstract, or keywords instead of big data analytics. Furthermore, these keywords are paired with another set of keywords "humanitarian" and "disaster" to encompass the entire HDO field. The exact search string used is given below:

(("analytics" AND "humanitarian") OR ("analytics" AND "disaster") OR ("big data" AND "humanitarian") OR ("big data" AND "disaster"))

Figure 2 Research capacity over the years by the number of articles. Source: Compilation by Author

The search strategy as shown in table 1, comprises 5 levels that have assisted in selecting the suitable articles and these are carried out within the Scopus. The use of the search string in the search area culminated in 1,563 documents in the first level. As the study area is multidisciplinary, 5 relevant subject areas are added at the second level and the number is down to 1,354. This study considers only peer-reviewed articles, which applied at level three significantly reduces the number to 483. The reasoning behind considering only the published work is it can improve the quality of the review since most publications adopt a meticulous peer-review process (Light and Pillemer, 1984). Furthermore, only journal articles are retained in level four but there is minimal change in the number of articles which has gone down to 468. In the end, filtering to articles in the English language leaves us with the final list of 417 articles. There was no restriction on publication year in the search, however, the oldest published article is traced back to the year 2009 as shown in figure 2. The data collection was started in April 2020, later the results were updated in July and in December same year. Scopus search results for this review are up to date as of 31st December 2020.
2.3. Abstract and Full-Text Review

A further shortlisting procedure is applied by reviewing the results from the search (inclusion and exclusion) criteria. The abstracts for 417 articles are reviewed thoroughly, however when the author felt that the abstract information of the article is not sufficient enough to determine the significance, the full-text review was performed. This process omitted approximately 61% of the articles and 160 articles are retained for the full-text review. This review is concept-centric in which a structure is developed to note down the key concepts for each article to obtain comprehensiveness from the associated literature (Webster and Watson, 2002). The inclusion criterion of full-text articles is solely assessed based on one single criterion; ‘Is the article at the intersection of BDA and HDO?’ This assessment is carried out by dividing each article into three different categories. As shown in table 2, category 1 represents the most relevant articles to the research area. Wherein category 2 is relevant to some extent in bringing BDA and HDO together. And the final category 3 articles are not related and do not contribute to the progress of this research. This review considered categories 1 and 2 articles which are 86.

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The focus of the article is on HDO and BDA as a key point.</td>
<td>n = 54</td>
</tr>
<tr>
<td>2</td>
<td>Considerable insights in the article on the intersection of BDA with HDO.</td>
<td>n = 32</td>
</tr>
<tr>
<td>3</td>
<td>The article is not relevant to the research area.</td>
<td>n = 74</td>
</tr>
</tbody>
</table>

Table 2 Full-text review results. Source: Compilation by Author

3. RESULTS

In this section, the author presents key findings from the final list of articles meticulously selected after quality assessment and these are presented chronologically. While there are 86 final papers in total, the author chose to exclude 13 review papers to obtain clear outcomes. As a result, 73 articles have been evaluated.

3.1. Disaster Categories

The disaster classification shown in figure 3 illustrates that scholars place a greater emphasis on natural disasters, as natural occurrences account for more than half of disasters in the reviewed papers. Within the natural disaster generic group, geophysical disasters, including earthquakes and tsunamis, comprise 15% and hydrological disasters, including floods and heavy rains, account for 14% of the total. In this, both floods and earthquakes are the predominant choices for researchers. The meteorological group of hurricanes and typhoons with 12% is another disaster group that has been prioritized to resolving the challenges. However, the climatological disaster group is relatively less explored with 6%, and biological group research is insignificant with 1%. A few scholars focused on multiple disaster groups within natural disasters in their work with 3% coverage. The remaining papers in the natural disaster group are generic and not aimed at any particular disaster group, accounting for 4%. This takes the overall interest in natural disasters by academics to 55%.
Though, the human-induced disaster generic group is less discussed by researchers, with just 8%. According to the Swiss Re’s (2019) report, 37% of disasters reported in 2018 are human-induced and the 10-year average is more than 30% but the scholars' focus in this area is trivial. Several articles did not cover either of the disaster groups with a significant 22% coverage, and this contains conceptual papers and empirical papers mainly related to generic humanitarian supply chain, ethics, and privacy. The technology was tested in a non-disaster environment in one paper, so it was not assigned to any of the disasters. Figure 5 shows the remaining 14% of studies on the combination of both natural and human-induced disasters.

Figure 3 Disaster cases in articles - separated by generic and first-level disaster group.
Source: Compilation by Author

3.2. Disaster Phase
Disaster events in the extant research articles are divided into four phases; prevention, preparedness, response, and recovery (Cinnamon et al., 2016; Kankanamge et al., 2020b; Sarker et al., 2020). Figure 4 shows the distribution of articles between these four phases wherein the prevention or mitigation phase represents with bare 4%, following that preparedness stage which is slightly better than the initial phase but still less represented with 6%. Scholars' key priority over the years is on disaster response incidents, with 38% coverage. And the final phase recovery is less of interest to scholars with 1%, thereby demonstrating a drastic imbalance in research interest between the four stages. Additionally, 11% of the research focuses on more than one phase categorised as multiple. Remarkably, 29% of the research talks about the complete cycle of disaster with nearly half of them
are conceptual papers. However, a sizeable portion of papers did not assess any single-phase as 11% of papers are located in the independent category. The independent category consists of articles that talk about the ethics of big data, big data in digital humanitarian practices, the hype around big data, and challenges, etc.

Figure 4 Articles based on disaster phase. Source: Compilation by Author

3.3. Disaster Locations

No region is immune to disasters, particularly to natural disasters, but some regions are seriously affected by both human casualties and economic losses. The Asian region still is vulnerable to disasters and ranks among the worst affected regions in the world (Swiss Re, 2019), and without any surprise, scholars favored examining the events in this region as shown in figure 5. The second most preferred region is the Americas but the United States is the country of choice for researchers turning blind eye to the South American region as 7 out of 8 papers focused on the United States with the main emphasis on hurricanes. The other regions Oceania, Europe, and Africa have received further less attention. Africa accounts for most human casualties to disasters second only to Asia (Swiss Re, 2019) but this region is least focused in this field where humanitarian and disaster assistance is paramount. Also, few studies are focused on multiple regions, but the large number is coming from the independent category which includes all the conceptual and some empirical papers where the research is not driven by the location.
Further, figure 5 displays the disasters by the year of occurrence. The disasters chosen by scholars are relatively new to the research timeframes, with an average time difference of 3.7 years between the disaster occurrence and the article publication, and these disasters occurred between 2011 and 2019. The year with the most scholarly papers (5) is 2012, which can be attributed to the gain of research interest in hurricanes in the United States. Similarly, a disaster that spans multiple years also represents most academic papers (5). The general category contains a huge number of articles as the studies with real disaster and humanitarian cases are minimal.

Figure 5 Region of disaster in articles. Source: Compilation by Author

3.4. Sources of Big Data
This study further assessed extant literature on the origins of data used for research, and figure 7 depicts all the sources of big data used. The least used data sources are authoritative data and crowdsourcing data with 1 article each. There are 2 studies each using maps data (such as micro
maps and heat maps), spatial data, and satellite data. Mobile data, including positioning data and call detail records, is another source that is marginally better used, accounting for 4 articles. The most important disclosure is the use of social media data with a staggering 30 articles and this usage is not restricted to developed regions but utilized across all regions, covering all disaster phases and further applied in most of the disaster groups. Further, 10 articles studied multiple big data sources, and the remaining 21 are general articles without any focus on data sources.

**Figure 7 Source of big data in articles. Source: Compilation by Author**

Within the social media data source, Twitter, and Weibo are preferred by the scholars in their research to find the solutions for HDO related challenges. The clear dominance of Twitter can be seen in figure 8 as it contains vast amounts of publicly accessible data that is easy to comprehend, and most significantly it offers timely data (Thom et al., 2016). However, over-dependent on Twitter might raise bias-related questions due to the heavy use of single social media (Avvenuti et al., 2018). Another social media Weibo presence is felt in the analysis with the representation of 4 articles but these studies are limited to the Asia region. Further, scholars used multiple social media data sources for their research in three instances and Twitter was the common source in all three studies. Authors claimed that the use of multiple social media platforms as a data source offers a holistic perspective of the disaster unfolding (Sherchan et al., 2017; Chaudhuri and Bose, 2020). Furthermore, one study conducted using Facebook as a data source.
3.5. Theoretical Underpinnings

Theoretical foundations used in this field are listed in table 3. There is no clear domination in which theory is preferred, not only that no single theory has appeared more than once in the table, and a couple of papers used more than one theory. The minimal use of theory has been stated in Akter and Wamba’s (2019) work but the improvement of theories inclusion can be seen in the last few years as the majority of theories mentioned in the below table are published in the last 3 years. The lesser number of theories in research papers may well be due to a much lower representation of the publications in the field of management.

<table>
<thead>
<tr>
<th>Theoretical Underpinnings in Articles</th>
<th>Author (Year)</th>
<th>No. of Articles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local Model Semantics</td>
<td>Tomaszewski and MacEachren (2012)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Crowd Theory</td>
<td>Givoni (2016)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Information Theory</td>
<td>Read et al. (2016)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Organisational Mindfulness (OD) Theory, Information System Design Theory</td>
<td>Amaye et al. (2016)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Innovation Theory</td>
<td>Sandvik et al. (2017)</td>
<td>n = 1</td>
</tr>
<tr>
<td>TOSE Resilience Framework (modified)</td>
<td>Papadopoulos et al. (2017)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Contingent Resource-Based View (CRBV)</td>
<td>Dubey et al. (2018)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Resource Dependence Theory</td>
<td>Prasad et al. (2018)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Social Exchange Theory</td>
<td>Li et al. (2018)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Disaster Damage Assessment Theory</td>
<td>Shan et al. (2019)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Organizational Information Processing Theory (OIPT), Swift Trust Theory</td>
<td>Dubey et al. (2019)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Resource-Based View Theory, Social Capital Theory</td>
<td>Jeble et al. (2019)</td>
<td>n = 1</td>
</tr>
<tr>
<td>Social Support</td>
<td>Yan and Pedraza-Martinez (2019)</td>
<td>n = 1</td>
</tr>
</tbody>
</table>
4. DISCUSSION

The extant literature projects the dire need for more research into the field of BDA in HDO, this research highlighted areas that are crucial for the successful HDO. Information is and will be one of the deciding factors of success in relief operations mainly in logistics and supply chain (Warnier et al., 2020) as disaster response is the most intensive phase. However, there are few possible hurdles to cross: how reliable the information is, how quickly it is available to process for analysis, and how complete the data is. Time and again reliability is going to be a challenge, especially when using crowdsourcing and social media data because of false data or duplication in data (Kankanamge et al., 2020a; Nagendra et al., 2020; Rogstadius et al., 2013). The data is often needed to be available less than 72 hours after the disaster situation (van den Homberg et al., 2018). And, the disaster assessment is never going to be effective without the complete information (Shan et al., 2019).

To begin with, the Humanitarian Data Exchange (HDX) may be a viable solution to two problems, data availability, and completeness. The OCHA platform has begun to create datasets for humanitarian and disaster response operations and now has 17,000 datasets with about 600,000 users (Centre for Humanitarian Data, 2020). However, this is a new initiative, and awareness within the humanitarian actors is essential so that the integrated datasets can be created for as many humanitarian and disaster situations as possible, thereby helping organizations make use of accurate data. Just 54% of these HDX datasets are complete as of now (Centre for Humanitarian Data, 2020). The completeness of these datasets and the continued addition of more locations would therefore be an excellent opportunity for relief operations and research.

Situational awareness, which helps in responding to sudden-onset disasters, is the other aspect that could contribute to a better response. Many emergency responders find that it is helpful to gain an understanding of the crisis in response (Zhang et al., 2020). All the sources of big data mentioned in figure 7, could improve situational awareness but social media data can often bring the ground reality, content dimension, and may well act as two-way communication between the affected people and relief coordinators (Wang and Ye, 2018; Zhang et al., 2019). But these sudden-onset disasters always put more pressure on disaster responders and at times this makes them opt for data that is less accurate because they don’t want to lose the valuable time window.

Then there is the coordination factor, it is required whether the coordination between multiple organizations; within the country or international, or between multiple teams within the same organization. The coordination aspect is a big sell, Dubey et al.’s (2018) research discloses BDA can influence and further improves coordination in the humanitarian supply chain (HSC). Recently, more data is generating from crowdsourcing as well, meaning coordination is also required between organizations and individuals. This can be a challenge when digital humanitarians join hands with traditional humanitarian organisations due to the difference in working speed, hierarchical structures, and the variance in expertise (Sharma and Joshi, 2019).

Aside from the obvious emphasis on performance factors involved in the use of BDA in HDO, the other element surfaced in articles is social dimensions in a disaster setting. These are as important
as any operational or managerial dimensions in HDO. Kontokosta and Malik’s (2018) work on how big data can be helpful to reach the most affected people with a minimum capacity of resilience is noteworthy. Four domains in the social dimension; economic strength, social infrastructure, environmental conditions, and physical infrastructure are considered to measure neighborhood resilience. Authors developed an index called REDI which can rank the most resilient and least resilient areas. This will certainly help humanitarian and disaster responders to prioritise and reach the least resilient neighborhoods putting the relief supplies for effective use and reduce wastage in supplies and logistical efforts. Santos et al. (2020) combined multiple dimensions stating any one dimension is not sufficient enough for disaster response. Conceptual and a group of multiple dimensions workforce (W), economy (E), infrastructure (I), geography (G), hierarchy (H), and time (T) called WEIGHT includes a couple of social dimensions. Authors think that reliance through data analytics can only be improved with the integrated use of multiple dimensions. Also, social media is going to be an important source of information for HDO, not only because of large volumes of data but its timeliness which is crucial in disaster response and the two-way communication option makes it the most favourable choice. Using social media data, there is a possibility to analyse public emotions and sending psychological relief (Yang et al., 2019). But, there are some concerns in relying on social media data such as false information and lack of geo-tagging which helps in identifying the location is almost not available, basic 1% in the case of Twitter (Rogstadius et al., 2013). Also, location tags are not precise enough but these facts are becoming obsolete (Kankanamge et al., 2020b), and acting to strengthen these problems would be better than absolutely discarding social media for relief operations.

Primary findings indicate that scholars’ interest in this field has risen to a 110% average change in research publications over the last decade which is derived from figure 2. The substantial growth has taken place over the last five years and 2015 can be seen as a turning point in this field. However, the major push is coming from computer science and engineering subject areas wherein management is far behind which needs to be balanced.

4.1. Future Research Directions

The avenues for future research are provided in table 4 from the viewpoint of big data sources where a single or different source of big data can be used to conduct the research.

<table>
<thead>
<tr>
<th>BD Source</th>
<th>Research Directions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Media</td>
<td>The location-routing problem (LRP) is one key area that can be hugely helpful for relief operations; either by delivering the supplies on time and potentially saving the unnecessary cost in logistics with effective route optimisation. Can big data, mainly social media be effective in developing LRP models? (Wu et al., 2020)</td>
</tr>
<tr>
<td>Social Media</td>
<td>The time dimension is the least explored area out of four dimensions of social media data, the other three; network, content, and space dimensions are comparatively well researched. Further, it would be worthwhile to consider all four dimensions simultaneously while using social media as a source of big data (Wang and Ye, 2018).</td>
</tr>
<tr>
<td>Social Media</td>
<td>The behaviour and sentiment of the affected individuals are areas less studied. A crisis data set that can be used as a standard guide for disasters is also not available. The creation of this data set would help identify the needs of the affected people by using social media data such as Twitter and help to create a sentiment model (Ragini et al., 2018).</td>
</tr>
<tr>
<td>Social Media</td>
<td>What are the causal effects between social media attention and social characteristics such as income, education, and wealth in disaster-affected areas? Would the use of substantial BDA in analysing the social media data to deliver the relief efforts will be biased? (Fan et al., 2020)</td>
</tr>
</tbody>
</table>
Crowdsourcing

How will geographically dispersed crowdsourcing networks be impacted by the diverse geopolitics involved in humanitarian assistance? Can digital humanitarians change the direction of this interplay and affect geopolitics with the addition of BDA? (Mulder et al., 2016)

Different Sources

The ever-increasing volume of big data offers possibilities that we never thought of two decades ago. Lin et al.’s (2020) work shows that we can now estimate the demand for relief supplies with the use of big data in the disaster response stage, this research has been carried out using Baidu. This will certainly help to save the relief wastage and logistical expenditure. Future work can be conducted using other sources of big data in various disasters and compare their effectiveness.

Different Sources

How will the efficacy of the HSC be impacted by Big Data Predictive Analytics along with social capital? (Jeble et al., 2019)

Different Sources

Considering BDA as organisational capability, research improvements in examining the intangible resource such as organisational culture have begun (Dubey et al., 2019). This needs to be expanded further to another intangible resource organisational learning and how the culture change will affect the use of BDA in HDO.

Different Sources

How do humanitarian agencies assign priority to the population at risk in delivering the aid? Can this be enhanced by incorporating data analytics?

Table 4 Future directions to research in the field of BDA and HDO. Source: Compilation by Author

The most hard-hitting disaster groups in recent years are climatological and biological, but they have been relatively uninteresting to scholars with a mere representation in the reviewed papers. In addition to the research perspectives listed in the above table, scholars must concentrate on these less explored disaster groups within the natural disaster generic group along with the human-induced disaster generic group to see how BDA can be beneficial. Further increase in the research gap between both disaster generic groups could lead to uneven arguments and justifications of BDA in the HDO spectrum. The disparity of research in disaster locations is much wider and concerning as developed economies got more attention than Africa, the poorest region in the global south. Africa accounts for most human casualties to disasters second only to Asia (Swiss Re, 2019) but this region is least focused in this field where humanitarian and disaster assistance is paramount.

5. CONCLUSION

At the beginning of this study, 168 million people required humanitarian assistance (beginning of 2020), by the end of completing this review the number rose to 235 million (at the end of 2020). There is no time to lose, certainly no data to lose. Humanitarian organizations must take advantage of BDA with the same earnestness as profit-oriented organisations by keeping the checks on ethical concerns. Providentially, academic research is expanding quickly in this spectrum especially in the last 2 years of research contributing more than 50% of overall research. There is also similar growth in the management subject area but the overall contribution to the field of BDA in HDO is trivial. As it is a multidisciplinary field, the contribution of other subject areas is often significant but the management subject area needs to catch up and increase the presence. This review is attempted to approach the topic and three research questions in a more integrated and systematic way. First, over the past couple of years, research on the use of BDA for HDO has significantly improved, showing the ability of researchers to explore what data analytics can do to enhance the way humanitarian and disaster relief operates. Management research, though, is well behind and fragmented in its contribution to the field. Second, the status of BDA application across different disaster categories, disaster phases, and disaster locations is imbalanced and research priorities are not utilised where it is more essential. In disaster phases, concentrating only on disaster response while overlooking the other three stages; prevention, mitigation, and recovery would not result in a holistic improvement
of the field. Furthermore, there is a high dependency on social media as a source of big data, which poses ethical, bias, and factual concerns that must be addressed. Third, the dearth of theoretical frameworks is evident in the field, while this seems to be improving lately, the proportion of papers with a theoretical lens in overall papers in each year is not encouraging. Irrespective of these critical findings, the review does have some limitations and the author is aware of these limitations during stage one in step three while designing the review protocol.

5.1. **Limitations**

There are two major limitations, one in database selection and the second in exclusion criteria which is not part of five-level search criteria. Although, database selection is logical in this review if the time and resources are allowed web of science can also be included for future reviews, which might bring a few more papers to the review process and provide a much clearer view of the topic. The second limitation is more of a feature related to the Scopus. The database has two options to refine the results namely ‘Limit to’ and ‘Exclude’. In the subject area, one of the refine results options in Scopus, won’t provide a unique breakdown for articles using ‘Limit to’ criteria. The reason is Scopus assigns each article to multiple subject areas making it impossible to get the unique numbers for each subject area when using the ‘Limit to’ criteria. Author rationale for using this criterion rather than ‘Exclude to’ is because the ‘Limit to’ feature eliminates all the documents which have subject areas mentioned in the ‘Exclude to’ list, including subject areas that the author is interested in but are excluded because of multiple subject area tags to each document.

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IMPACT OF CULTURE ON THE ADOPTION OF DIABETES SELF-MANAGEMENT APPLICATIONS: CAPE FLATS, SOUTH AFRICA

Fazlyn Petersen, University of the Western Cape, Fapetersen@uwc.ac.za

Abstract: Diabetes is a global health problem with a high mortality rate. The research indicates low levels of technology use amongst diabetic patients in low socioeconomic environments and minority groups. We posit that the culture of patients is a potential reason for the low adoption and use of technology. However, research on the proliferation of culture at an individual level is limited. Therefore, this paper assessed the influence of culture on mobile application adoption and use amongst diabetic patients in the Cape Flats, South Africa. This study used key constructs from the Theory of Planned Behaviour (TPB) and Hofstede’s cultural dimensions. It was analysed using survey data from 439 respondents using purposive sampling. It was found that the dimensions of Hofstede and the Theory of Planned Behaviour can identify how culture influences mobile application adoption of diabetic patients in the geographical Cape Flats area. However, this research indicates a stronger relationship between culture and diabetes self-management activities than culture and the adoption of mobile applications.

Keywords: Mobile applications, Theory of Planned Behaviour (TPB), Hofstede’s cultural dimensions, Western Cape, diabetes self-management

1. INTRODUCTION

Non-communicable disease (NCD) is the leading cause of death globally (Mutymbizi, Booysen, Stokes, Pavlova, & Groot, 2019) and it is expected to surpass other causes of mortality in Africa by 2030 (World Health Organization, 2014). Diabetes mellitus, a worldwide pandemic presents one of the major non-communicable diseases (NCDs) in South Africa. Diabetes is a chronic disease with a high level of mortality rate and has become increasingly prevalent in low-middle income countries (LMICs) (World Health Organization, 2016). In Africa, it is estimated that 16 million people are living with diabetes (International Diabetes Federation, 2017) and it is expected to surpass other causes of mortality in Africa by the year 2030 (World Health Organization, 2014). Statistics show that in 2017, 10.4% of the Western Cape population has succumbed to diabetes (Statistics South Africa, 2016).

Self-management is an essential part of diabetes management. diabetic patients must follow the self-management activities consist of healthy eating, being active, monitoring, taking prescribed medication, problem-solving, healthy coping and reducing risks (American Association of Diabetes Educators, 1997). Poor self-management can lead to significant mortality and a poor quality of life (Reyes, Tripp-Reimer, Parker, Muller, & Laroche, 2017). The risk of having diabetes is determined by factors such as age, ethnicity, socioeconomic status and lifestyle factors (World Health Organization, 2016). Although the pervasiveness of diabetes varies with socioeconomic status, the disparities can be worsened by the unhealthy lifestyles adopted by individuals (Mukong, Van Walbeek, & Ross, 2017).

In the current era, there is significant potential for modern technology, such as mobile technologies to be used to address disease management. Mobile health (m-health) interventions seem to be developed and implemented in a sociocultural vacuum – “the template for many m-health interventions are mainly interventions from developed countries” (Müller, 2016 p.295). Therefore, understanding patients self-management and cultural value systems is an important factor for designing effective self-management interventions that could ultimately influence self-management behaviours (Ayele, Tesfa, Abebe, Tilahun, & Girma, 2012). Designing ICT interventions must consider a “patient-centred communication style that incorporates patient preferences; assesses literacy and numeracy, and addresses cultural barriers to care” (American Diabetes Association, 2015 p.S5) to improve health outcomes.
Culture is defined as "the collective programming of the mind which distinguishes the members of one human group from another" (Hofstede, Hofstede & Minkov, 2010 p.5). Culture is context-specific. Research indicated that culture is unique to geography and may not be seen in isolation (Dwivedi, Shareef, Simintiras, Lal, & Weerakkody, 2016). The culture within the South African context is complex due to apartheid and the division of the population based on race and gender (Bekker, Leidlé, Cornelissen, & Horstmeier, 2000; Shefer et al., 2008). The Western Cape is heterogeneous in terms of culture, linguistics and religion (Bekker et al., 2000). The Cape Flats, an area in the Western Cape, was created during Apartheid to move non-white residents out of the City Centre (Farrar, Falake, Mebaley, Moya, & Rudolph, 2019). The Cape Flats area consisted of low-cost public housing known as townships and informal settlements. (Farrar et al., 2019). The Cape Flats is home to “predominantly isiXhosa-speaking ‘Black Africans’ and people belonging to an ethnically heterogeneous group of brown people known colloquially as ‘Coloureds’” (Farrar et al., 2019 p.3). The research indicates that in a ‘black’ and ‘coloured’ community in the Western Cape there are traditional roles of male dominance and female subservience however this is changing over time (Bekker et al., 2000). There is also a growing diabetes population in Cape Town (Kengne & Sayed, 2017). Diabetes control is lower in patients with low socioeconomic conditions, residing in areas such as Bishop Lavis (Booysen & Schlemmer, 2015) and Khayelitsha (Guwatudde et al., 2018) in the Cape Flats.

There has been extensive research about the link between cultural factors and the acceptance of technology (Al-jumiley & Hussain, 2014; Barton, 2010; Kovačić, 2005; Srite & Karahanna, 2006; Tarhini, Hone, Liu, & Tarhini, 2017). These studies illustrate that cultural backgrounds play an important role in affecting the acceptance and use of technology. Researchers have applied Hofstede’s cultural dimensions in technology acceptance and adoption models (Caporarello, Magni, & Pennarola, 2014; Hoque & Bao, 2015). However, there is a low level of technology acceptance and use for diabetes self-management in geographical areas, such as the Cape Flats (Petersen, Pather, & Tucker, 2018). Additionally, the effect of culture on technology adoption has not yet been studied in this context. Therefore, this research objective determined how culture influence m-health adoption for self-management amongst diabetic patients in this context.

2. CULTURE AND ADOPTION

Hofstede’s cultural dimensions are defined and applied to South Africa in Table 1 below:

<table>
<thead>
<tr>
<th>Construct</th>
<th>Definition based on Hofstede et al. (2010)</th>
<th>South African cultural dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power distance (PD)</td>
<td>The “extent to which the less powerful members of institutions and organizations within a country expect and accept that power is distributed unequally” (p.61).</td>
<td>While Hofstede’s cultural dimensions are indicated for South Africans (Cronjé, 2006), in some research, the following reference (Hofstede, 2019) indicates that it is for White South Africans. It also cautions that these values may not apply to the Black or Coloured South African population. The PD value for White South Africans indicates that they accept a hierarchical order where power is not equally distributed (Hofstede, 2019).</td>
</tr>
<tr>
<td>Individualism-collectivism (IC)</td>
<td>Individualism refers to “societies in which everyone is expected to look after him- or herself and immediate family. Collectivism refers to “societies in which people from birth onward are integrated into strong, cohesive in-groups” (p.92).</td>
<td>The IC value for White South Africans indicates that they prefer taking care of themselves and their immediate families only (Hofstede, 2017). This value may be different for closely-knit Black or Coloured families and communities.</td>
</tr>
<tr>
<td>Masculinity-femininity –</td>
<td>Masculinity stands for a “society in which emotional gender roles are distinct” (p.519). Femininity is seen as a “society in which emotional gender roles overlap: both men and White South Africans view South Africa as a masculine society where society is driven by achievement and success (Hofstede, 2019).</td>
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Research also indicates several potential culture-related influences on technology adoption, which warrants further investigation (Petersen, Brown, Pather, & Tucker, 2019). Research shows that differences between social structures, the standard of living and religion may influence individuals obligations to behave healthily (Hjelm, Bard, Nyberg, & Apelqvist, 2003). The research indicates that culture may impact diabetes self-management. For example, individuals from different societies practice diverse religious obligations, eating habits social customs and this may influence their beliefs, behaviour, perception and attitudes towards health (Swierad, Vartanian, & King, 2017). Research shows that culture and socioeconomic status shaped diabetic patient eating patterns (Matima, Murphy, Levitt, BeLuc, & Oni, 2018).

Cultural values influencing technology adoption have been widely studied from a national perspective, the studies on an individual level are limited (Sunny, Patrick, & Rob, 2019). Research into the role of culture on diabetic patients’ adoption of m-health is warranted given the previous studies have shown that behavioural intention on its own is not a predictor of use (Petersen et al., 2018). Additionally, other factors that influence m-health adoption and use such as culture and research should be centred on how people use technology (Müller, 2016).

The four prominent models for adoption used in mobile health services are the Theory of Reasoned Action (TRA) (M. . Fishbein & Ajzen, 1975), Technology Acceptance Model (TAM) (Davis, 1989), the Theory of Planned Behavior (TPB) (M. . Fishbein & Ajzen, 1975) and the Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh, Morris, Davis, & Davis, 2003) are summarised in Figure 1.

TRA includes the key beliefs formulating attitude in that the attitude toward the behaviour and normative beliefs are important in determining whether individuals will perform the desired behaviour (Fishbein & Ajzen, 1975). TRA includes the key beliefs formulating attitude in that the attitude toward the behaviour and normative beliefs are important in determining whether individuals will perform the desired behaviour (Fishbein & Ajzen, 1975). The desired behaviour in this study refers to the performance of self-management activities.

The TPB model includes expands TRA by adding perceived behavioural control (PBC). PBC is the “perceived ease or difficulty of performing the behaviour” (Ajzen, 1991 p.188). In a comparison between TRA and TPB, the inclusion of PBC explained more of the variance in behaviour than TRA (Madden, Ellen & Ajzen, 1992). TPB is used more extensively in predicting health behaviours (LaMorte, 2018).

TAM compares favourably with alternative models such as TRA and TPB (Venkatesh & Davis, 2000). Based on Davis (1989), TAM includes perceived usefulness (whether patients believe that using a mobile application would improve their health) and perceived ease of use (whether patients believe that using a mobile application would be effortless).

| Uncertainty avoidance (UA) – | The extent to which the members of a culture feel threatened by ambiguous or unknown situations” (p.191). | There is a low UA value for White South Africans. The value is indicative of a society that is more relaxed and does not fear uncertainty (Hofstede, 2019). |
| Long-term orientation (LTO) | “The fostering of virtues oriented toward future rewards—in particular, perseverance and thrift” (p.239). | White South Africans indicate a low score. Therefore, they value traditions and may view change negatively (Hofstede, 2019). |
| Indulgence-Restraint (IR) | Indulgence refers to “a society that allows relatively free gratification of basic and natural human desires related to enjoying life and having fun” (p.519). Restrained refers to a “society that suppresses gratification of needs and regulates it using strict social norms” (p.521). | The high IR value for White South Africans indicates that they prefer acting on their impulses, enjoy having fun and spending as they wish (Hofstede, 2017). |
The UTAUT model expands TAM with the inclusion of Social Influence (SI): “the degree to which an individual perceives that important others believe he or she should use the new system” (Venkatesh et al., 2003:451) and Facilitating Conditions (FC): “the degree to which an individual believes that an organisational and technical infrastructure exists to support the use of the system” (Venkatesh et al., 2003:453).

UTAUT and TPB constructs cover similar constructs in terms of mobile health services (Sun et al., 2013). However, TPB has been used in studies to predict self-management behaviours in people who are at risk of diabetes and diagnosed with type 2 diabetes (Boudreau & Godin, 2014; Traina, Mathias, Colwell, Crosby, & Abraham, 2016). Additionally, it has been found that the TPB constructs are significant predictors to carry out self-management behaviours of diabetic patients (Gatt & Sammut, 2008). Research shows that the TPB has been used to attain an improved knowledge of the perceptions underlying the adoption of health-related behaviours (Akbar, Anderson, & Gallegos, 2015). UTAUT was not effective in predicting the acceptance and use of ICT for diabetic patients in the Western Cape (Petersen et al., 2018) therefore, TPB was selected as the basis of the research model.

3. RESEARCH MODEL

In this study context, culture is viewed based on diabetic patients’ perceptions of health and adoption of mobile applications. To address the research objective, the research model was developed consist of two theoretical frameworks. Hofstede cultural dimension and TPB was used (Figure 2).

The TPB constructs are imperative predictors of “intent to carry out self-management behaviour in persons with type 2 diabetes” (Gatt & Sammut, 2008 p.1525). Moreover, all of the Hofstede constructs can influence technology acceptance and use. The TPB model can predict diabetes patients’ self-management behaviours and thus can affect the acceptance and use of m-health applications. The TPB model can be used as predictors of the Hofstede cultural model as diabetes patients’ attitude and values can be influenced by their beliefs regarding whether to adopt m-health applications.
In summary, the research model (Figure 2) used two main elements used to gain insights into diabetes patients’ adoption of m-health applications for self-management activities:

1. Hofstede’s cultural dimensions model was used to understand whether diabetes patients’ culture influences their self-management behaviours and whether their culture influences their mobile application adoption for their self-management.

2. Theory of Planned Behaviour (TPB) was used to provide insight into respondents’ adoption of m-health applications to manage their diabetes condition.

The inclusion of the AADE 7 self-management behaviour activities model was used to understand diabetic patients’ self-management behaviours.

4. RESEARCH DESIGN AND METHODOLOGY

This research paradigm used was interpretivism. Interpretivism is associated with an inductive approach. An inductive approach was used for understanding the impact of culture on patients’ adoption of diabetes self-management applications (Saunders, Lewis, & Thornhill, 2009).

4.1. Data collection

Qualitative data was collected from 438 diabetic patients via a survey. Purposive sampling was used and respondents eligible for inclusion were diabetic patients residing in the Cape Flats. The areas that are predominant in this study are from Mitchell’s Plain and Khayelitsha as these areas showed a low level of diabetes self-management was practised (Daivadanam et al., 2017; Khalied, 2017).

4.2. Data Analysis

The study used thematic content analysis to identify how culture influence mobile application adoption and use for diabetes self-management. The data analysis was based on the key thematic areas identified in the research model (Figure 2). The qualitative evidence was analysed with Atlas.ti software data to identify how culture influences mobile health adoption. The themes were derived from the core constructs of the TPB (Davis, 1989), Hofstede cultural dimensions and AADE 7 self-management behaviour activities. Respondents’ responses were coded and grouped according to the constructs and thereafter patterns and relationships have been identified based on existing research.

4.3. Ethical considerations

The research was conducted according to the ethical standards specified by the Higher Committees at the University of the Western Cape. Respondents received an information sheet and consent form before any data being collected. The respondents’ personal information was protected as no clinical data or unique identifiers were collected.
such as respondents’ ID numbers were collected. Respondents were informed that this was a voluntary process. Respondents reserved the right to refuse to answer any question with which they felt uncomfortable.

5. FINDINGS

The themes identified in this study aimed to identify how culture influences mobile application adoption of diabetes self-management. The section commences with the respondents’ demographics and concludes with thematic content analysis using the research model in Figure 2.

5.1. Respondent demographics

The analysis of demographic data indicated that the majority of respondents were female (58.6%), with grade 12 as their highest level of education (36.2%). Respondents were older than 50 (39.9%), with type 2 insulin-resistant diabetes, using oral diabetes medication such as Metformin or Glucophage. Respondents resided in the Cape Flats in the City of Cape Town. The top five areas were Belhar (11.9%), Athlone (9.7%), Mitchell’s Plain (8.6%), Khayelitsha (4.7%) and Gugulethu (3.5%). The most important observation is that the majority (64.7%) of respondents strongly disagreed that culture affected their ability to adopt diabetes mobile applications.

5.2. Thematic Content Analysis

When a diabetic patient trusts their doctors or prefers visiting a doctor as opposed to using an m-health application, they form part of a power distance society. This was evidenced by the following quote, “I don't use mobile applications at all for my diabetes as I'm high risk and prefer professional advice and assistance” (Coloured, male, older than 50 years). The quotation also shows the relationship between power distance, reducing diabetes risks self-management activity and the use of mobile applications.

When a diabetic patient subscribes to a high uncertainty avoidance society, s/he may find it difficult to adjust to technological changes. Uncertainty avoidance was evidenced by the following quote, “Nobody I know uses it. Most of my family has and they never used it. We just used to the old way of going to the doctor” (Coloured, male, 18 - 24 years). The comment also highlights that uncertainty avoidance may not be influenced by age as this respondent was young. The quote also links to a low long-term orientation.

In terms of individualism, if a patient forms part of an individualistic society, s/he will make their own informed decision as to how to manage their condition. Individualism was evidenced as respondents indicated that others do not influence their decision to use m-health applications. “My culture does not affect my ability to use mobile health application to manage my diabetes. This is mainly because I do not centre my life based on what other people may say or think because my health is important to me” (Black, female, 25 – 34 years).

A link between individualism and perceived behavioural control is evidenced by the following quote, “I am allowed to use any smart devices, and the problems is that I find technology difficult for me” (Black, female, 35 - 49 years).

There was also a link between individualism and the problem-solving diabetes self-management activity, “As time has passed, our culture (isiXhosa) has become more flexible to the fact that we use technology for innovation and to solve problems so my culture does not restrict me to gain access to proper technological solutions for illness or treatment” (Black, male, 25 – 34 years).

However, a collectivist cultural construct relates to the subject norm theme in TBP as family and important others influences’ the decision to adopt mobile applications. Patients who form part of collectivistic cultures will make health-related decisions based on the values and beliefs of their societies. A respondent highlighted this point in the statement, “It does not really affect my culture as most of the people that I am surrounded by has mobile applications and are technologically advanced. Therefore they largely influence my ability into using mobile applications” (Coloured, male, 25 – 34 years).

Respondents indicated a relationship between collectivism, social norms and eating healthy. A negative relationship is evidenced by the following quotes, “In our Black culture we have gotten used to the whole notion of eating full meal plates every day and that does affect my health” (Black, female, 35 - 49 years).
However, a positive relationship was also indicated, “They know my diet, so they always prepare the right food for my situation like fruit and vegetables” (Black, male, 25 – 34 years).

When a patient forms part of the feminine society, s/he will care for others and make informed health decisions to assist themselves and others in leading healthier lifestyles. The femininity cultural construct was evidenced by the following quote, “As a single parent to three daughters’ majority of my day consists of praying, cooking, cleaning and family time. I, therefore, don't have much time to figure out how or remember to use mobile applications” (Coloured, female, older than 50 years). Respondents indicated that they do not have time to manage their condition or use mobile applications due to their family responsibilities. Hence, there is also a link to social norms.

A link between femininity and a negative attitude to using m-health applications was also highlighted by the following statement, “I live in a township and mobile applications aren’t really something that people do. I am also a 56 year old woman and I don’t really have the energy to try and learn how these fancy are used” (Black, female, older than 50 years).

Respondents indicated that there was a low long-term orientation. They are more traditional, they prefer going to the doctor than using an application. Evidence from respondents indicated that “My culture does not affect my ability to use mobile applications. I just feel it’s better to do things the old-fashioned way” (Black, male, 25 – 34 years).

Adhering to religious practices was also indicated and linked to the self-management activity of eating healthy, “During the month of Ramadaan, we are not to eat anything during the day. This obviously means I cannot have consistent meals through the day as we cannot be fasting and eating etc. This does affect my energy levels and allow for room of fatigue to come about” (Coloured, female, older than 50 years).

The following quotation indicated a link between the low long-term orientation and perceived behavioural control, “I am not exposed to technology so I can’t use some technological tools that help me manage my illness” (Black, female, 25 – 34 years).

Long-term orientation and adhering to religious practices were also linked to taking prescribed medication. This is evidenced by the following quotations, “I go to a traditional healer twice a month to for herbs to keep my body clean and strong” (Black, female, 25 - 34 years) and “It teaches discipline and that has helped in terms of me taking my medication every time, and not eating what I am not supposed to eat” (Coloured, female, 35 - 49 years).

However, a short-term orientation was evidenced by the following quote, “My culture encourage change and adapting to change. So it encourages technology” (Coloured, male, older than 50 years).

When a diabetic patient subscribes to an indulgence society, s/he will make health-related decisions that are satisfactory to them to ensure that they are happy. Respondents indicated that they prefer spending money on things that are fulfilling to them. The view of indulgence is supported by the following quote, “I can do what I what as long it helps me to have a long and prosperous life” (Coloured, male, 35 - 49 years).

The link between an indulgence society and healthy coping was supported by the following quote, “My culture supports me in adopting habits which will allow me to live a full and healthy life” (Coloured, female, 35 - 49 years).

As indicated in the demographic analysis, the majority of respondents (64.7%) indicated that culture did not impact their adoption of diabetes self-management applications. Socioeconomic status was emphasised by the following quote, “I would not exactly say my culture affects it rather my economic status as a domestic worker. I am a single mother of 4 and grandmother of 2 all depending on me. I cannot afford a smartphone and therefore not so familiarised with the internet and mobile applications” (Black, female, 35 - 49 years). However, this quote also indicates social norms and being part of a feminine society.

Respondents indicated a lack of knowledge affects the use of diabetes self-management applications, “Culture does not forbid it but there is a lack of knowledge” (Coloured, female, older than 50 years). Age and affordability were identified as important factors that negatively affect the use of applications, “Not interested

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in using a smart phone as my age doesn't allow for it. [I] don't have enough funding for data or the phone” (Coloured, female, older than 50 years). The crime was also highlighted “The area that I live in (Bridgetown) is not safe and I have a fear of being robbed if I am using my smartphone in public” (Coloured, male, 18 – 24 years).

6. DISCUSSION

The evidence did not indicate that culture influences the adoption of diabetes self-management applications in this context, unlike the existing research. However, this research indicated a stronger relationship between culture and diabetes self-management activities than culture and the adoption of mobile applications. The finding that culture influences healthy eating especially for Coloured and Black respondents is supported by research that indicates culture affects diabetic patient eating patterns (Matima et al., 2018). The link between culture and exercise and the use of diabetes mobile applications for exercise was not explicitly found in this study.

Cultural, social and family influences can shape people’s beliefs and attitudes. Other factors such as age, affordability and a lack of knowledge also influenced mobile application adoption. These factors are supported by a study showing the challenges for adopting technology for diabetes self-management in low-resource areas in the Western Cape, South Africa (Petersen et al., 2019). Perceived behavioural control was also supported by a study that identified the usability of diabetes applications as an important factor in South Africa (Mainoti, Isabirye, & Cilliers, 2019).

Respondents preferred to follow the traditional way of seeking health care advice, uphold traditions and were sceptical about change. The evidence supports Hofstede’s view of White South African culture with a low long-term orientation (Hofstede, 2019). The power distance identified in this research may be beneficial when healthcare practitioners recommend and encourage patients to use mobile health applications (Mainoti et al., 2019).

White South Africans form part of an indulgence culture (Hofstede, 2019). They are free to make their own choices. This is consistent with the research finding where diabetic patients can make their own decision whether to use mobile applications for diabetes self-management. The finding of the link between long-term orientation and perceived behavioural control is supported by a study that indicates long-term orientation is positively related to perceived usefulness and perceived ease of use (Sunny et al., 2019).

7. CONCLUSION

This study investigated how culture influenced mobile application adoption amongst diabetic patients. Drawing from the research, Hofstede’s cultural dimensions and the TPB were used to design the research model. The research contributes to the body of knowledge where there is limited research in this context. The results did not indicate that Hofstede’s cultural dimensions and the TPB can identify how culture influences mobile application adoption.

The research can be used to design more culturally sensitive interventions for the context where the use of mobile applications is low. Future research could ask more specific questions, using a cultural model, as it appears that the definition of culture may not be consistent across different groups.

The findings identified in this study are limited to patients with type 2 diabetes residing in the Cape Flats and thus is not a representation of the entire Western Cape population.

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GLOBAL TRANSFERS: M-PESA, INTELLECTUAL PROPERTY RIGHTS AND DIGITAL INNOVATION

Christopher Foster, University of Manchester, christopher.foster-2@manchester.ac.uk

Abstract: In July 2020, in the midst of the COVID crisis, the Kenyan mobile operator Safaricom announced that the intellectual property rights (IPR) for mobile money service M-Pesa were “moving back into African control”. This paper tracks how the IPR originally came to be held outside Kenya, and the implications for understanding M-Pesa as an inclusive innovation. Through reflection of this analysis of IPR and innovation, the paper contributes to discussions on structural aspects of digital innovation in the global south. By focussing on IPR, it unpacks some of the processes by which global intellectual property regimes and cross-border IPR practices shape uneven outcomes and power.

Keywords: mobile money, intellectual property, inclusive innovation, digital innovation, digital capitalism, Kenya

1. INTRODUCTION

There has been an emergence of global digital innovations that follow common patterns - operating at a global scale, owned by large firms and shaped by demands of financialization, market dominance, intellectual property control and data ownership (Srnicek, 2016). A crucial question is how to integrate these more critical perspectives into research on digital inclusion and development. Literature on inclusive innovation has made pragmatic investigations of how technologies and processes might be inclusive of marginalised groups (Heeks et al., 2014). But the digital products and services being discussed are frequently the very same ones that are being critiqued as part of the emerging era of ‘digital capitalism’.

This paper focuses on one aspect of this issue by exploring intellectual property rights (IPR) in digital innovation. Who gains rights when intellectual property is generated is a key structuring aspect in shaping modern economies, and plays an important role in determining who gains from innovation. Exploring the role of IPR in the contexts of digital innovations can therefore provide important perspectives on digital development.

This paper explores the IPR through the case of Kenyan mobile money service M-Pesa. M-Pesa has been fraught with tensions around IPR during its entire history. These tensions can be argued to have had a significant influence on M-Pesa trajectories and its impacts. The paper highlights how M-Pesa is part of a global network of actors with different agendas and with complex relationships of control. In the case of M-Pesa, not only has control of IPR led to significant bottlenecks in innovation in Kenya, but also significant financial transfers to the UK which call into question the more optimistic claims of inclusive innovation.

2. INNOVATION AND IPR AT A MACRO LEVEL

2.1. Innovation in the global south

Subsets of digital innovation linked to development goals initially tended to follow paradigms linked to ICT for development (ICT4D) (Unwin, 2009). Small-scale digital innovations and infrastructure were rolled out in specific contexts, supported by diverse actors including governments, NGOs,
corporate CSR and telecoms firms (Murphy & Carmody, 2015). With the growth of access, however, it has been useful to think about digital innovation as having moved away from ICT4D towards “digital development”, aligned to the expanding digital economy across the globe (Heeks, 2020). As such increasingly one needs to consider the relationship between global firms involved in the digital economy and claims about impacts in the global south.

An important framework for examining such relationships is that of inclusive innovation which examines “the means by which new goods and services are developed for and by marginal groups” (Foster & Heeks, 2015, p. 2). The discussion of development impacts has often come through a focus on ‘inclusivity’ examining local adoption, use and small-scale impacts (Heeks et al., 2013). More systematic thinking has, however, begun to move beyond such fleeting development gains to think more systematically about how innovations reproduce or change processes within and across societies in areas such as innovation and gender, neoliberal growth models and the ownership of knowledge (Jiménez & Zheng, 2017; Pansera & Owen, 2016; Papaioannou, 2016; Smith et al., 2016). This paper aligns to such work through an analysis of intellectual property, an important structuring factor in the economy. In the next sections, some of the key tenets of IPR institutions are discussed to understand their links to innovation in the global south.

2.2. IPR and inclusive innovation

“Intellectual property rights” include a range of different rights that protect individuals and organisations who create “intellectual property”. This includes copyright on creative works and computer programs, trademarks on brands and marks, and rights on innovative ideas including patents, industrial designs and trade secrets.

Underlying global regimes of intellectual property are powerful global institutions, particularly the World Intellectual Property Organisation (WIPO) and the Trade-Related Aspects of Intellectual Property Rights (TRIPS) that define strong intellectual property regimes across the globe (Peukert, 2017). Three decades after the introduction of TRIPS, the evidence on strong IPR regimes suggests overall negative consequences towards the global south (Chang, 2001; Peukert, 2017; Stiglitz, 2014). Those examining global trade have critiqued the impacts of IPR regimes which narrow the ability for global south states to build domestic innovation and tend to reinforce the dominance of IPR within the global north (Chang, 2001; Lall, 2003).

Over time a range of more detailed critiques of strong IPR regimes have been discussed that are relevant to inclusive innovation. Important questions have emerged about how societal orientated research can fit into IPR regimes that primarily concentrate on firm ownership (Ghauri & Rao, 2009). Organisations that are involved in innovation (non-profit, public, universities, social enterprises) may have agendas that go beyond profit, but these goals can often be dissipated within the present institutions. Furthermore, as IPR has become more global, a key issue relates to differentiating between firm created intellectual property and local and indigenous knowledge, creativity and innovation. Case studies have highlighted these concerns in the global south, when indigenous knowledge ‘discovered’ by corporate actors are problematically incorporated into intellectual property (Finger & Schuler, 2004; Srang-iam, 2013).

2.3. IPR and the digital economy

Intangibles, investments made in creating intellectual assets, are increasingly important in an economy driven by information (Haskel & Westlake, 2017). This is particularly the case for global digital firms, where the generation of intellectual capital (ideas, brands, software, data, relationships) are at the core of their global business models. As firms move beyond material assets, IPR is a crucial way to protect these investments. WIPO data has highlighted growth in IPR in recent years: with global patents growing from 1.6m filings in 2004 to 3.3m in 2018; and trademarks applications from 4.6m in 2004 to 14.3m in 2018 (WIPO, 2020). For technology-intensive firms, building ‘portfolios’ of intellectual property claims is now an important part of firm strategy in competitive marketplaces (Rice, 2015). These expansionist trajectories of IPR have also emerged out of the
relaxation of requirements of novelty in patents. Increasingly, patents based on software and business models have been permitted in many nations, when previously they were seen as abstract ideas and therefore less patentable (Bessen & Hunt, 2007; Hall & Harhoff, 2012).

IPR assigns firm exclusivity to an ever-growing range of ideas, brands and processes this has led to the argument that it takes ideas and innovation away from the ‘commons’ with important economic impacts (Stiglitz, 2014). From a development perspective, these trends are highly problematic considering the often-global scope on IPR and the skew in IPR ownership towards the global north (ibid). Some accounts of IPR expansionism suggest that we are seeing a small number of firms building out global intellectual monopolies, where “intellectual monopoly capitalism” is defining a new domain of global economic dominance beyond markets (Pagano, 2014). A key example of intellectual monopoly capitalism has been global digital firms that have been at the forefront of IPR expansionism and rapid globalisation (Durand & Milberg, 2020; Rikap, In press).

In summary, this section outlined some of the important aspects of innovation and intellectual property. It introduced the link between inclusive innovation and the global digital economy. It outlined the emergence of strong IPR regimes that are skewed towards the global north. It has highlighted the growing importance of intangible assets in the digital economy and the implications of IPR expansionism. Such arguments are well documented at this macro-level, but there is very little analysis of how such processes unfold on the ground. In particular, little is known about how these processes shape innovative digital products and services in the global south where development aims (or claims) are included.

3. APPROACH

The goal of the remainder of the paper is to unpack these issues through an analysis of M-Pesa. The paper undertakes a qualitative analysis examining the history of IP and IPR. A qualitative approach is crucial as it allows us to unpack the specific activities that have had significant effects on IPR.

The analysis builds upon outcomes of qualitative research undertaken with a range M-Pesa actors in Kenya during the periods 2010-2012 and 2015-2016. This provides the foundation for understanding the historic evolution of the service. Alongside this, the author has continued to be involved in conversations and workshops with various policy and practice actors, including M-Pesa agents and ICT consultants. In addition, this paper analyses a range of technical documentation relevant to the IPR including patents, project evaluations, and company documentation which are key to illuminating the often-tecnocratic aspects of intellectual property.

The case is set up as follows. In section 4.1 the paper provides an overview of the case, introducing the M-Pesa innovation and actors, and summarising the overall impacts of the IPR. Section 4.2 then makes a detailed historical account of how intellectual property has been generated and the different aspects of intellectual property rights. For space, only the two most important aspects of IPR are discussed - patents and software.

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1 Given that this paper will argue that intellectual property is multi-faceted and complex, it is appropriate for the author to acknowledge that this paper has been inspired by a vibrant discussion amongst interviewees and online in Kenya over the last decade. This has often centered on the debate “is M-Pesa a Kenyan innovation?” Interview respondents and those within Kenyan media and blogosphere have made interesting interventions to this discussion which are relevant to this analysis of intellectual property. This paper therefore acknowledges the work done by Alex Kuria, Tefo Mohapi, Brian Gachichio, Cyprian Nyakundi, Kenya West and Nairobi Law Monthly
4. M-PESA AND IPR

4.1. Introducing M-Pesa

4.1.1. Key actors

Accounts of the M-Pesa service has been outlined in great detail elsewhere (e.g. Foster & Heeks 2013a, Hughes & Lonie 2007, Ngugi et al. 2010, Omwansa 2009) therefore only a brief account is reprised in this paper relevant to the history of IPR. M-Pesa is a well-known service in Kenya that initially allowed money to be exchanged between mobile phone users through mobile messaging. It provides a convenient mechanism for person-to-person transfer of money, with significant use by low-income groups. Over time, M-Pesa has expanded to serve as a platform for an increasingly diverse range of services as outlined in the most recent statistics in Table 1.

<table>
<thead>
<tr>
<th></th>
<th>Total for Quarter</th>
<th>M-Pesa</th>
<th>M-Pesa market share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active subscriptions</td>
<td>29,185,577</td>
<td>28,842,584</td>
<td>98.8%</td>
</tr>
<tr>
<td>Agents</td>
<td>202,102</td>
<td>173,259</td>
<td>85.7%</td>
</tr>
<tr>
<td>Transfers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Business-to-business</td>
<td>$8,360,196,019</td>
<td>$8,360,196,019</td>
<td>100.0%</td>
</tr>
<tr>
<td>Person-to-person</td>
<td>$6,417,217,788</td>
<td>$6,413,246,371</td>
<td>99.9%</td>
</tr>
<tr>
<td>Business-to-consumer</td>
<td>$3,477,971,699</td>
<td>$3,475,750,580</td>
<td>99.9%</td>
</tr>
<tr>
<td>Consumer-to-business</td>
<td>$2,955,776,655</td>
<td>$2,952,232,096</td>
<td>99.9%</td>
</tr>
<tr>
<td>Consumer-to-gov</td>
<td>$221,914,717</td>
<td>$108,827,318</td>
<td>49.0%</td>
</tr>
<tr>
<td>Deposits</td>
<td>$5,789,785,352</td>
<td>$5,774,508,633</td>
<td>99.7%</td>
</tr>
</tbody>
</table>

Table 1: Mobile money statistics in Kenya, Q3 2019-2020 (Jan – March 2020)

Source: (CAK, 2020) based on operator returns.

M-Pesa is run by Kenyan mobile operator Safaricom. The beginnings of the M-Pesa service emerged in a project supported by the UK’s Department of International Development (DFID) with DFID provided matched funding alongside UK-based Vodafone Group, the parent company of Safaricom. The basis of the M-Pesa service was an outcome of this project. The story of the rapid scaling of M-Pesa in Kenya is well-known, with M-Pesa revenue becoming an increasingly important aspect of Safaricom’s financial health as outlined in Figure 1.
Several Kenyan actors play an important role in the service. Agents are independent firms who provide the local “face of M-Pesa” through registration and cash-conversion service on the ground. Over time, the number of third parties involved in M-Pesa has also greatly expanded as it has become a platform, integrating a range of banks, business, micro-finance and government actors.

Table 2 highlights corporate actors associated with Safaricom. In Kenya, the government retains a large stake in Safaricom, as well as significant shareholdings, said to be owned by elite groups (Tyce 2020). Thus, while the UK’s Vodafone Group has controlling ownership of Safaricom, the firm has a range of shareholders, sometimes with diverging agendas related to their domestic or international focus.

One important driver of direction for Vodafone Group is that it controls or has stakes in a range of mobile operators across the globe. With M-Pesa’s success, Vodafone Group has leveraged the service by introducing it across a range of its subsidiaries including Egypt, Ghana, DRC, Tanzania, Mozambique, Lesotho and India (Vodafone Group, 2019).

<table>
<thead>
<tr>
<th>Period</th>
<th>Ownership of Safaricom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-IPO (June 2008)</td>
<td>60% Government of Kenya</td>
</tr>
<tr>
<td></td>
<td>40% Vodafone Kenya Limited</td>
</tr>
<tr>
<td></td>
<td>● 87.5% Vodafone Group, 12.5% Mobiletea</td>
</tr>
<tr>
<td>Post-IPO</td>
<td>35% Government of Kenya</td>
</tr>
<tr>
<td></td>
<td>40% Vodafone Kenya Limited</td>
</tr>
<tr>
<td></td>
<td>● 100% Vodafone group</td>
</tr>
<tr>
<td></td>
<td>25% Market Shareholders via IPO</td>
</tr>
<tr>
<td>Post-Vodafone restructure (2017)</td>
<td>35% Government of Kenya</td>
</tr>
<tr>
<td></td>
<td>40% Vodafone Kenya Limited</td>
</tr>
<tr>
<td></td>
<td>● 87.5% Vodacom, S Africa, 12.5% Vodafone Group</td>
</tr>
<tr>
<td></td>
<td>25% Market Shareholders</td>
</tr>
</tbody>
</table>

Table 2: Major ownership changes in Safaricom

Source: Safaricom annual reports and company presentations

An important driver of recent changes of M-Pesa IPR assets is the 2017 move of Safaricom to come under the control of Vodacom, South Africa (itself a subsidiary of Vodafone Group UK) (Vodafone Group, 2017). Official explanations for this corporate reshuffle revolve around regional
simplification of structures (Vodafone Group, 2017), but it has also been reported in the business press that this was done with a possible sell-off of Vodafone’s African assets in mind (Fildes, 2017).

4.1.2. Impacts of IPR

Key intellectual property rights related to M-Pesa include its trademarks, patents related to innovative aspects of the service and the copyright embedded in the software for the service. From its launch in 2007 up until 2020, M-Pesa IPR was controlled by the Vodafone Group. To use the M-Pesa service Safaricom, therefore, paid an annual fee to the Vodafone Group (as shown in Table 2). This was positioned as a “service fee” that allowed Safaricom to use the M-Pesa service (and permitted the use of other IPR assets).

The direct impact of the service fee has been significant transfers from Safaricom to Vodafone Group. Figure 2 & Table 3 show an estimate of the value of these service fees, which reached a peak of around €26m in 2015. As an estimate for the period 2010-2019, this resulted in a direct transfer of around €170m. One might find the extent of such transfers surprising given the origins of M-Pesa as a jointly funded development project and the development claims that have been made over the years about the service.

![Figure 2: Transfers from M-Pesa. See Table 3 for details](source)

Source: Author’s calculations based upon company reports.

<table>
<thead>
<tr>
<th>Financial Year</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
<th>19</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-Pesa revenue (€m)</td>
<td>72.0</td>
<td>99.6</td>
<td>152.5</td>
<td>198.7</td>
<td>222.4</td>
<td>327.7</td>
<td>359.4</td>
<td>501.4</td>
<td>505.0</td>
<td>663.2</td>
</tr>
<tr>
<td>M-Pesa service fee (%)</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10/5*</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Estimated service payment (€m)</td>
<td>5.3</td>
<td>10.2</td>
<td>13.2</td>
<td>18.6</td>
<td>23.1</td>
<td>26.1</td>
<td>25.6</td>
<td>22.4</td>
<td>14.9</td>
<td>11.6</td>
</tr>
</tbody>
</table>

* Note: Fee moves from 10% to 5% on 1st Aug 2015

Table 3: M-Pesa revenues and transfers

Source: Author’s calculations based upon company reports. See appendix for discussion.

It is also important to highlight the indirect impacts that IPR control has had on innovation trajectories. In interviews with those involved in M-Pesa in Kenya, there has been an ongoing frustration for many years about the relatively slow upgrading of new services and features of M-Pesa (Foster, 2014), with Safaricom tending to prefer simple integration of new actors over radical changes. One of the key reasons for this is that with Vodafone Group controlling the IPR, and with
the use of M-Pesa across the globe it has become more difficult for Safaricom to influence the directions around the service and push technical upgrading.

This may change with the new joint venture on M-Pesa announced in July 2020 between Safaricom and Vodacom South Africa. As mentioned in the abstract, the joint venture was reported in the press as bring back “full control of the M-Pesa brand, product development and support services” to Kenya (Phillip, 2020), although what this means in terms of the ownership of IPR has not yet been spelt out. The two firms each paid 1,073 million KSh (£7.02m) to form the Joint Venture. Associated with this has been strong articulations that it will lead to a renewal in innovation of the M-Pesa service in Africa (Vodacom, 2019).

4.2. Unpacking M-Pesa’s IPR

4.2.1. The origins of IPR

As outlined in the previous section, the origin of M-Pesa was a donor project for the UK development agency DFID. It is worth examining the treatment of IPR issues in this project as an important aspect of the history of the IPR.

The project occurred under the DFID Financial Deepening Challenge Fund (FDCF), which supports commercial firms to become more involved in development. There have been significant evaluations made around such donor “challenge funds”. Evaluations suggest they are often “launched with more enthusiasm than forethought…there is considerable confusion about what international development agencies should be seeking to achieve by means of them, and how” (Davies & Elgar, 2014). The typical focus was that they would support private firms by making certain markets more financially viable in the global south (Brain et al., 2014). With comparatively limited amounts being provided, and typically structured as one-off funding, there has rarely been an expectation of innovation (Pompa, 2013).

With innovation being a peripheral goal, approaches to dealing with IPR have been poorly thought out. When a specific project has become innovative (such as M-Pesa) there appears to be a lack of clear processes to deal with issues. Internal reports and reviews of the FDCF have alluded to such issues. In the mid-term review, IPR is brought up as a significant problem.

“Intellectual property rights were also not adequately considered in the design process. As many proposals involve customised ICT development, this poses a serious problem” (Ebony Consulting, 2003, p. 9)

A principle in donor-supported projects in the UK is that IPR should be shared, where firms would “give DFID a license to use the project material; this would include the right to publish, copy and distribute all material include written material and software produced under a FDCF grant” (Ebony Consulting, 2003, p. 28). This, however, proved problematic where some commercial firms suggested that “signing an agreement that potentially gave DFID rights to their IPR was a problem” (Irwin & Porteous, 2005, p. 9). In the case of the FDCF, some workarounds were made,

“... require IPR co-ownership only on software developments made under grant funding. That means that if the initial software was acquired before the grant, the institution will retain exclusive IPR” (Ebony Consulting, 2003, p. 28).

Overall, in reflecting on such experiences, the full-term review of the FDCF ultimately suggested that the best way forward on IPR was to

“avoid funding the development of new technology…it avoids getting into debates about who ultimately owns the IPR” (Irwin & Porteous, 2005, p. 44).

The recommendations outlined here are embedded in long unread institutional reports and might seem minor. But the direction taken in the early 2000s underlies the IPR tensions that face in M-
Pesa today. The lack of guidance and workarounds in the FCDF contributed to M-Pesa IPR becoming solely owned and controlled by the parent company Vodafone Group in the UK.

4.2.2. Contributors to intellectual property
In contrast to this singular ownership and control of IPR, a range of actors have played an important role in shaping the M-Pesa service. This discussion is not intended to suggest that Vodafone or Safaricom have not played a key role, but it highlights a diverse set of contributors.

The key contributors are summarised in Table 4. Examples of those contributing include those involved in precursor innovation such as those transferring money more informally within East Africa using mobiles which were well-known prior to pilot studies. Trial users in the donor pilot project also played a crucial role in shaping the M-Pesa service to what it is today. As the service was rolled out, agents and other associates have driven forward the service through adaptations as it has rapidly scaled.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Details and actors</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precursor innovations</td>
<td>M-money services such as SmartMoney (2000) G-Cash (2004) (Philippines) and CelPay (2002, Zambia) pre-date M-Pesa with very similar models. Informal money transfer using mobile happening during the early rollout of mobile money in East Africa approximating M-Pesa</td>
<td>(Chipchase &amp; Tulusan, 2006; Porteous, 2006)</td>
</tr>
<tr>
<td>DFID trial</td>
<td>The DFID trial was originally positioned as a broader micro-finance project with the core transfers of M-Pesa are just one component. Accounts of the pilot outline how pilot participants (users and agents) began to undertake mobile transfers that were outside the principal micro-finance activity. This was identified by the pilot coordinators and drove the idea that the main focus should solely be on the mobile transfers</td>
<td>(Foster &amp; Heeks, 2013b; Hughes &amp; Lonie, 2007)</td>
</tr>
<tr>
<td>Policy actors in commercialisation</td>
<td>A key process post-trial before commercial rollout was ensuring the service fit within regulation. This involved inputs from several players including the UK Financial Services Authority (FSA) and the Central Bank of Kenya (CBK)</td>
<td>(AFI, 2010; Morawczynski, 2010)</td>
</tr>
<tr>
<td>Agents and scaling</td>
<td>Once the service was launched, adaptations of the service were a key to service growth, involving a diversity of actors including agents and other associates. These activities were crucial in ensuring that the service was viable and manageable as it rapidly scaled.</td>
<td>(Foster &amp; Heeks, 2013b)</td>
</tr>
</tbody>
</table>

Table 4: Diversity of actors contributing to M-Pesa.
Source: Extended from (Foster, 2013)

These contributors to M-Pesa align with the idea that innovation should be seen as a process. Such a position closely connects with theories of “innovation systems” that see the processes of innovation as increasingly distributed amongst an interacting set of actors (see extended discussion in Foster & Heeks, 2013a).

4.2.3. Patents
An important part of M-Pesa IPR is a set of patents that have emerged over the last decade (listed in Table 5). The patent profile associated with M-Pesa has primarily been defensive so far². We

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2 These patents appear to have been little used in litigation at present, besides some cases in Kenya where filing dates have enabled Safaricom to claim prior art over competing claims of invention on specific aspects of mobile money (e.g. Mohapi, 2017)
examine three aspects of the 10 patent filings found, in line with the literature discussion on IPR:
the origins of the ideas in these patents, the basis of novelty claims, and the type/scope of the patent.

<table>
<thead>
<tr>
<th>Title</th>
<th>Priority Date</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Mobile Account Management (Murdoch et al., 2007)</td>
<td>2005</td>
<td>World</td>
</tr>
<tr>
<td>2) Mobile Transactions (Cornforth et al., 2012)</td>
<td>2010</td>
<td>World</td>
</tr>
<tr>
<td>3) Delivery System and Method (Reeve et al., 2012)</td>
<td>2011</td>
<td>World</td>
</tr>
<tr>
<td>4) Cellular Airtime Management (Cornforth et al., 2016)</td>
<td>2012</td>
<td>US, Africa</td>
</tr>
<tr>
<td>5) Mobile Savings Account (Cornforth et al., 2014a)</td>
<td>2012</td>
<td>Africa</td>
</tr>
<tr>
<td>6) Mobile Money Transfer (Cornforth et al., 2014b)</td>
<td>2012</td>
<td>Africa</td>
</tr>
<tr>
<td>7) Optimizing financial transactions network flow</td>
<td>2014</td>
<td>Not granted</td>
</tr>
<tr>
<td>(Ignatyev et al., 2015)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8) Determining multiple users of a network enabled device</td>
<td>2014</td>
<td>US</td>
</tr>
<tr>
<td>(Scarr et al., 2015)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9) Mobile transaction validation (Cornforth et al., 2012)</td>
<td>2015</td>
<td>Not granted</td>
</tr>
<tr>
<td>10) Digital currency conversion (Desiree, 2016)</td>
<td>2015</td>
<td>Not granted</td>
</tr>
</tbody>
</table>

Table 5: Patents linked to M-Pesa
Source: Author’s analysis based on patent search.

**Source of novelty:** Three sources underlie the novelty of claims. A first cluster formalizes mobile/mobile money practices that emerged informally in Kenya (#1, #4, #5, #6). A second solve specific problems emerging as M-Pesa has expanded as a service (#2, #8). The third describe new or future features (#3, #7, #10). The first category is the most controversial in terms of the discussion of IPR, in that a number of the patents align to common practices occurring amongst users of mobile, or mobile money in Kenya. These patents then look to formalise these practices, often through describing potential software systems which would, in the most part, support these practices. An example of this is the principal initial 2005 patent (#1) whose claims cover a software system to manage payments for MFI (micro-finance institutions), where MFI transfers might be done through mobile messaging. The presence (as outlined in the previous section) of precursor services such as G-Cash and Celpay, as well as more informal practices around mobile use within MFI suggest that much of the novelty in this patent comes out of activities that were already emerging.

**The basis for novelty claim:** In most of the patents, novelty aligns to well-known techniques or prior art, which are claimed to be novel in the presence or application to mobile money. A group savings patent (#5) which mirrors informal approaches to group savings in Kenya is an example of this. Its basis for novelty rests on the format of the system proposed - rather than saving groups distributing cash to group members, they would use systems that integrate automated mobile money to mobile airtime conversions.

**Scope of patents:** All the patents are software or process patents. The software patents describe how they would set up aspects of mobile money software and its operation. Process patents focus on techniques or processes that allow mobile network owners to make a better analysis of the mobile money network (e.g., identify fraud or improper activities within a mobile money system). In terms

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3 A patent search was made for patents that included the terms “mobile money”, “mobile finance” or “M-Pesa”. Patents were then filtered out to only include those relevant to the actors involved in this case. All patents found were associated with the Vodafone Group.

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of scope, at least if one takes them at their broadest independent claims\(^4\), they define extremely broad fields of novelty. Although there is little evidence of any litigation, the initial mobile account patent (#1) for example, defines a broad field many MFI system that integrates mobile money may be infringing. Similarly, the patent that outlines a technique for management of payments over airtime (#4), could suggest patent infringement in a growing number of payroll or non-profit payment systems that integrate mobile money payments.

4.2.4. Software
Central to IPR is the software that enables the operation of the M-Pesa system. During the initial DFID pilot, this was contracted to a UK-based software firm, Sagentia. As mobile money interactions did not align with existing banking systems, proprietary software was written from scratch embedding several technical innovations (Wooder & Baker, 2012). Given the interactive processes of innovation during the M-Pesa pilot and early stage of the rollout (as outlined in 4.2.2.), the software was also adapted over time, dependent on the evolving business proposition and regulatory requirements (Wooder & Baker, 2012). As the service grew the responsibility for the software was directed to IBM from 2009.

During the earlier fieldwork in 2010-2011, the fact that M-Pesa software was hosted by IBM in Germany was often a subject of animated discussion by those running the service on the ground. At that time M-Pesa was having significant problems with delays and system failure, and M-Pesa agents often blamed it on the location of servers, rightly or wrongly. There was also a broader unease amongst policy experts in Kenya that large volumes of Kenyan financial transactions were being routed through Germany.

The M-Pesa G2 project (concluded in 2015) was a cross-country software project involving Vodafone, Safaricom, IBM with Huawei as the main software development partner. The aim was to upgrade the M-Pesa software. Most symbolically, the upgrade was accompanied by the first celebration of “bringing M-Pesa” home, when M-Pesa servers and software were relocated to Kenya.

It was only later that questions surrounding the G2 project came to light. Following accusations of corruption in Safaricom, auditors KPMG were commissioned to undertake a forensic investigation of recent contracts. The report was leaked to the Kenyan press in 2016 (KPMG, 2016). It reveals the cost to Safaricom for this upgrade to be $12.5m. This involved a disputed procurement process with KPMG commenting that “based on the value of other proposals...the cost agreed with Huawei is relatively high” (KPMG, 2016, p. 111). In terms of intellectual property, the KPMG report expressed concern that,

"although the cost of this project was borne largely by Safaricom, it does not retain exclusive use of intellectual property on the project and similar mobile money projects can be rolled out in the territories without any benefits to Safaricom” (KPMG, 2016, p. 110).

Safaricom paid the complete cost of the upgrade project. Yet the control remained within Vodafone Group.

5. DISCUSSION

5.1. M-Pesa, innovation and IPR
The ownership and control of IPR within M-Pesa has been wrought with tensions throughout its history, and this has had a significant impact on the directions of innovation. Safaricom operates the

\(^4\) As would be expected for professionally written patents, they seek to define their novelty as generically as possible (to widen their scope of possible claims). A set of dependent claims within patent then provide more detailed contexts. This enables patents to cover as broad an area as possible, where dependent claims allow more refined claims innovation to protect more specific embodiments should the broader claims be found to be invalid during litigation.
M-Pesa service in Kenya, but important decisions about directions of innovation have often been defined by the Vodafone Group in the UK. While this should not be surprising given the head-subsidiary firm relations, one can identify diverging goals and aims amongst the different stakeholders in the UK and Kenya. The Vodafone Group wishes to ensure the service maximises revenues across multiple jurisdictions. Safaricom stakeholders have looked towards cementing its market dominance and introducing further innovations. Underlying these diverging positions is the IPR, whose ownership pushes control towards the Vodafone Group. In addition, IPR ownership has led to the situation where significant transfers of funds are moving from Kenya to the UK in the form of service fees (as well as additional cost of software contracts and the 2020 purchase of the IPR).

How IPR came to be fully controlled by the Vodafone Group is complex, where different aspects of IPR (software, patents, branding) have different paths. The lack of attention to intellectual property during the DFID donor pilot was highly problematic in this respect. In terms of the generation of IP, innovative actions of leaders and software developers associated with Vodafone Group in the UK should not be ignored. Yet the extensive research on M-Pesa has elucidated the reality that a diversity of actors contributed to innovation, including more marginal actors in Kenya, even if such contributions are not acknowledged within the IPR.

As M-Pesa has become a global service with centrally controlled IPR it has become embedded within the strategies of the multinational parent firm, with goals to maximise its global profits. The trends of corporate expansion across multiple territories and the building of a patent portfolio to support this are in line with the literature on globalised digital firms which draw on IPR to support such intangible assets. However, one can also see the more nefarious nature of digital capitalism in the case of M-Pesa and its IPR. The extent of the various payments from Kenya to the UK is surprising given the donor-funded origins of the service. That Safaricom produced software at its own cost for Vodafone UK suggest issues of governance. The nature of patent portfolios linked to local knowledge in Kenya that are filed and controlled in London mirrors histories of British colonial power in Africa.

The recent announcement of M-Pesa IPR being returned to Africa signals hopes of a more balanced direction in the future. Yet this may simply open a new chapter in the complex relationships between different corporate subsidiaries, IPR and innovation.

5.2. IPR, digital innovation and inclusive innovation

As the in-depth account illustrates, many aspects in this case are context-specific. However, we can reflect more broadly on insights for IPR and digital innovations, particular for a growing range of digital products and services in the global south.

Findings reflect the broader literature on IPR regimes often leading to skewed control and detrimental impacts in the global south. As M-Pesa has shown, IPR is an important crucible for control of the directions of innovation in the digital economy, and where services expand globally it can result in new types of financial flows move from (domestic innovators in) the South to (head offices in) the North as a result of regimes of IPR.

The present IPR system is poorly set up to deal with the nature of modern innovation, and this is emphasised in the case of M-Pesa. The service embeds the involvement of a variety of actors that are important to innovative processes. Such processes and actors are, however, largely invisible in the IPR. In the case of M-Pesa, it is the managers and technologists in London and Cambridge who have the resources to go through the patent system, capture knowledge and write the code and who hence have control of the IPR. All the authors of patents found, for example, were based outside the Kenyan context but through their involvement with activities in Kenya have been able to stake claims for control of key ideas. There are also questions about how quite generic ideas are being taken out of the global ‘commons’ around mobile money with potential implications for who can innovate in these areas in the future.
As the literature review has outlined, there have been important critiques of IPR regimes when they look to embed public or social agendas, or when intellectual property embeds local knowledge or practices. Yet, there is scant evidence that such ideas have been so far incorporated or considered within thinking around digital innovation and this could be the focus of future more technical actions.

6. CONCLUSION

The case of M-Pesa in Kenya and IPR has been used to highlight important domains of control of innovation and problematic South-North transfer of resources. These problematise aspects of M-Pesa in terms of claims for development. More broadly, the different challenges of IPR discussed highlight the need for further research on inclusive innovation through the prism of IPR regimes. These are arguably not fit for purpose in the emerging era of digital capitalism.

Further research is needed to think more carefully about best practices. Academic work which opens up further cases of digital innovation in the south would be important empirically. Such research could also be more closely linked to more frameworks of global justice and economic dependency. More technical work can be done to consider how diverse actors involved in socially orientated innovations and local knowledge can be better embedded in IPR.

REFERENCES


**APPENDIX – NOTES OF CALCULATIONS OF M-PESA TRANSFERS**

* Fee moves from 10% to 5% on 1st Aug 2015

**Estimating M-Pesa service costs:** The details of the service agreement(s) or full data on service fees are not in the public domain. However, corporate documentation and financial reports from Vodafone Group highlight the method by which M-Pesa service costs are calculated.

Service fees are calculated based on a percentage of M-Pesa revenue (on a sliding scale as shown in the table). Service fees also include an additional component concerning indirect revenue gains of Safaricom as a result of savings in airtime commission costs. Where customers use M-Pesa to top-up directly, Safaricom saves of distribution and commission payments to local mobile vendors. In
the case of Table 3, it is possible to calculate the former based upon company reports, but not the latter.

Based on the above discussion, the service fees for a financial year are calculated based on quarterly revenue splits, delayed by one quarter. This is multiplied by the service commission.

This estimation should be seen as a best-guess estimate of the M-Pesa service fee. For triangulation, several years data are available within corporate reports of the exact fee paid for services (for 2011 & 2016-2018). This suggests this estimate is a good estimate, typically an underestimate by up to €3m. Thus, the data highlights general trends around transfers rather than represent an exact figure.
CONCEPTUALISING HEALTHCARE-SEEKING AS AN ACTIVITY TO EXPLAIN TECHNOLOGY USE - A CASE OF MHEALTH

Karen Sowon, University of Cape Town, kc.sowon@uct.ac.za
Wallace Chigona, University of Cape Town, Wallace.chigona@gmail.com

Abstract: The purpose of this paper is to engage with the Information Systems’ contexts of use as a means to explain nuanced human-technology interaction. In this paper, we specifically propose the conceptualisation of healthcare-seeking as an activity to offer a richer explanation of technology utilisation. This is an interpretivist study drawing on Activity Theory to conceptualise healthcare-seeking as the minimum context needed to explicate use. A framework of the core aspects of AT is used to analyse one empirical mHealth case from a Kenyan context thus illustrating how AT can be applied to study technology use. The paper explicates technology use by explaining various utilisation behaviour that may emerge in a complex human-technology interaction context; ranging from a complex adoption process to mechanisms to determine continuance that differentiate trust in the intervention from trust in the information, and potential technology coping strategies. The paper is a novel attempt to operationalise AT to study technology use. It thus offers a broader explication of use while providing insights for design and implementation made possible by the conceptualisation of healthcare-seeking as an activity. Such insights may be useful in the design of patient-centred systems.

Keywords: Activity theory, Technology use, mHealth, Healthcare-seeking

1. INTRODUCTION

Context plays an important role in how a repertoire of Information Systems (IS) are used (Cecez-Kecmanovic et al., 2014), and is therefore critical in understanding individuals’ technology use. Characteristics of the context may provide mechanisms for success or failure in users’ interaction with innovations. Thus, taking a completely social or completely technical perspective to IS behaviour are extreme positions. Valuing the social and the material over the technology is problematic as it leads to some form of analytical fallacy; since technologies have been known to have agency (see Orlikowski, 2005). The nature of technological agency and whether it is delegated or not is a subject we do not address here.

Given the balancing act that is required to study the interaction between technology and the social without embracing technological determinism, taking the technology for granted, or allowing the technology to vanish from view, a robust approach is necessary. Such has been the argument behind using a socio-technical approach in IS studies. An example of such an approach is the perspective of studying technology in use (in-situ). Such an attempt would argue for example that a hammer in a mason’s hand is epistemologically different from a hammer in a blacksmith’s hand; all because the ‘context of use’ differs between these two environments. The argument, therefore, is that such an approach to analysing both the context and the technology offers a more nuanced understanding of the complex relationship between humans and technology such as technology use.

In IS, while there have been many grand theories that have been useful in understanding the use and adoption of technology, these theories have been criticised for being too techno-centric assigning all the change agency to the technology (Awa et al., 2016; Venkatesh et al., 2007). To address these concerns, IS researchers have had to turn to social theories to offer a better understanding. These
Theorists provide the vocabulary to address the “situated entanglement of the technology and the social” (Orlikowski, 2005, p. 185). Thus, social theories allow the researcher to study the characteristics of the context including the social aspects that may influence how people interact with technology. Some of the commonly used theories include Actor Network Theory, Structuration Theory and Activity Theory (AT), which have been useful for explicating the broader relationship between technology and human activity (Karanasios & Allen, 2014; Klein & Myers, 2001). While Structuration Theory is beneficial for studying organisational IT use, ANT assigns equal agency between human and non-human actors (Leonardi, 2011). In other words, in ANT, there is symmetry of agency between the human actors (users) and non-human actors (technology artifacts). AT, on the other hand, acknowledges that while both the technology and the actor (user) have agency, the relationship is asymmetrical. Thus, AT provides a more compelling theory to study technology in use since we start off with the assumption that human agency has intentionality (Cecez-Kecmanovic et al., 2014). In other words, though human actors and technology have agency, “ultimately, people decide how they will respond to the technology” (Leonardi, 2011, p. 151). Hence AT’s perspective is one of ‘agentic people actively pursuing an objective, not passively accepting and using technology’ (Blayone, 2019, p. 457).

AT has been embraced in fields related to IS to understand work processes and transformation. These fields include HCI (Bødker, 1996; Hautasaari, 2013), Information Systems Design (e.g. Mursu et al., 2006) and computer-supported collaborative work (e.g. Zurita & Nussbaum, 2007). This is reasonable since primarily, the strength of AT lies in its ability to theorise human doing as an activity and understand this activity through its different phases of existence; what is called the activity network. AT has also been extensively used in educational technology to understand how teachers and students use technology artifacts to achieve their teaching and learning goals (see Karakus, 2014). While a quick look at the literature seems to suggest that AT has gained traction, a deeper analysis indicates that the IS field may benefit from more studies that show how AT may be operationalised to study other IS phenomena. While having the concepts to frame IS research (Karanasios & Allen, 2014), the theory’s application to IS research has remained abstract and relatively scarce in IS-related phenomena like use.

Technologies are continuously changing, and complexity in interaction is ever increasing with their varied application in almost every sphere of life. Of interest is the growth of innovations in healthcare especially as they are used by consumers to facilitate their healthcare-seeking. These include mHealth, which is of specific interest to this study. mHealth which has been defined as the use of mobile devices to deliver healthcare services has experienced growth in developing country contexts (Lee et al., 2016). The growth is largely attributed to the potential that this technology presents to increase healthcare delivery, bridge the health inequality gap, and hence help developing countries to faster address their health-related goals.

The healthcare-seeking context where such technologies are introduced is a complex environment. It represents a combination of multiple stakeholders that may have similar or conflicting objectives, and whose achievement may be mediated by a panoply of factors. Some of these critical factors include socio-cultural beliefs which in healthcare-seeking define the meaning of sickness and when one can or should not seek healthcare. As such, the use of technologies like mHealth in such a space is a phenomenon worthy of careful study to understand why, when, and how such interventions work when they do. Such studies will pave way for the scalability and replicability of interventions in other contexts since such innovations are not a ‘one size fits all’. Since AT provides a way to theorize human activities and understand them within their context of use, we argue that studying use from the perspective of AT will prove useful. This study, therefore, seeks to answer the following question:

How can conceptualising healthcare-seeking as an activity be used to explain mHealth use?

By studying technology in situ, proponents of such approaches argue that the examination of how humans interact with technology could inform human-centred IS design so that technology solutions
are effective and appropriate (Bannon & Bødker, 1989; Benson et al., 2008; Karanasios, 2018). Hence, in answering this question using AT, we desire to show that we can generate insights for the design and implementation of technologies like mHealth. While we use the case of mHealth, we believe that the insights will be useful in varied contexts seeking to understand the use of consumer health information technology as well as other technology use contexts.

Using AT as the conceptual basis, this study analyses one healthcare-seeking empirical context where an understanding of technology use was sought. We adopt maternal health as an instrumental case for its nuanced rich context, which would better demonstrate all the concepts in an AT context.

The rest of the paper is organised as follows: The next section defines healthcare-seeking and introduces the AT concepts that are applied to conceptualise healthcare-seeking as an activity. The mHealth case study is then presented, and we thereafter demonstrate how the proposed conceptual framework can be applied, by using it to analyse the empirical case. We conclude by discussing the contribution of the paper and highlighting opportunities for further research.

2. CONCEPTUALISING HEALTHCARE-SEEKING AS AN ACTIVITY

2.1 What is Healthcare Seeking?

In health, patient health outcomes are not the sole result of efficacious health interventions (Alexander & Hearld, 2012). The impact of these interventions is mediated by the context. Commonly, socio-cultural factors may enable or impede the achievement of the desired health outcomes. These hindrances or enablers often manifest in healthcare-seeking behaviour which has been defined as the actions or inactions that individuals undertake for the purpose of finding a remedy in their perceived illness (Olenja, 2003). These decisions to seek and use healthcare may subsequently be surrounded by various beliefs of the nature, cause and meaning of sickness. These subsequently determine when, where, and how patients seek healthcare especially in medically pluralistic environments such as is common in Africa (Aikins, 2014). Thus, theorizing healthcare-seeking as an activity requires the chosen approach to have a means of capturing the nuances of the healthcare-seeking context, while being able to account for the goals of the healthcare-seeker when engaging in healthcare-seeking.

The next section presents the underpinning of AT, from which we derive a conceptual lens to examine healthcare-seeking as the total activity that provides the context to understand mHealth use. This lens is applied to analyse one empirical study in the later sections of the paper.

2.2 Introduction to Activity Theory

AT has its foundations in Russian psychology. “An activity is a form of doing [that is] directed to an object” (Kuutti, 1996, p. 27). The theory argues that human activities like learning or seeking healthcare are historically, culturally, and socially situated (Leontiev, 1978). Activities represent human agency in undertaking purposeful actions and consequently give meaning to human actions. This implies that human actions can only be understood within the context of the activity, which is the notion behind AT’s principle of ‘unity of consciousness’. While AT has a rich genealogical history, time and space do not allow us to focus on those details in this paper. However, we choose to apply the second generation AT that was expanded and popularised by Engeström (Engeström, 2001), which recognised the biggest limitation of the first generation as being the focus on the individual. The addition of building blocks in the second generation like rules, community, and division of labour provides AT a further means to account for and understand context (Allen et al., 2011).

AT posits that with the help of a tool, a subject undertakes an activity, motivated by a particular motive/object (Allen et al., 2013). The subject is the individual ‘whose agency is chosen as the point of view in the analysis’ (Hsu et al., 2010, p. 1246) and who has the aim to transform the object into a desired outcome. A maternal health client, therefore, engaging in healthcare-seeking in the pursuit
of a successful pregnancy, and whose utilisation of a health information technology artifact is being studied would be an apt representation of a ‘subject’. The motive/object of a healthy pregnancy then would give meaning and direction to the actions or chains of actions (like Health Information Technology (HIT) use or lack of it thereof) which are carried out by the subject. This argument on the importance of the motive as being the reason for the activity is defined by AT’s principle of ‘object orientedness’. The Artifacts/Tools, (e.g. mHealth) acting as resources for the subject in the pursuit of the motive (Yamagata-Lynch, 2010) would therefore enable or constrain the subject’s potential to manipulate and transform the object of the activity. This principle of ‘mediation’ is therefore critical in fully explicating artifact use within its activity context.

**Rules/Values.** Rules mediate the subject-community relationship. They are both implicit and explicit (Kuutti, 1996) and place limits on the activity being undertaken. A researcher applying AT may distinguish between the explicit norms (rules) and the implicit norms (values). For example, in a maternal healthcare-seeking context, the latter may include the healthcare system rules like the need for an appointment card that shows a record of all ANC appointments as a prerequisite for a mother to be admitted into a health facility for child delivery. Values on the other hand may include the culturally shared beliefs, norms, and values about pregnancy. For example, in some African societies, it is believed that the early periods of pregnancy are particularly susceptible to witchcraft (Nyemba-Mudenda & Chigona, 2018; Simkhada et al., 2008). In light of such beliefs, a woman may be compelled to keep the pregnancy secret to safeguard herself from people that could ‘harm’ the pregnancy. Openly disclosing one’s pregnancy may also be associated with boastfulness which may result in embarrassment should one not carry the pregnancy to term (Pell et al., 2013). Pregnancy is also evidence of sexual activity, and consequently, women may be shy to disclose their pregnancy (Finlayson & Downe, 2013). All these cultural perceptions influence when and how women in developing countries engage in healthcare-seeking for example by starting ANC late in the third trimester only when the pregnancy is evident/showing (Simkhada et al., 2008; Uldbjerg et al., 2020; Wang et al., 2011).

**The Community.** The community is generally invested in the object of the activity system. Yamagata-Lynch (2010, p. 2) clarifies that the community “is the social group that the subject belongs to while engaged in an activity”. The community may, therefore, refer to a community of practice, or a community of purpose. The former shares common ways of seeing and doing things (Hsu et al., 2010), while the latter connotes a shared motive, rather than practice. Since the maternal healthcare-seeking context reflects the coming together of stakeholders that share a motive, say the desire for a successful pregnancy, we hereafter adopt the term community of purpose (CoP) for its appropriateness to this research.

In a maternal healthcare-seeking context, the CoP may include the healthcare providers, as well as various other individuals that may have a stake in a pregnancy. For example, female kin remain crucial because pregnancy-related authority may be socially defined as belonging in the female domain (see Ensor & Cooper, 2004; Mumtaz & Salway, 2007). On the other hand, partners have been reported to being the decision-makers and often the main controllers of household resources. Thus they play a critical role in a woman’s healthcare-seeking behaviour (Kaiser et al., 2019; Shaikh & Hatcher, 2004).

**Division of Labour.** Though the community shares in the object of the activity, the division of labour define their interaction and stipulate who can do what. This division is both horizontal, defining the responsibilities between members and vertical with regard to the division of power and status (Hsu et al., 2010; McMichael, 1999). In a healthcare-seeking context, various stakeholders have different responsibilities. However, in addition to these horizontal assignments, power dynamics may mediate how community members interact with the object of say a healthy pregnancy. For example, healthcare-seeking behaviour may be influenced by the health client’s perception of the authority of health professionals. The health clients may therefore fear to engage the practitioners and feel compelled to conform to their ‘directions’ for fear of being labelled difficult (Entwistle et al., 2010;
Frosch et al., 2012). These patient-doctor relationships may influence how maternal health clients pursue their motive of a successful pregnancy.

Put together, Figure 1 illustrates the key concepts of AT as operationalised to define healthcare-seeking as an activity

![Figure 1: A diagrammatic representation of maternal healthcare-seeking activity](image)

Other than the principles of unity of consciousness, object orientedness, and mediation that were mentioned earlier, AT provides three other powerful principles: the hierarchical structure of the activity, contradictions, and internalisation/externalisation; that may provide insight to the human-technology interaction within the activity context.

The hierarchical structure of the activity (Figure 2) posits that an activity which is the ‘why’ a subject engages in an endeavour like healthcare-seeking represents the top-most process layer. Next to this at a lower level are actions that encompass the ‘what’ is done to fulfil the motive of an activity, followed by operations that entail the ‘how’ people carry out these actions. While operations may be mental/cognitive processes that may not be observable depending on the study, it is reasonable to assume that the actions of the subject are manifestations of these subconscious processes.

![Figure 2: Activity hierarchy showing what and how motives are pursued](image)

In a mHealth mediated healthcare-seeking context, therefore, the step to use mHealth may be considered an action within the activity hierarchy. This view is corroborated by Karanasios (2018). The author posits that in the IS context where an activity is mediated by an IT artifact, users’ interaction with the technology can be viewed as an action. These levels are not fixed but can move up and down as conditions change (Kaptelinin & Nardi, 2006). Karanasios (2018) explains that when conditions (at the lowest level of the activity hierarchy) change, requiring actors to adopt new actions and goals, people may adapt provided the motive of the activity remains unchanged. However, people get unsatisfied when their motives are frustrated. Thus, the hierarchy of activity may prove useful if we are attempting to understand technology use in light of a subject’s motives in a technology-mediated activity context. For example, how might users’ interaction change in response to their use of technology enabling or constraining their desired motive? Do they adopt
certain technology utilisation behaviours that may influence their long-term use? Such insights would prove useful in being able to explicate a ‘continuum of use’ from adoption to continuance which are important topics in IS acceptance.

Contradictions seen in structural tensions within the activity holds that the dialectical relationship between actors and their environments results in a type of development. In a healthcare-seeking context mediated by mHealth, we may analyse how these tensions develop within the activity, how the elements in the activity system (e.g., users/subjects) respond to these tensions and subsequently how such adaptations give further insights to technology use.

Internalisation/Externalisation. Internalisation is the internal reconstruction of an external operation (Allen et al., 2011). We posit that a researcher could further explicate technology use by analysing how the subject’s internalisation of the IS artifact (mHealth) within the activity gives rise to varied utilisation behaviour. Externalisation, on the other hand, is the creation of either new artifacts, or ways of working, triggered by the awareness of tensions in the existing system (Frambach et al., 2014; Nowé, 2007). In light of the internal processes, viz. the subject’s maternal socio-cultural context in maternal healthcare-seeking, and tensions raised by interacting with say mHealth, the maternal health clients may adopt new ways of using the mHealth intervention to solve existing tensions. The analysis of such externalisation allows the researcher to complete the dialectical study of the relationship between technology and the user as it allows one to explicate how the subjects’ externalisation of their activity context shapes the use of technology. In other words, we argue that using AT, research questions that seek to explain the phenomenon of utilisation within a context of use may be phrased from the perspective of internalisation and externalisation to capture the complex relationship between users and technology.

To summarise this section, activity theory provides a set of concepts to unpack the relationship between technology and HIT utilization as elaborated in Table 1.
Table 1: How conceptualization of healthcare-seeking as an activity may be applied to study HIT utilisation

<table>
<thead>
<tr>
<th>Concept</th>
<th>Potential benefit</th>
<th>Sample operationalization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Provides the context for studying technology in use</td>
<td>The Healthcare-seeking activity</td>
</tr>
<tr>
<td>Subject</td>
<td>The individual (s) whose utilisation is being studied</td>
<td>The maternal health client</td>
</tr>
<tr>
<td>Object</td>
<td>Provides the means to understand not only ‘what’ activity (healthcare-seeking) that people are doing, but also ‘why’ they are doing it; thus, providing perspective to why health clients may use technology in the first place.</td>
<td>Pursuit of a successful pregnancy</td>
</tr>
<tr>
<td>Action</td>
<td>Actions can best gain meaning when examined under the context of the activity in which they are performed. As an action, the use of technology can best be explicated within the healthcare-seeking activity in which it is performed</td>
<td>Using mHealth technology during pregnancy with the goal to access pregnancy-related educational content</td>
</tr>
<tr>
<td>Activity Hierarchy</td>
<td>May be useful in understanding different ‘subject’ responses that may result from a change in goals and conditions within the activity.</td>
<td>Analysing how changes in conditions may subsequently affect the goals and motives of the healthcare-seeking activity and how such changes may affect actions such as the use of technology</td>
</tr>
<tr>
<td>Contradictions</td>
<td>Provides a means to analyse the healthcare-seeking activity for tensions that may influence/change the use</td>
<td>Explore how tensions impact the actions of the subject (technology user)</td>
</tr>
<tr>
<td>Internalisation</td>
<td>Provides an analytical means to study the dialectical relationship between technology and the subject more holistically.</td>
<td>Main study questions may be phrased as follows:</td>
</tr>
<tr>
<td>Externalisation</td>
<td></td>
<td>How does the maternal health clients’ internalisation of mHealth shape their utilisation?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>How does maternal health clients’ externalisation of their healthcare-seeking socio-cultural context shape their mHealth use?</td>
</tr>
</tbody>
</table>

2.3 Opportunities for AT in Studying Technology Use

Though use has traditionally been defined as involving a user, employing an object (system) to accomplish a task (Burton-Jones & Straub Jr, 2006), individuals’ usage decisions happen within rich social contexts (Lewis et al., 2003) that would provide far richer understanding if included in the study of the phenomenon. Newer definitions (e.g. Barki et al., 2007) encompass a person’s interaction with technology where a user employs IT to accomplish a certain task, as well as the person’s activities to adapt, change or modify the human-technology interaction context. Two benefits of AT to study use stand out; i) the relationship between the subject, tools and objects as purposeful activities in AT is in harmony to the traditional construction of ‘use’; ii) owing to its ability to incorporate an structure/activity and context in the same environment, AT is able provide a more nuanced understanding of usage decisions influenced by context.
We will analyse one empirical case using the operationalisation presented in Table 1. The perspective of healthcare-seeking as an activity will be used to illustrate the technology use phenomena and how this perspective may provide a richer means to reflect on technology design and implementation implications.

3. METHODOLOGY

The subset of research presented here constitutes data gained from a research project whose data was collected between January and May 2019. The project adopted a case study design and was qualitative in nature, using interviews, focus group discussions and participant observations to collect data. A total of 38 interviews that were between 45–60 minutes were conducted, including maternal health clients, their partners and key informants involved in the implementation of the mHealth project. The women were largely of low socio-economic status and at least 75% being between the ages of 20–29 years. Almost all the women reported being married and less than one third had attained a tertiary level of education. Three focus group meetings, lasting approximately 90 minutes each were organised: two with 14 maternal health clients and one with the participating partners. All primary data from the interviews and FGDs were translated and transcribed verbatim into English. The transcripts were uploaded to NVivo v12 for further analysis. The analysis followed a hybrid approach entailing both deductive and inductive analyses. The use of Braun and Clarke’s (2006) thematic analysis allowed themes to emerge from data and the theoretical framework (Frambach, Driessen, & van der Vleuten, 2014). As such, using the principles of AT as a guide, the initial codes to represent the data categories were developed based on the concepts of the theory. Thereafter, these categories of data were inductively analysed to develop further themes. Thus, while the lower-level themes were represented by AT concepts such as object, mediation, rules etc., higher-level themes were inductively developed from the prominent themes that emerged from these lower-level categories of the data. The insights from the data analysis are used to both enrich the description of the context; since in AT the context is in fact the activity system itself (Nardi, 1996b), as well as offer theoretical insights.

4. THE MATERNAL HEALTHCARE SEEKING CONTEXT

This section describes the PROMPTS intervention, a mobile phone service in Kenya that was implemented as a way to send stage-appropriate pregnancy-related messages to maternal health clients from low socio-economic groups living in peri-urban areas of the capital city Nairobi. The mHealth intervention was implemented as a toll-free service. Automated messaging was combined with a clinician-supported helpdesk to answer maternal health clients’ questions. Upon interacting with the mHealth poster at the ANC clinic, interested mothers could self-register by sending a short message to a short message code. The mother was then required to respond to a short SMS survey where they provided details of their gestation age and their preferred language for receiving the health messages. The SMS service did not require the women to provide any personal information like name or residential address.

Such mHealth services are prevalent in Kenya as in most developing countries where mHealth holds the potential to help developing countries to achieve their health-related developmental goals. The health sector conditions in such countries that make mHealth a promising technology for transforming the health sector include distance of health facilities, high cost of care and a resource-strained healthcare system to mention a few (Gabrysch & Campbell, 2009; Mannava et al., 2015; Simkhada et al., 2008).

However, while healthcare demand and supply factors influence when, why and how health clients use health interventions, other reasons like socio-cultural factors shape healthcare-seeking behaviour. This is particularly evident in maternal healthcare-seeking where numerous pregnancy beliefs, norms and values may inform perceptions about healthcare-seeking. In this empirical context, like in other developing country contexts (see Mumtaz & Salway, 2007; Zamawe, 2013), pregnancy was seen as a normal condition, with some of the potential risks being considered a
natural part of the journey. Consequently, the women sought care only when they experienced something that was deemed to be unusual or when a symptom persisted. The women believed that the appropriate time to start ANC was when the pregnancy begins to ‘show’, and this was mainly attributed to the need to protect the pregnancy from any undesired eventualities like witchcraft. “Some people are not good, and they might do some things that might cause you to lose the pregnancy through miscarriage” [Mother 4].

To be admitted in a healthcare facility for delivery, mothers in the empirical context needed to have a clinic card, a failure to which they may have risked being turned back by the healthcare workers when they were due for delivery. This is a common predicament that maternal health clients in other developing country contexts face (Finlayson & Downe, 2013; Mrisho et al., 2007).

5. ANALYSIS

In this section, we demonstrate the application of the theoretical framework that was discussed in the previous section to analyse the PROMPTS empirical context. The analysis reveals that the desire for a healthy pregnancy, both directed and motivated the maternal health clients’ healthcare-seeking activity, while mHealth as a technology artifact mediated the healthcare-seeking activity as shown in Table 2. Consequently, the action of using the mHealth intervention was to pursue goals like accessing pregnancy-related care and support, and pregnancy information, within the realities and conditions of the existing healthcare-seeking context such as a resource-constrained healthcare system.

Table 2: How the use of AT facilitated an understanding of technology mediation in its context of use

<table>
<thead>
<tr>
<th>Concept</th>
<th>Empirical scenario</th>
<th>Analysis enabled by AT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community (of Purpose)</td>
<td>Courtesy of their position as care providers, the HCPs were expected to provide information, care, and support.</td>
<td>Analysis of tensions between elements of the activity, in this case, the CoP and Division of labour mHealth provided an avenue to resolve this contradiction by providing alternative access to pregnancy-related information and care resulting in partial substitution of the CoP.</td>
</tr>
<tr>
<td>Division of Labour</td>
<td>Older female kin courtesy of their experience were expected to support the maternal health client.</td>
<td></td>
</tr>
<tr>
<td>Rules/Values</td>
<td>Cultural norms restricting maternal health clients to seek maternal healthcare services only when the pregnancy was 'showing'</td>
<td>An analysis of how IT can support rules in an activity v/f. imposing new rules, making them visible, or negotiating rules (Nardi, 1996a) The mHealth intervention allowed women to interact with maternal services while maintaining their value system.</td>
</tr>
</tbody>
</table>

5.1 Conceptualising use as internalisation

Adoption of technology. While some uncertainties facilitated the adoption of mHealth, some resulted in hesitation to adopt the technology. Using the intervention proved useful in mitigating the pregnancy-related uncertainties associated with openly sharing one’s pregnancy for the fear of an ‘evil eye’/witchcraft. However, while it presented the opportunity to access useful information to mitigate uncertainties related to endangering the pregnancy from lack of/following wrong
information, the use of the intervention also presented concerns on the trustworthiness of the information with regards to harming the pregnancy.

Other uncertainties related to the material context influenced the maternal health clients’ response to the intervention. The popularly used money transfer service ‘M-Pesa’, also gave opportunities for fraudulent activities leading unsuspecting subscribers to lose money in social engineering scams (Buku & Meredith, 2012). Thus, mobile phone users were often suspicious of unsolicited messages. The study participants were suspicious of the intervention for fear that it was a scam that would lead to their loss of airtime. "They might say it's free and maybe you have only twenty Shillings' credit¹, and then you send the message, and they [the mHealth intervention] consume your credit." [FGD Participant]. This uncertainty led to hesitation to adopt the intervention.

Learning about the intervention from the health facility, therefore seemed to engender a sense of trust that the intervention was legitimate while the features like the toll-free design enabled the maternal health clients to overcome initial perceptions of risk and uncertainty about the intervention being a fraud. Being a toll-free service may have also increased the trialability of the intervention and afforded the women the agency to make mHealth adoption-related decisions. The trialability of an innovation is positively correlated to the likelihood of adoption (Rogers, 2010). These insights in the analysis were useful in seeing how technology characteristics and implementation circumstances may have engendered initial trust. The initial trust subsequently contributed to helping technology users overcome their perceptions of risk and uncertainty associated with the use of new technology. This made the following proposition possible:

**Proposition 1.** Where context and technology characteristics provide sufficient resources for the artifact to be sufficiently legitimised for initial trust, users are likely to adopt new technology.

Dissonance from using technology as a substitute. The action of using mHealth to pursue a healthy pregnancy was made possible by the existing conditions presented in the healthcare-seeking context viz. a resource-constrained healthcare system, negative attitudes and behaviour of clinicians, and socioeconomic barriers which affected when and how the maternal clients could use traditional healthcare services. The complexity and tensions between the community and division of labour (Tensions 3, 4 in Figure 3) resulted in further challenges in the healthcare-seeking activity. While it was the ‘responsibility’ of clinicians and next of kin to provide pregnancy-related care and education, this division of labour failed because of:

1. The spatial separation between the women and their experienced, older relatives whose responsibility it was to offer information and support.
2. The low doctor-patient ratio which resulted in hurried consultations with limited time to provide sufficient information. “It is often difficult to give individualised care because of the workload” [Healthcare Providers].

All these factors led to a perceived usefulness of mHealth for the maternal health clients to overcome these barriers, thus leading to the use of mHealth as a substitute. Using the intervention for a purpose other than that which it was designed for (undesired technology framing) led to incongruence and further tensions (depicted as 1 in Figure 3). The foregoing analysis enabled us to suggest the following proposition:

**Proposition 2:** When the perceived usefulness of mHealth presents the opportunity to use it as a substitute, mHealth users may develop undesired technology framing and experience dissonance.

5.2 Conceptualising use as externalisation

As maternal health clients experienced tensions/contradictions/challenges within the activity system (Figure 3), further use behaviour was elicited in the attempt to resolve the tensions. We discuss a few of the possibilities for understanding use that was gained from the analysis of some of these

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¹ Prepaid airtime or talktime that allows the mobile phone user to make calls or send text messages.
contradictions.

Legitimisation. This understanding is obtained by analysing contradiction 6 in Figure 3. At the core of legitimacy is reducing uncertainty by developing trust (Deephouse & Suchman, 2008). Our analysis showed that maternal health clients legitimised the mHealth intervention to build further (post-adoptive) trust. This was achieved by using the characteristics of the intervention and messages being shared via the platform, as well as comparisons with other sources of information to draw ‘judgements’ on the trustworthiness of both the information and the intervention itself (Sowon & Chigona, 2020). The characteristics of the intervention such as its responsiveness, anonymity, facilitated the legitimisation of the intervention beyond initial trust. Post adoptive trust is necessary for use continuance (Akter et al., 2013; Kaium et al., 2020). The analysis made the following proposition possible:

**Proposition 3:** mHealth users employ technology characteristics and the community of purpose to legitimise the intervention beyond initial trust

![Figure 3: Contradictions in the maternal healthcare-seeking activity system](image)

Negotiated use. While the design features of the intervention, as well as the components of the material context, may have facilitated agency to adopt, further analysis of contradiction 5 (Figure 3) revealed a change in dynamics when it came to appropriating the pregnancy-related information that was received through the intervention. So long as the intervention was offered free of charge and was associated with a legitimate entity, the decision to adopt mHealth may have been immaterial in terms of consequences. However, since the appropriation of information may have reflected a more material decision in the CoP reflecting a higher risk to the shared motive of a successful pregnancy, maternal health clients engaged in a process of negotiating their mHealth use. Their aim here was to make their use of mHealth a culturally appropriate behaviour given the interdependent nature of
the maternal healthcare-seeking context in the empirical setting. The idea of seeking appropriate use has been alluded to before by other theorists like Rogers (1995) in concepts like compatibility in the diffusion of innovations theory. Following this analysis, the following proposition was possible:

**Proposition 4:** When stakeholders play a vital role in the CoP, mHealth users employ legitimated mHealth interventions to negotiate use.

*Technology coping strategies.* As noted earlier, the varied use of technology in a manner different from what it was intended for resulted in dissonance for the maternal health clients. This mainly occurred in situations when the intervention ‘failed’ in engaging them by providing quick feedback, whenever the mothers were using it to access urgent care. "I thought [the delay] was not good because it could be an emergency and sometimes when asking for information you require the response immediately...". To resolve this, further analysis of the contradiction indicates that the mothers adopted varied technology coping strategies. Some mHealth users accommodated the technology, whereas some completely abandoned it.

AT’s principle of the hierarchy of activity was useful to further elucidating the difference in behaviour. Some analysis using this perspective indicated that where the mHealth intervention was sufficiently legitimised for the maternal health client, the need to wait for a response reflected a change in conditions rather than the frustration of the maternal healthcare-seeking motive. This led to adopting technology accommodation coping strategies. On the other hand, for the maternal health clients for whom the mHealth technology had not been sufficiently legitimised, the delay in receiving a response threatened their very motive of healthcare-seeking. For this reason, such users abandoned the use of the intervention. The analysis, therefore, allowed us to make the proposition that:

**Proposition 5:** Health clients may abandon technology (e.g., mHealth) when it is deemed to frustrate their healthcare-seeking motive.

### 6. DISCUSSION AND CONCLUSION

This study was founded on the argument that studying technology in situ is a much better perspective to studying concepts of human technology interaction like use. The study thus proceeded to demonstrate how conceptualising healthcare-seeking as an activity may prove useful to this end. Traditionally, technology use has been explicated using theories like TAM and UTAUT. Unlike these theories, we have demonstrated that AT allows for a broader understanding of use while not losing the original definition that entails a user, system and task. (Burton-Jones & Straub Jr, 2006). However, since individuals’ usage decisions happen within rich social contexts (Lewis et al., 2003), we explained that broader perspectives would provide a far richer understanding. Hence, rather than just conceptualising use as a user employing IT to accomplish a certain task, we approached it as including a person’s activities to adapt, change or modify the human-technology interaction context. In this study, we have demonstrated that AT has all the necessary vocabulary and conceptual underpinning to extensively explicate an individual’s activities to adapt, change or modify the technology, thus offering richer insights on use. Such perspectives may be what the IS field needs to provide a ‘next-level’ understanding of the interaction between technology and humans within their social contexts. It is evident that such an expanded view may better explain salient technology acceptance outcomes without precluding IS use behaviours included in the traditional view of the construct. It also helps us to move beyond adoption to understanding the complete continuum of user-technology interaction in a way that allows researchers to reflect on the design and implementation implications.

Adopting an activity perspective to understanding user-technology interaction especially in a context such as mHealth where the artifact is a combination of the technology itself and the information may complicate the idea of use and the understanding of the user technology interaction at the two levels. However, analytically separating the IT construct as we have done here allows for richer insights to emerge. For example, while use of mHealth as a technology was an autonomous
decision, the appropriation of information depended on the material context which necessitated the maternal health clients to negotiate use.

We conclude by suggesting that AT offers a powerful tool to investigate the situated entanglement without embracing technological determinism, taking the technology for granted, or allowing the technology to vanish from view (Orlikowski, 2005). The scarcity of AT application may be associated with its robust, complex, and abstract nature (Mwanza, 2001; Wiser et al., 2019). The application of AT requires the researcher to select a practical level of abstraction (Allen et al., 2011; Engeström, 2001). We believe that our application is an appropriate attempt to operationalise AT in Information Systems especially as a tool that can be used to understand use. The key concepts can be applied as sensitising devices in analysing empirical cases. The analysis of mHealth within the context of the healthcare-seeking activity not only explicated the phenomenon of use but was also useful in revealing the different design and implementation characteristics of the context and the technology such as were useful in shaping the maternal health clients’ utilisation behaviour. Such insights could provide a patient-centred perspective to the design and implementation of health information systems. Thus, the benefits of conceptualising healthcare-seeking as an activity serve an important role in bringing together the HCI and IS fields. These have historically been known to adopt varied theoretical perspectives according to their focal interest: the former on design of technology artefacts, and the latter on IS-related development and change (Avgerou, 2010).

This study uses one human engagement (healthcare-seeking) to operationalise AT and to show how the phenomenon of use may be understood. Insights on use may vary in other human activities where technology is used. We, therefore, encourage other IS researchers to test the application of AT presented here, in other technology contexts. This will serve to validate the findings that have been presented here and to build further evidence that would be useful in the further theorization of technology utilisation phenomena while building the evidence on how AT may be operationalised in IS research.

On a practical and theoretical level, the complexity of certain AT concepts may be more complicated than could be captured in this study. For example, the dichotomy between internalisation and externalisation, when one ends and where the other begins may limit the extent to which they can be separated for analytical accessibility. The conceptualisation we presented here may also be limited to the extent that we adopt an instantiation of the activity at a particular point in time. We encourage other researchers to explore the value of the activity system and the aspect of a changing activity based on tensions, contradictions and changing needs and motives of the subject on explicating utilisation.

7. ACKNOWLEDGEMENT

The empirical study was part of a PhD research that adopted a case study design with the goal to explicate how the healthcare-seeking socio-cultural context shaped mHealth utilisation. The project was approved according to the Faculty of Health Sciences Human participants’ research ethical requirements at the University of Cape Town and complied with the Helsinki 2013 ethical principles for conducting human participants’ research.
REFERENCES


FRAMEWORK FOR MANAGING CYBERCRIME RISKS IN NIGERIAN UNIVERSITIES

Bukhari Badamasi, American University of Nigeria, bukhari.badamasi@aun.edu.ng
Samuel C. Avemaria Utulu, American University of Nigeria, samuel.otulu@aun.edu.ng

Abstract: Universities in developing countries, including those in Nigeria, experience cybercrime risks due to poor management of their cyber spaces and resources. The outcome of these cybercrimes are threats and breaches of universities’ cyber security. The threats and breaches have resulted in substantial financial, social, and intellectual property losses. In the recent past, Nigerian universities have started to respond to these cyber-attacks. Many of them now invest in anti-cybercrime tools and programs to mitigate cyber security threats and breaches. Despite this, the number of times Nigerian universities suffer from cyber-attacks and the losses that result from them keeps increasing. Our observation, however, indicates that most Nigerian universities run their cyber security without using scientifically derived frameworks that spell out how to manage threats and breaches that emanate from within and outside them. We consider this a problem to ongoing efforts made by Nigerian universities to mitigate cyber security threats and breaches. The study reported in this paper was therefore, carried out to explicate how Nigerian universities can develop actionable frameworks that can help them to mitigate cyber security threats and breaches. The study is based on literature review and propose how an actionable framework that Nigerian Universities can adopt to setoff cybersecurity programs can be developed. The process comprises of problem identification, description of objectives, designing and developing the artefact, testing, and evaluating the artefact, and communicating the result. We conclude that the framework provides a lucrative starting point for Nigerian universities to setoff efficient and effective cyber security program.

Keywords: Cybercrime, Cybersecurity, Cybersecurity Management Framework, Nigerian Universities.

1. INTRODUCTION

Universities are highly dependent on the Internet and cyberspaces within it to actualize their statutory responsibilities. According to Li et al. (2018), cyberspace refers to an interconnected and interdependent information technology (IT) based networks that include the Internet, telecommunication networks, computer systems, and social systems. Aheleroff et al. (2021; p.5) also stated that “cyberspace has emerged as a powerful interconnected digital technology with the ability to achieve the most complex manufacturing paradigms due to the advancement features associated with Big Data, Internet of Thing, and Blockchain technology”. Cyberspaces have evolved tremendously over the years, providing a variety of digital platforms universities need to manage teaching, learning, research, community development and administration (Taylor, 2017). Cyberspaces have helped universities to manage admission processes, students’ life issues, finance, examinations and records, and to facilitate academic processes (Hunton, 2011). It follows that every contemporary university carries out its statutory responsibilities and provide services to staff, students, parents and guardians, funding agencies, government, accreditation agencies, and other stakeholders using cyber spaces. Despite the advantages of cyberspaces offer universities, they also pose critical threats and challenges to their well-being and operations. This is given the evolution of cybercrimes and their growth in the recent past. Reports in the extant literature show that a variety
of culprits that have become very challenging to identify and apprehend have emerged within cyberspaces universities use to actualize their statutory responsibilities.

Recent incidences of cybercrimes in universities has resulted to a new understanding among cybersecurity scholars that cybercrime is not limited to financial and related institutions. Demers et al. (2017) for instance, revealed that cybercrimes perpetrated against universities is increasing at an alarming rate. Demers and his colleagues argued that the education sector is second in the league of industries that suffer cybersecurity threats and breaches. According to France-Presse (2020), the FBI and the Cybersecurity and Infrastructure Security Agency (CISA) both announced that organizations researching COVID-19, particularly universities, were at risk given China’s attempt to steal coronavirus research data. Attempts were made by Chinese government-affiliated organizations and others to unlawfully acquire valuable intellectual property and public health data related to vaccines, treatments, and testing (Xie, 2020). Walker (2020) also reported that the United Kingdom (UK) Security Minister alleged that he was more than ninety five percent certain that state-sponsored hackers backed by Russian Government targeted organizations and universities in the UK and Canadian that were working on a coronavirus vaccine. There are similar reports in the extant literature indicating that the National Cyber Security Agency (NCSA) in Nigeria and its counterparts in other countries were adamant that the attacks on drug companies and research groups were carried out by “Russian Intelligence Agency” (Parsons, 2020). Sobers (2021) further stated that universities were ranked as the most dangerous place for an individual to reveal sensitive information. Opinions propagated by Demers et al. (2017) and Sobers (2021) fits into recent occurrences of cybercrime experiences of Nigerian universities.

Examples of cybercrime cases in universities in Nigeria include the incidence of Denial of Service (DoS) attack in which an unknown person abused the Network Time Protocol (NTP) server in the Federal University of Technology Akure (Mojeed, 2020). Madonna University in the Eastern Nigeria also reported that hackers accessed and tempered with over 25,000 data in their database (Egbunike, 2019). In 2016, 2017, and 2018, Ahmadu Bello University, Zaria, Nigeria disclosed incidents that potentially exposed a serious breach in the university website that resulted in a compromise of students and staff data (Bukhari, 2018). In another incident, a university staff was found compromising the admission records and printing fake admission letters for some applicants. In a similar incident, a staff of the Management Information System (MIS) Unit was apprehended for breaching the security protocols and conniving with some students of the University to illegally allocate rooms and print admission letters (Bukhari, 2018). All these challenges are good examples of cyber security issues Nigerian universities contend with.

Studies have however, shown that to manage cyber security risks, there is the need to plan for them (Clausen, 2019; Mamogale, 2011). Planning for cyber security risks requires putting in place adequate measures to avoid cyber-attacks and/or to manage their effects if they eventually occur (Alpert, 2012; S. T. Clausen, 2019; Kuusikallio, 2017; Mamogale, 2011). It is therefore, follows that, that major challenge confronting Nigerian universities is the need to develop frameworks that will serve as guides to programs they develop to avert cybercrimes and to reduce the effects of cybercrimes when they are perpetrated. In developed countries, a good number of universities, have cyber risk management frameworks, this however, cannot be said about Nigerian universities and most universities in developing countries (Singh & Joshi, 2017). The case in Nigeria, with regards to the small number of universities that have frameworks for managing cybercrimes, is unique. Ryder and Madhavan (2019) opinion that strategies used to fight cybercrime in developing countries are weighted towards short-term responses and IT challenges and that the strategies do not always spell out how to manage the consequences of cybercrime incidences succinctly captures the situations in Nigeria.

In our opinion, a good cybercrime management framework should be weighted towards long-term responses and should provide grounds for the careful monitoring of cyberspace before, during and after cybercrime occurs. The indication is that a cybercrime management framework must be holistic and must bring into bear every aspects of cyberspace management. This is given that cybercrime
management involves different tasks and skills and diverse stages. Our study is an ongoing large scale and longitudinal study that is being carried out in the Nigerian university context. The study is relevant because Nigerian universities are among universities in developing country contexts with high risk of cybercrime incidents (Eboibi, 2020). Consequently, the research study reported in this paper is a part of the large scale and longitudinal study. This particularly study was informed by the question, how perspectives in the design science method can facilitate the development of cybersecurity management framework for Nigerian universities. To answer this question, five specific questions derived from the design science method process were raised including: what are the cybersecurity problems Nigerian universities are facing and what are the likely problems they will face in the future? What should the objectives of cybersecurity programs of Nigeria universities be? How can appropriate cybersecurity program be designed and implemented by Nigerian universities? How can the appropriateness and adequacy of Nigerian universities’ cybersecurity programs be tested and evaluated? How can cybersecurity programs of Nigerian universities be communicated to necessary stakeholders? The paper aims to develop a cybersecurity management framework that is useful to Nigerian universities and universities in other developing countries that operate in socio-technical environments that are similar to those in the Nigerian university system. The remaining part of the paper includes review of related literature, methodology, proposed framework, and conclusion and limitations.

2. REVIEW OF RELATED LITERATURE

2.1 Cybercrime

Cybercrime has become the world's second-largest man-made risk (Soomro & Hussain, 2019). It encompasses all illegal activities perpetrated by scammers, hackers, and internet fraudsters. The illegal activities may include human activities carried out to gain illegal access to data and information or sending spam, malware, worms into devices, networks, or even organizational information systems and global connection to make them malfunction (Mary, 2016). Cybercrimes have had debilitating effects on individuals, governments, organizations, and universities (Adesina & Ingirige, 2019). It has cost billions of dollars’ worth of damages, data loss, and website defacement. It has sent many governments, organizations, and individuals into bankruptcy and global shock (De Paoli et al., 2020). Cybercrime has remained a major threat to universities, particularly as it touches that core mandates of teaching, learning, research, community services, and administration and management of staff and student records (Bukhari, 2018). There are indications in the extant literature that the COVID-19 era is likely to result in a surge in the number of cybercrimes perpetrated against universities. Traxler et al. (2020) for instance, opined that COVID-19 has forced an increase in the dependence on cyberspace for both individuals and organizations and that this is likely to result in cybersecurity threats and risks. Morgan (2020) also observed that more than four thousand malicious COVID-19 related websites appeared on the internet within months of the first COVID-19 pandemic in 2020. He argued that the occurrence of cybercrime in 2021 would be in every eleven seconds; a fit that is almost four times the average in 2020 (every nineteen seconds) and almost twice the pace in 2019 (every forty seconds) (Morgan, 2020). Meanwhile, cybercrime is projected to cost the global economy $6 trillion yearly from 2021, up from $3 trillion in 2015. While from 2025, cybercrime will cost $10.5 trillion annually. Besides the United States and China, cybercrime would eventually be the world's third-largest economy (Sausalito, 2020). Losses to ransomware are projected to cost the world $20 billion by 2021, which is 57 times what they were in 2015 ($325 million) (Chapman, 2019; Morgan, 2020). As a result, ransomware is the fastest-growing form of cybercrime even in universities. Furthermore, spear-phishing emails are used in 91 percent of cyberattacks, infecting organizations and universities.

There is no doubt that insights in the extant literature indicate the need for a robust cybersecurity management framework that can provide actionable knowledge to organizations and universities. In its entirety, cybercrime risk management frameworks provide a multiplicity of guiding principles and action plans aimed at addressing cybercrime and its related incidents. In Nigeria, the Office of
the National Security Adviser (NSA) in collaboration with the National Information and Technology Development Agency (NITDA) shares similar views with Microsoft and the National Institutes of Standards and Technology on the threats to be addressed through the implementation of a consolidated cybersecurity framework (Osho & Onoja, 2015). Although, this is mainly for organizations like the financial sector, oil and gas, and other conglomerates. This situation makes our attempt at producing an actionable cybersecurity framework for Nigerian universities a worthwhile venture.

2.2 Cybersecurity issues in Universities

Cybersecurity is derived from two words: cyber and security. According to Valeriano and Maness (2015), cyber is related to the technology which contains systems, network and programs or data (Valeriano & Maness, 2015). On the other hand, Schneier (2009) argued that security relates to protection of systems, network, application, and information. Sanoo (2018) further described cybersecurity as the protection of interconnected systems, including hardware, software, and data from cyber-attacks. One important factor that Valeriano and Maness (2015), Sanoo (2018) and Schneier (2009) did not include in their definitions is the social: values, norms and cultures conjectured by organizations as suitable and logical ways of behaving and relating with others. Consequently, we take cybersecurity to be primarily about people and the social structures and work processes they create, and technologies they put together to encompass the full range of threat reduction, vulnerability reduction, deterrence, international engagement, incident response, resiliency, and recovery policies and activities, including computer network operations, information assurance, law enforcement. Some authors have proposed similar view about cybersecurity in the extant literature. These authors argued that the body of technologies, processes, and practices designed to protect networks, devices, programs, and data from attack, theft, damage, modification or unauthorized access constitute cybersecurity management protocols (Abu-Taieh, 2017; Rashid et al., 2018; Sanoo, 2018). Cybersecurity is used in different areas in universities, and each university has its area of usage or application. Most universities in the world has deployed cybersecurity to protect their network, and data on the cyberspace. Universities in the developed countries such as University of Arizona, University of Edinburgh, University of Bristol, University of Sheffield, Princeton University, University of Illinois, University of Leicester, Carnegie Mellon University, and University of Pittsburg uses different cybersecurity frameworks to manage cybersecurity risk. The framework deployed helps to facilitate the strategic vision of the universities and facilitate the protection of information systems against compromise of its confidentiality, integrity, and availability (Webb & Hume, 2018). Whilst doing this, it recognizes the ability to discover, develop, and share knowledge among employees. While Nigerian universities are reluctant about cybersecurity framework.

Several studies were conducted to examine issues concerning cyber security threats in Nigerian Universities. A study conducted by Ekpoh et al. (2020) in which factors that served as cybersecurity threats to universities were examined at University of Lagos, it was found in the study that there existed a strong positive relationship between location, culture, facilities and personnel security of universities, while a weak, positive correlation existed between school climate and personnel security. The study concluded that indiscipline, poor staff and student’s safety and security awareness, inadequate capacity building for security personnel, poor funding of institutions, and outdated security framework, were the major determinants of security lapses in Nigerian Universities. A study was conducted by Dagogo (2005) on the role of security agents in curbing cybercrimes in Universities in the North-East Nigeria using seven tertiary institutions. The study revealed that training and re-training of security personnel and cybersecurity expert significantly affect their level of service delivery. Statistically, Nigerian universities ranked 43 in Europe, the Middle East and Africa and ranked third among the nations that commit cybercrime in the world (Makeri, 2017).
2.3 Cyber Security Framework

Cyber security management framework has to do with mitigating cybersecurity risks. It is a relatively new and growing aspect of risk management in organizations. Organizations, including universities, face risks due to natural occurrences, human resource failures, third-party contractors, financial mayhem, chaotic conditions, and security breaches. Risk is an unpredictable occurrence of an incident or situation in organizations or universities that has negative impact, such as time, cost, or quality (Mikkola et al., 2020). A risk may have one or more triggers or causes, and if it happens, it may have diverse effects. Every facet of universities’ information systems and technical and social environments can face diverse risks which are likely to be caused by poor preparation and management procedures, and lack of centralized management systems (Hollis, 2015). Consequently, risk management (RM) has become an important and integral part of cybersecurity management in organizations over the last few decades (Whitehead, 2020). It encompasses the mechanisms involved in hazard preparation, assessment, interpretation, reactions, and threat management and regulation (Purohit et al., 2018), which is further described as a role that enables and adds value to organizations while increasing the likelihood of achieving strategic objectives. Meanwhile, every organization that wants to excel, must develop strong capabilities to handle complex risks. Contemporary organizations must build an empowering atmosphere that reduces the negative consequences of risk. The idea that it is advisable that universities have cybersecurity frameworks stems from insights propagated in the RM domain. this is given the relationship between critical aspects of RM and those of cybersecurity frameworks namely, techniques, processes, and resources used to define and manage risks (Aven & Renn, 2010).

There are several cybersecurity frameworks in use across the world, depending on person or organizational preference and adaptation (Pattinson et al., 2018). Defense in Depth and Defense in Breath, NIST Cybersecurity Framework, The Lockheed Martin Kill Chain, Specified Frameworks, Global Cybersecurity Index, and Cybersecurity Risk Framework (Smith, 2019). However, the most widely used framework developed by the US National Institute of Standards and Technology (NIST), offers a high-level taxonomy of cybersecurity outcomes as well as a methodology for assessing and managing them. According to NIST (2020), the NIST Cyber Security Framework (CSF) describes five core functions that organizations should address to pro-actively manage cybersecurity threats to their business operations; identification, detection, protection, reaction, and recovery. Another cybersecurity framework widely used in organizations is the Global Cybersecurity Index (GCI) conceptual framework designed by the International Telecommunication Union (ITU) in collaboration with ABI research institutes (ITU, 2015). The framework seeks to evaluate a country or organization’s development in cybersecurity systematically. The objective of this framework is for cybersecurity to be a focal point in information systems organizations and users of those systems (ITU, 2015). Five critical factors were identified as the constructs which determines the dimension of cybersecurity within organizations (ITU, 2015; Maarten et al., 2015; Stein, 2008). These constructs include technical measures, legal measures, capacity building, cooperation, and organizational measures.

Although existing frameworks are simple and actionable, most of them do not directly address cybersecurity issues faced by universities. The peculiarities of universities in developing country contexts also raises concerns that are not directly addressed in existing international frameworks. To control cybersecurity threats, universities must have a thorough understanding of their socio-technical contexts, operations, drivers, and security issues. Since the threats, goals, and processes of each university are distinct, the techniques and approaches used to achieve the objectives that inform cybersecurity frameworks usually differ. As a result, this study invites Nigerian universities and universities in similar developing country context to be clear about their socio-technical contexts, operations, drivers, and security issues. To achieve this clarity of purpose, Nigeria universities must provide answers to the questions raised in this study namely: what are the cybersecurity problems Nigerian universities are facing and what are the likely problems they will face in the future? What should the objectives of cybersecurity programs of Nigeria universities be? How can appropriate
cybersecurity program be designed and implemented by Nigerian universities? How can the appropriateness and adequacy of Nigerian universities’ cybersecurity programs be tested and evaluated? How can cybersecurity programs of Nigerian universities be communicated to necessary stakeholders? Painstaking and scientifically derived answers will provide grounds for a unique cybersecurity framework.

3. METHODOLOGY

The study adopted the interpretive philosophy. The Interpretivist philosophy will have scholars believe that social realities, such as cybercrime and cybersecurity, and IS artefacts including frameworks, are socially constructed, that is manmade (Ngwenyama, 2014). It also makes scholars to work with the assumption that the human actors involved in the use of IT and the IT itself are subjective and act based on socially constructed notions (Utulu & Ngwenyama, 2017). The method adopted for the study is the literature review method. Extensive review of the literature was carried out on themes relating to cybercrime, cybersecurity, and design science research approach. The literature review method adopted in the study was more like the snowball technique, where works cited by the works we consider primary to our debate and the works that cited them were selected and used to come up with the arguments that we presented in the paper. This literature review method has been used by Averou (2008), Heeks (2017) and Olagunju and Utulu (2021). The literature reviews method is unlike the systematic literature review or grounded theory literature review that are based on premeditated procedures (Okoli & Schabram, 2010; Utulu et al., 2013; Wolfskinkel et al., 2013). Theoretical perspectives of the design science research approach were used to come up with the cybersecurity management framework that we proposed. Baskerville et al. (2018), argue that design science method involves the creation of an artefact, framework, model, or theory in which the current state of practice can be improved together with the existing knowledge. Hevner and Chatterjee (2010) further stated that design science method is a problem-solving paradigm which results, among others, in the development of models or frameworks that are useful to solving practical problems.

4. PROPOSED FRAMEWORK

4.1 Identifying Cybersecurity Threats Nigerian Universities are likely to face

The primary tasks of universities are production and dissemination of scientific knowledge research and scientific knowledge publication. Globally, universities are vulnerable to diverse forms of cybersecurity problems, including theft of intellectual property, compromise of student and staff records and hacking of university portal (Oliver, 2010). Moreover, different forms of cybercrime ranging from admission falsification, impersonation, illegal room allocation, website defacement, hacking of log-in details, printing of fake admission letters among others are the cybersecurity challenges facing Nigerian universities (Bukhari, 2018; Igba et al., 2018; Okeshola & Adeta, 2013). The emerging problems that Nigerian Universities may face are numerous. Some of the problems include beneficiary of a will scam. According to Bian et al. (2018), will scam occurs when cybercriminal send e-mail to claim that the victim is the named beneficiary in the will of an estranged and stands to inherit and estate worth millions. Another emerging cybersecurity challenge is online charity. In online charity, cybercriminals host websites as if they are charity organizations. They use the websites to solicit for monetary and material donations (Saulawa & Abubakar, 2014). The possibility that cybercriminal can set up fake websites and lure donors to donate to universities is high. Another cybercrime Nigerian Universities suffer from is computer/Internet service time theft. Culprits develop means of connecting privately owned cyber cafes to networks owned by universities in ways that are difficult to detect and thereby run their cafés at the expense of the universities (Oliver, 2010).
4.2 Setting Objectives for Nigerian Universities’ Cybersecurity Programs

The main objectives of cybersecurity programs are to help Nigerian universities reduce the vulnerability of the information systems and networks they operate in cyberspaces. Setting adequate and appropriate objectives for cybersecurity programs can be a very complex task for universities, including Nigerian universities (Igba et al., 2018). This is because the extent to which cybersecurity programs of Nigerian universities can reach is highly dependent on the objectives the set. Consequently, the values cybersecurity objectives of Nigerian universities are functions of their understanding of cyber security threats they face, the extent they are able to articulate and share information about the cybersecurity threats with necessary stakeholders and the ways they are able to translate their understanding of the cybersecurity threats to cybersecurity management policies and practices (Bian et al., 2018; Saulawa & Abubakar, 2014). The extent Nigerian universities collaboratively work with public, private, and international entities with regards to their cybersecurity programs is also a function of the adequacy and appropriateness of the cybersecurity objectives they set. Cybersecurity objectives provide the framework of reference that helps organizations to understand current trends in cybercrimes and solutions that are effective and efficient in tackling them. Cybersecurity objectives also provide grounds the measure levels of integrity, reliability and efficiency of cybersecurity programs.

4.3 Techniques for Managing Cyberattacks by Nigerian Universities

Cybersecurity policy framework is the first point of action for managing cybersecurity threats. Although it evolves from cybersecurity objectives set by universities, it spells out what Nigerian universities should do and how to do what they have to do with regards to cybersecurity threats. Each universities cybersecurity policy should be integrated with other universities and organizations and should provide room for determine other universities and organizations should policy to avert or management cybersecurity attacks (Makeri, 2017). An appropriate cybersecurity framework should also define required cybersecurity education and training universities need to provide members of university communities. It is also necessary to educate members of university communities and various organizations universities deal with in the best practice for effective cybersecurity management. It should also spell out cybersecurity requirements of other organizations the universities deal with. For example, some universities in the developed countries have a policy that all systems in their purview must meet strict security guidelines (Ekpoh et al., 2020). Automated updates are sent to all computers and servers on the internal network, and no new system is allowed online until it conforms to the security policy (Iriqat & Molok, 2019). Cybersecurity management resources required to avert or manage cybersecurity attacks are also to be spelt out in cybersecurity policy frameworks. Cybersecurity policy frameworks Nigerian universities use should also spell out the role ISPs are to play within universities’ cyberspace and how to ensure high level of security at servers in order to keep clients secure from all types of cyberattacks (Odinma, 2010).

4.4 Cybersecurity Programs Appropriateness and Adequacy Assessment

An important part of the cybersecurity management framework proposed in this paper is making room to assess the appropriateness and adequacy of the entire cybersecurity management framework. This could be done in two way (Pavol Zavarsky & CISM, 2014). First, is appropriateness and adequacy assessment that is based on assumptions (Armenia et al., 2021). Second, is the appropriateness and adequacy assessment that is based on experience (Glantz et al., 2016). The first option occurs given that appropriateness and adequacy are determined before the occurrence of cyberattack. The second option occurs after a cyberattack when a university assesses its cybersecurity management framework vis-à-vis the nature and strategy cyberattack it suffered. The attack may not be a serious attack, but it provides avenue for cybersecurity management framework appropriateness and adequacy assessment. These two approaches to assessing the appropriateness and adequacy of universities’ cybersecurity management frameworks can help those concerned to modify existing cybersecurity management frameworks. They help to open avenue for
constructive feedbacks from those concerned. The use of stakeholders’ feedbacks and recommendations are made possible by cybersecurity appropriateness and adequacy assessment.

4.5 Communicating Cyberattack and Management Outcomes to Stakeholders

This requirement is important, and can be used during two different situations. The first situation is pre-cyberattack situation while the second situation is post-cyberattack situation. During the pre-cyberattack situation, universities are expected to communicate how their cybersecurity management framework works and the role of each stakeholder group. In the second situation, universities are to communicate loopholes in the cybersecurity management framework that resulted to the cyberattack experienced and how the updated cybersecurity management framework solves the problems that resulted from the loopholes. Communicating ideas across large organization is a complex task (Smith, 2019). Heide et al. (2018; p. 2) in his article “Expanding the Scope of Strategic Communication: Towards a Holistic Understanding of Organizational Complexity”, describes strategic communication as an academic movement that has been formulated as an ambition to break down the silos surrounding closely related communication disciplines and create unifying framework that integrates public relations, organizational communication, marketing communications and other areas” Organizations should communicate strategically to purposefully fulfill their overall missions. This complexity is also applicable to efforts made by organizations to communicate cybersecurity management framework across the length and breadth of organizations. The complex nature of cybersecurity threats and the difficulty in knowing the perpetrators and understanding their motives makes the act of communicating cybersecurity management frameworks across the length and breadth of organizations a complex endeavor. Aside this, some aspects of cybersecurity management frameworks that universities may use may be made clandestine. So, it is important to know and understand those that these aspects should be
communicated to and how to effectively and efficiently do this without jeopardizing the overall cybersecurity management program.

5. CONCLUSION AND LIMITATION

The rapid expansion of cyberspaces and universities transfer of their major activities and operations into cyberspaces have led to the increase of cybercrime perpetrated against universities. The frequency in which universities across the globe suffers from cybersecurity attacks indicate the need for Nigerian universities to develop cybersecurity management frameworks that they can use to coordinate their cybersecurity management programs. This is not to say that Nigerian universities do not have cybersecurity strategies they use. It however, indicates that they need to make concerted efforts towards formalizing and documenting their cybersecurity management strategies into actionable frameworks. This paper presents a proposed framework that provides good grounds for Nigerian universities to set off their actions towards developing actionable cybersecurity frameworks. The paper proposes three-stage based cybersecurity management framework for Nigerian universities namely, pre-cyberattack readiness, cyberattack management and post-cyberattack activities. Each stage was broken down into actionable processes. The limitation of the framework and by extension this paper, is that it is not based on empirical research study. It is based on literature review. An empirical study would have provide empirically derived insights on how the proposed cybersecurity management framework will work in real life situations. However, the
paper and the proposed framework provide grounds for conducting empirical studies on cybersecurity management framework for universities.

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DIGITALISING THE WATER SECTOR: IMPLICATIONS FOR WATER SERVICE MANAGEMENT AND GOVERNANCE

Godfred Amankwaa, Global Development Institute, University of Manchester, godfred.amankwaa@manchester.ac.uk
Richard Heeks, Global Development Institute, University of Manchester, richard.heeks@manchester.ac.uk
Alison L Browne, Department of Geography, University of Manchester, alison.browne@manchester.ac.uk

Abstract: Digital technologies are becoming central to water governance and management, yet their impact and developmental implications are under-researched, particularly in the global South. This paper addresses this knowledge gap by examining the process of water service digitalisation and the resulting effects on service providers. Drawing on qualitative methods, we apply ideas on digitalisation, value, and power to investigate the implementation and impact of digital technologies in Ghana’s state water utility company. We find digital water innovations to be recent, and delivering relatively limited impacts as yet, with value mainly accruing at the utility’s operational rather than strategic level. The digital technologies present avenues for power shifts and struggles internally and externally as well as some changes in water management structures and responsibilities. We end with a brief discussion on the implications for water service governance and research.

Keywords: digital water, digitalisation, value, power, Ghana.

1. INTRODUCTION

The water sector increasingly needs innovation, and one important strand of that innovation has been digital water innovations (DWIs) (Daigger et al., 2019; Sarni et al., 2019). New technologies, ideas and approaches for digitising and “smartening” water systems are being embraced wholesale alongside the utilisation of data analytics in order to improve the sector (Hope et al., 2011; Cominola et al., 2015; Wade et al., 2020). Specific impacts claimed for DWIs include better service provision and a reconfiguration of the relationships between water users, providers and infrastructures (Guma et al., 2019; Hoolohan et al., 2021).

Although DWIs are in use in cities worldwide, arguments about their impact and developmental implications in the global South have to date been based on little research and evidence (Amankwaa et al., in review). As digital technologies are becoming a central feature of water governance in global South cities, important questions regarding how digitalisation and datafication transform, reproduce and reconfigure relations, power dynamics and knowledge systems within water service governance and management remain to be answered.

This paper aims to address this knowledge gap by focusing on the digitalisations associated with Ghana Water Company Limited (GWCL); Ghana’s sole urban water service provider. Over recent years, GWCL has implemented a number of different digital water innovations and our analysis here provides new insights into the nature and limits to organisational value provided by these systems, and into change in organisational structures and power that have been associated with these new systems. By focusing on the impacts of digitisation and datafication in a public water utility, this paper also adds to understanding of water and development, and to case material on the role of digital in development of the public sector in the global South.
The paper has five sections. In the following section, we briefly examine the literature on ‘digitalisation, development and power’ to understand the development impacts of digital in the water sectors. We discuss the progress of digitalisation in GWCL and the study methodology, and then present the study findings. The paper ends with the discussions and conclusions.

2. LINKING DIGITALISATION, DEVELOPMENT AND POWER

Digitalisation and its associated processes (e.g., datafication) are seen as integral to “smart city” visions across the world and have spread over the past decade to the global South through the aegis of local and global technology firms (Mayer-Schönberger & Cukier, 2013; Datta, 2015; Joss et al., 2015). In most global South countries, this agenda has focused on products such as data management systems for utilities and the application of digital technologies to urban development problems as ways of creating more efficient urban processes (Taylor & Richter, 2017; GSMA, 2020). Looking specifically at the water sector, we find digital technologies being implemented in both privatised and public water companies (Sarni et al., 2019).

In this paper, we focus on a public water utility (GWCL) to investigate the process of water services digitalisation and the resulting effects on service providers. To do this, we take inspiration from the concept of ‘datafication and power’ (Heeks et al., 2021) and logic of epistemic determinism (Cherlet, 2014) in order to explain how digitalisation and datafication relate to value, decision making and power.

In the literature on impact of digitalisation, two particular impact domains can be identified: value and power. Value deals particularly with the improvements that digital systems can make to organisational decisions. This is often discussed in terms of impacts across the organisational decision levels: operational, tactical and strategic (e.g., Turban et al. 2018). Value-related impacts of DWIs reported to date have typically been based on experiences in the global North or just on pilot or proof of concept experiences in the global South (Heymans et al., 2014; Ndaw, 2015; Monks et al., 2021). What evidence is available from the global South to date suggests limited value being derived from digital technologies for water service providers at either operational level such as improved water supply monitoring or more strategic value such as increase provider revenue (Hellstrom & Jacobson, 2014; Sarkar, 2019). Overall, however, there is so far little direct evidence about the impact of DWIs on decision-making and value in global South water provision (Amankwaa et al., under review).

The broader impact of digital systems includes how digital intersects with power and wider politics. Some studies have explained that the introduction of digital systems brings new actors and power dynamics in terms of “who counts”, who has epistemic control and the implications of new structures and positionality of relations arising from digitalisation (Cherlet, 2014; Taylor & Broeders, 2015; Heeks et al., 2021). There is a very small amount of evidence of potential loss of power by groups or shifts in power and rights between groups in developing countries through digital systems in public utilities (Heeks et al., 2021). Others have argued that digital systems may empower some actors such as large corporations or the state at the expense of others (Hilbert, 2016).

In the water sector however, evidence-based analysis of broader impacts and power relations of digitalisation is much more limited, especially among water service providers in the global South (Taylor & Ritchie, 2017). There is little evidence and exploration of how the context of interests and power shapes DWI implementation and the complementary changes in capabilities, incentives and management processes it might bring within the water service governance and management (Amankwaa et al., under review).

In sum, we know from past literature that digital water innovations have the potential to impact both value and power in global South water systems, but we have as yet too little evidence on this. We now move to explain how this current study sought to illuminate these issues.
3. DATA AND METHODS

3.1. Research setting

This study focused on Ghana based on the current spate of digital systems roll-out within the water sector as part of both national and water service provider goals (World Bank, 2019; Amankwaa et al., 2020). To address the research aims, we employed a case study approach to enable in-depth research of digital technologies and their impact (Yin, 2014). The chosen case was that of the Ghana Water Company Limited. GWCL is the sole government-owned water utility company in the country, and it is responsible for the production, transmission and distribution of water in urban areas in Ghana. The Company manages 90 water systems serving about 11 million people nationwide with headquarters in Accra alongside 15 regional and 90 district offices (GWCL, 2019).

Alongside its critical role in Ghana’s water sector, GWCL was also selected because it has been following digital road map, implementing digital water innovations in its operations from source to consumer (GWCL, 2019; Waldron et al., 2019; Amankwaa et al., 2020). As summarised in Table 1, these relate to three main domains. Distribution and delivery applications have mapped and modelled the Company’s water infrastructure and monitor water flow and pressure. User-related systems monitor water use levels and digitise billing, payment and other interactions with consumers. Internally, an enterprise resource planning (ERP) system is in operation across procurement, HR, accounting and other departments.

<table>
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<tr>
<th>Stages of the water value chain</th>
<th>Activities</th>
<th>Key digital water innovations implemented</th>
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| Distribution and delivery     | Water distribution and monitoring | - Geographic information system  
- Hydraulic modelling  
- Sensors (SCADA (supervisory control and data acquisition), loggers, etc.)  
- Telemetry system |
| End-users                      | - Water consumption  
- Consumption monitoring and revenue collection  
- Service feedback | - Smart (ultrasonic) meters with ‘drive by’ radio technology  
- Electronic billing and payment system  
- Online customer feedback services (e.g., customer mobile apps and portal)  
- Customer engagement channels including call systems, Telegram and WhatsApp |
| Internal                       | Procurement (Materials), HR, accounting, etc | - ERP system |

Table 1. Digital water innovations implemented by GWCL.

Implementation of these digital systems has been slowed by both human and technical factors. However, these have not prevented the implementation. Digital water innovations may still be at a relatively early stage, but they are sufficiently embedded to make a study of their impacts practicable: another rationale for the selection of GWCL as a case study.
3.2. Methodology

Within the case study strategy, the research reported here adopted qualitative methods comprising key informant interviews and policy document analysis. Initial interviewee sampling was purposive and snowballed, beginning with pre-existing contacts in GWCL and from them identifying those within GWCL involved with decision-making processes at different levels in the organisation. Contacts with external experts were snowballed to add others based on recommendations. In all, the first author conducted 16 semi-structured interviews from November 2020 to February 2021, with 12 GWCL professionals (senior officers and mid- and operational-level staff), one representative of an international water organisation who had previously worked for a water-related civil society organisation in Ghana, two GWCL external partners, and one consultant of USAID who was working on public utility digital water innovations in Ghana. These people were selected in order to triangulate evidence sources and because of their explicit knowledge on the subject of digital innovations in the urban water sector.

The interviews were designed around issues identified from the literature: the type and nature of technology implemented, drivers of implementation, issues around value created, and broader impacts associated with digitalisation and datafication. Due to Covid-19 restrictions, interviews were conducted online using Microsoft Teams and Zoom or via phone calls. All interviews were conducted in English and they were of 30–50 minutes’ duration. Interviews were audio-recorded, or the researcher took handwritten notes where respondents were not comfortable with recording. Company reports were sourced from GWCL and broader policy documents on digital and water in Ghana were downloaded from government, international, civil society and other organisations.

Data from the different sources were transcribed as text, coded and thematically analysed by comparing the different responses in order to identify common trends, themes, similarities and contrasts. Coding and analysis were done using key dimensions highlighted in the literature – particularly value and power – as a starting point. Once new themes emerged, iterations were made and coded as part of a revised coding frame.

4. FINDINGS

4.1 Organisational value and impact of digitalisation

The organisational value of digital water innovations can be analysed in relation to GWCL’s different areas of activity.

*Faults and leakages* of the main water distribution system used to be detected via customer reportage and perhaps field officers. According to a GWCL Engineer, this is still the case for smaller distribution lines and the end-pipes linked to domestic and other user properties. However, main (transmission) boundary pipeline networks of the operational areas in Accra and the larger distribution lines of the network now use a combination of SCADA sensors and telemetry systems to automatically report falls in water pressure or faults, with instant alarm notifications sounding in GWCL’s central control room. When this happens, an instrumentation engineer in the control room can identify the likely location of the problem. In some cases, it can now be resolved remotely or, if a field officer needs to be despatched, they can be directed to the likely location so that fault location and resolution is now more efficient (GWCL Engineer 4). All of this is facilitated by mapping of the network which, as a GWCL Technician explained, has given location IDs to all main elements of the water network including customer locations. In sum, then, digitalisation has been associated with better and faster monitoring, fault location and resolution.

These deployments also offer real-time data for the *day-to-day operation* of water systems. A GWCL Engineer indicated that, “...the SCADA systems and boundaries gives us clear picture on
how much water is going in and out of the three regions: Tema, Accra West and Accra East. This offers a basis on where to ration water to or not on daily basis”. Likewise, a GWCL Meter Technician explained that, “data from Telemetry and SCADA has helped them allocate water and ration water to regions and know how much water is distributed to particular regions”. The digital technologies are therefore allowing a better understanding and intervention in terms of routing and rationing of water in the Company’s different regions of operation.

General billing was reported to be more accurate and faster than previously. Previously, analogue meters might not be present at all or if present might not actually be read – so-called “armchair meter reading” – with the entered number being some mix of guesswork, intuition and experience of the meter readers (GWCL Engineer 1). For large-scale users then usage is recorded automatically: “using bulk meters with sensors has informed us the right amount of water a particular industrial customer uses to enable accurate billing” (GWCL Meter Technician 1). For smaller-scale including domestic consumers, meters are read using handheld devices with an eReader app. This includes the option to take a picture of the meter which can be referred to later in case of any query or challenge to the reading, and it also allows remote co-monitoring of readings by supervisors and middle managers. Although the direct causal link to digital technology is hard to establish it is noted that a marginal increase in billing performance has occurred in recent years with, for example, an increase of 4.2% in 2018 compared to 2017 (GWCL, 2019).

Payment has also been digitalised with the option for customers of mobile and other digital payment channels, linked to the ability of customers to receive their bills digitally via SMS or email (GWCL Regional Officer 1; Amankwaa et al., 2020). Internal cost-benefit analysis indicates that using digital payment channels rather than cash payments saves the company about 10% of the administration cost of collecting and processing bills (DWI Consultant). Linking digital technology to wider impacts is difficult. However, GWCL saw a 14.1% increase in revenue for the year 2018 (GWCL, 2019) and GWCL officials largely attribute this to the introduction of digital billing and payment systems (GWCL Engineer 1).

Finally, customer engagement systems have been digitised with a call centre management system and use of messaging platforms like Telegram and WhatsApp. One indicator of value was that the number of customer complaints at the district level was said to have decreased because of these systems, and rectification time is reported to have also decreased significantly (GWCL District Officer 1; GWCL, 2019).

Looking at the overall pattern, the first finding would be that digital water innovations do appear to be adding value to the operations of this public water utility. But “operations” is the key term. If we look in terms of operational, tactical and strategic levels then almost all of the value to date is being derived in terms of operational decisions and processes. While these may aggregate up to impact organisational performance indicators – perhaps, for example, in terms of operational revenue – there is limited evidence yet of impact on higher-level decisions and processes. For example, we did not yet find an impact on the typical strategic decisions required of water utilities such as risk analysis, infrastructure expansion and development, or corporate reform (MacGillivray et al., 2006; Mugabi et al., 2007; Mutikanga et al., 2011). This concentration of digital value at the lower levels of the organisation may reflect the relative recency of digitalisation. Perhaps linked to this also seems to reflect a lack of understanding in the organisation of the strategic value of the data being generated as a result. As one example, we were unable to identify anyone within GWCL whose role was to process and analyse the new digital data within the organisation and present it to middle and senior managers for their use.

4.2 Powershifts, digital water politics and water governance

The first component of broader impact of digitalisation found was change in some organisational structures and responsibilities. We found that there has been a centralisation of power and focus
around digital in the organisation. A Technology and Innovation Department (T & I) had been expanded and given sole responsibility for overseeing all issues relating to digital transformation within GWCL: not just implementation but also strategic decision-making (GWCL Engineer 2). This integrates a whole series of previous distributed and separate responsibilities, covering three technology-related bodies – the Geographic Information Systems Department, the ICT Department, and the Metering, Instrumentation and Non-Revenue Water Reduction Department – plus the Research unit (GWCL, 2019).

Given the growing role of digital within GWCL, T & I has increasing outreach and connections with the rest of the organisation. Because of the introduction of smart meters, for example, Engineers and officials in the T & I department link out to meter readers and technicians; providing support and running training programmes. Because of the sensor and telemetry systems, they support and train field officers. Because of the growing role of digital in operations, they support and train regional and district managers. These were tasks not previously undertaken and/or not previously centralised in one department being the responsibility of commercial and operations departments in the organisation (GWCL Engineer 1). Where the scope and reach of earlier incarnations would have been restricted largely to corporate headquarters, “T & I managers and officers have now become central points in dealing with most technical field complaints associated with digital technologies such as meter reading” (GWCL Engineer 1). An institutional equivalent of the central control room with its panopticon-style overview of the whole water distribution network, the T & I Department now has a digital overview of the whole organisation, linked through the threads of its digital systems to every part of GWCL and its operations.

The other impact-related finding concerns the powershifs and struggles among actors. Digital water innovations have been associated with some shifts in the locus of power within and outside the utility. First, there has been an upward shift in power to management from operational staff (mainly meter readers and some technicians). Previously, these staff lay largely beyond the direct gaze of management, but this is no longer the case. For instance, middle and even senior managers can now monitor how lower-level staff operate and get data on their performance. Even the Managing Director of the company can now monitor the operational performance of all of meter readers (GWCL Meter Reader 2). A meter reader recounted: “I got my appraisal delayed because my performance information on the system indicated I hadn’t achieved the 100% targets for the past three months. Data about work and our information is everywhere even to the Chief Managers, so there’s no room for shoddy works”. Middle- and senior-level managers have thus gained greater power through their access to and capacity to use digital data as a managerial and epistemic resource within the organisation. Via digital technology, they have been able to cut through organisational layers that previously interceded between top and bottom of the organisation.

Second, there has been a shift of some form of power to private sector actors though this has continuously been contested as part of a historical pattern. This began shortly after the turn of the century when Indian company Aquamet was issued a contract in 2004 to supply, install and collect revenue from prepaid water meters (Shang-Quartey, 2017). Though the digital component of this project was limited, technical faults along with the clash between profit and public welfare logics led to the contract being abandoned. The connection between digital and privatisation continued, however, with a management contract being issued to Aqua Vitens Rand Ltd in 2006. During the five-year period of the contract, the foundations were laid for many of the digitalisations described above including metering and mapping and customer engagement (Abubakari et al., 2013). However, due to human and technical implementation issues, these did not deliver the desired impacts and – driven much more by wider failure to improve water services and conflict between public and private sector culture and objectives – the contract was not renewed when it ended in 2011. These experiences stymied a further attempt in 2014 and 2015 to roll out prepaid meters. Despite this being a GWCL initiative, huge opposition by civil society organisations – shaped by past experiences of private operators and feeling that these meters “contributed to attempts in
privatising ‘public’ water in the country” (Former Civil Society Organisation Coordinator) – led to these initiatives being abandoned.

More recently, implementation of the electronic billing project gave some form of de facto control of the system to a private operator; SOFTtribe. SOFTtribe is a Ghanaian software developing company that was contracted to develop, manage, operate and provide data integration services for GWCL’s e-billing and e-payment systems (DWI Consultant). SOFTtribe’s control over key aspects of the system after about two years led to disagreements on the operationalisation, management and ownership of the system and its related data. This ultimately led to termination of the contract between GWCL and SOFTtribe. This was therefore just the most-recent example of concerns about the way in which private sector deployment of digital systems has led to a loss of power and control from public to private sectors. This shift has derived from the power of the rights, processes and resources including data and knowledge that are bound up into digital systems; those powers increasing as digitalisation spreads within the organisation.

A third potential power shift could be between the public utility and its customers. When asked how customers are represented in the digital water value chain, GWCL engineers and meter readers held the view that technologies such as smart meters offer customers elements of greater operational transparency and service benefits. For example, smart meters enable customers to just pay for “what they consume” and afford them the data resources necessary for them to monitor and challenge water bills (GWCL Meter Reader 3). But conversely, customers and their actions become more transparent to GWCL, with the Company now knowing locations, accurate usage levels and more about their customers.

5. DISCUSSION AND CONCLUSIONS

In this study, our overall interest was to understand the impact of water service digitalisation on water service providers in the global South. We focused on a public utility to understand how digitalisation and datafication impact the water service governance and management. Two core findings emerged which forms the basis for discussion. First, the impact of digital water innovations is not yet transformative: they have had limited impact in more strategic terms but are already delivering value at the operational level. Second, digital technologies present new avenues for power shifts and struggles between and within organisations as well as changes in organisational structures and responsibilities in water governance.

A few years into implementation of a programme of digital transformation, we found that value from digital systems was emerging slowly within GWCL and may be making some contribution to a few organisational goals. While some literature assumes that digital water systems will be applied to strategic and outward-facing purposes (Antzoulatos et al., 2020), in GWCL they were rather focused on operational level activities and decisions such as using technologies for accurate meter reading, pipeline monitoring, and producing real-time data for the day-to-day operation of water systems. We found some potential evidence of financial value, with the internal estimate of 10% cost savings in relation to the billing and payment systems. It is beyond the scope of this study to undertake cost-benefit analysis but there is potential that digital systems may make a positive contribution to the financial bottom line, particularly as growing numbers of customers adopt digital payment. Studies have reported similar benefits in the global North (Beal & Flynn, 2015; March et al., 2017). However, literature on actual benefits in global South water systems is very limited, and our findings therefore provide a first set of systematic, real-world evidence on the organisational value of digital water innovations.

Aside from these operational-level impacts, digital technologies have not yet been transformative as there is little sign of value at the strategic level and in terms of organisation-wide performance indicators. One indicator of this was the lack of strategic value extraction from the great deal of data now being generated by GWCL’s new digital systems. Overall, therefore, this study questions the
narrative of “digital water transformation” (Alabi et al., 2019; Hoolohan et al., 2021) and instead highlights the much more incremental value being delivered by digital water systems.

Within the digital water literature, there are arguments that digitalisation is associated with a reconfiguration of the relationships and power relations between stakeholders in the water sector (Guma et al., 2019; Hoolohan et al., 2021). Evidence from our study emerged to not only confirm the existence of such reconfigurations but also to provide a first clear mapping of them in a global South context. For instance, it emerged that, internally, digital systems have brought about changes in organisational structures and responsibilities in water governance. Contrary to the findings of earlier literature (Owen, 2018; Sarni et al., 2019), we found that – rather than automating human labour – the focus of those interviewed was the way in which digital systems increased the workload of some utility workforce especially those at the forefront of digital operations. As digitalisation introduces new equipment and new systems to the water sector, the emphasis here – as predicted by Wallis & Johnson (2020) – has been a need to employ new expertise and talent.

The rationality and automation associated with digital systems might suggest they could eliminate or reduce power struggles. The findings suggest the opposite, however: that these technologies have been associated with and even triggered power shifts and struggles within GWCL and with external partners such as Aquamet and SOFTtribe. Internally, these relate to the power provided by digital data and the transparency of actors and actions this provides. Externally, that some power leads to conflict over data systems ownership and control. The findings are in line with those of earlier literature which links digital water systems to shifts in power from public to private sector (Taylor & Richter, 2017), and to similar findings in other public utilities (Heeks et al., 2021).

Alongside the power dynamics and shifts we have seen associated with digital water systems, there are wider questions about who is empowered or excluded by these powershifts and struggles. In our study, we found that central management and certain central departments (e.g., T & I) within the company seem to have epistemic control over different aspects of the digital water system. Internally, then, digital systems have provided central management and supervisors with direct monitoring and epistemic control over the activities of some field and other lower-level staff. The latter have thus been disempowered in relative terms. While it did not explicitly emerge from interviews, the centralisation and relative empowerment of the T & I Department is likely to lead to tensions with other departments about who leads new digital initiatives and who controls digital systems and their related powers.

This discussion reinforces previous analyses that suggest digital infrastructures and technologies perform (power-related) political work with important consequences for water governance (von Schnitzler, 2016; Guma et al., 2019; Hoolohan et al., 2021). Insights into the power relations and digital water politics are important for the design, implementation, and governance of digital systems and water services. Therefore, the analysis here will be vital for understanding how digitalisation and datafiication transform, reproduce and reconfigure relations, power dynamics and knowledge systems within the water sector.

5.1 Conclusions

This paper has provided real-world case evidence and empirical insights into the impacts and implications associated with water service digitalisation in the global South. It has also responded to recent calls by scholars like Hoolohan et al. (2021) and Amankwaa et al. (in review) on the need for systematic examination of the impacts of digital water innovations within a wider socio-technical and social political lens. Both water researchers and practitioners need to recognise both the value and political impacts of digital water innovations. For researchers, more work on these issues is required including analysis of digital systems over time; for example, to see if they start to have more strategic and transformative impacts within water service providers, and externally to understand more fully the way that digital impacts power balances and relations with external
stakeholders including customers. Water service providers need to understand the “value gap” between the impact digital systems could have and what they currently have; for example, seeking more ways to extract strategic value from the datafication these systems enable. They need to grasp the politics of digital; seeing that these systems cannot simply be understood in technocratic terms, and particularly understanding how digital may change the relationship with their customers. There is the need, for example, more inclusive models of water management that could be applied to the growing diffusion of digital water systems; models that consider the everyday realities of end-users in global South cities.

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ICT USE AND LIVELIHOODS OF WOMEN MICROENTERPRISES IN MALAWI

Donald Flywell Malanga, University of Livingstonia, dmalanga@unilia.ac.mw
Memory Banda, University of Livingstonia, mbanda@unilia.ac.mw

Abstract: This study aimed to assess the impacts of ICTs on livelihoods of women microenterprises in Malawi. The study was an interpretive qualitative approach in which semi-structured interviews, observation and field notes were used to collect data. About 25 women involved in various microenterprises in three rural areas of Karonga district in Malawi were purposively selected to participate in the study. The framework for the study was based on Serrat’s sustainable livelihood approach. The study noted that the use of ICTs potentially enabled women microenterprises to build their financial, human, social, and informational capital assets. The study found that ICTs to some extent contributed to the livelihoods of women microenterprises such as improved access to information; diversification of business opportunities, improved communication, improved marketing, and reduced transport costs. As a result, this led to sustainable use of resources, improved well-being, and empowerment for women. However, unreliable electricity; lack of affordable ICT devices; lack of awareness to utilise ICTs in businesses and lack of ICT literacy skills were major concerns that affected women microenterprises. The study offers insights to research practitioners, policy makers and other stakeholders on the role of ICTs in fostering women microentrepreneurship in rural communities of Malawi.

Keywords: ICTs, women microentrepreneurship, livelihoods, women microenterprises, Malawi, developing country, Africa

1. INTRODUCTION

Empowering women through microenterprises in developing countries is considered a vital issue for socio-economic development (Osman, Malanga & Chigona, 2019b; Makoza & Chigona, 2012). A recent global study on entrepreneurship found that women are the majority among the upcoming microenterprise owners in the developing world (Azerbaijan, 2016). For instance, in Sub-Saharan Africa, the female-to-male microenterprise ratio is very high in comparison with North Africa and the Middle East (Kelly, et al., 2016). Women are far more likely to be in self-employment as opposed to being employers or wage workers. Further, women entrepreneurs are more likely than men to be in services and in traditional lower value added sectors such as food processing, and garments (Qureshi & Xiong, 2017). Women are also less likely to register their business than men (Hallward-Driemeier, 2011). This gender disparities in microenterprises underscore for more investment and diversified women microentrepreneurship (Osman, Chigona & Malanga, 2019a). This is because such microenterprises arguably create incomes, jobs, skill development, alleviate poverty, and eventually crucial agents of change in the informal economy (Afrah & Fabiha, 2017).

Microenterprises are simply described as businesses owned by less than five employees (Kelly, et al., 2016; Abor & Quartey, 2010). They are characterised as being informal, survivalist, low revenue, no business records, and have no clear separation of business and personal finances (Makoza &
Chigona, 2011). However, studies also indicate that the majority of women engaged in such microentrepreneurship face a number of setbacks such as limited resources, capacity and access support (Adams, 2012).

The situation is further exacerbated by cultural norms and values, high women reproductive workload and children concerns, and low education levels (Lwoga & Chigona, 2020). Further, the repressive laws and customs rooted in cultural beliefs make women's ability to manage property and conduct business hindered, and sometimes they cannot travel without their husbands’ consent, thus making women microenterprise chances of survival limited (Qureshi & Xiong, 2017).

Prior studies suggest that as Information and Communication Technologies (ICTs) continue to diffuse, and greater attempts are made to apply them to microenterprises to enhance rural-poverty reduction agenda (Makoza & Chigona, 2012; Duncombe & Heeks, 2005). In this study, ICTs are defined as electronic means of capturing, processing, storing and communicating information. These may include modern digital ICTs (such as internet, computers, social media, and mobile phones, etc.) and tradition ICTs such as radios, televisions (TVs), and landline telephones (Duncombe & Heeks, 2005).

In comparison to the developed world, few microenterprises in developing countries have direct access to modern digital ICTs. The majority of women microenterprises possess traditional ICTs such as radios, with limited access to personal landline phones and television due to high cost (Qureshi & Xiong, 2017; Duncombe, 2006). However, since the majority of women microenterprises operate in rural areas, application of ICTs into their businesses could potentially address some of the problems (Osman, et al., 2019b; Sife et al., 2017). In this regard, ICTs such as mobile phones, social media, internet, traditional radios and TVs etc can potentially support the livelihoods of women microenterprises through increased labour productivity, increased income, better communication, and better access to information and reduced costs (Osman et al., 2019b; Good & Qureshi, 2009).

In Africa, studies have found that use of ICTs in microenterprises assist in reducing information failures that impact on investment decisions and business activities (Esselaar, Stock, Ndawalana &Deen-Swarry, 2007; Duncombe &Heeks, 2005). Besides, studies have shown that women that adopt ICTs such as mobile phones in their business activities, more often, are able to keep in contact with customers and clients compared to any other form of communication (Esselaar et al., 2007). On the other hand, full optimal use of ICTs in women microenterprises is beset by myriad challenges. These include low education, lack of access to financial credit, lack of access to markets, lack of ICT skills for use in business, repressive cultural norms, lack of access to affordable ICTs such as smartphones (Qureshi & Xiong, 2017; Charman, 2016).

In Malawi, anecdotal reports suggest that the number of women using ICTs in their business activities is burgeoning. However, there is paucity of empirical studies on the impact of ICTs on the livelihoods of women microenterprises in the country. The majority of studies available have focused much on adoption of ICTs by small and medium enterprises (SMEs), and has paid little attention to microenterprises (Makoza & Chigona, 2012). Due to uniqueness of women microenterprises, the findings reported from such SMEs studies cannot be generalized to microenterprises, particularly for those owned by women. Moreover, studies focusing on adoption of ICTs by SMEs alone have been critised for being limited in scope because they do not take into account human development aspects such as livelihoods (Osman et al., 2019a; Makoza, 2011), which was the main objective of this study. To bridge this knowledge, the main research question posed for the study was: How do ICTs impact on the livelihoods of rural women microenterprises in Malawi? The study aimed to answer the following four sub-questions:

- How do ICTs help women microenterprises deal with vulnerabilities?
• How do women microenterprises use ICTs to strengthen utilisation of their capital assets?
• How do ICTs strengthen the livelihood structures of women microenterprises?
• What are the effects of ICTs on livelihood outcomes of women microenterprises?

To address these questions, the study was guided by sustainable livelihood approach (SLA) (Serrat, 2017) as a theoretical lens. The paper is arranged according to the following sections: background to the study, analytical framework, methodology, results and discussion, and conclusion.

2. BACKGROUND TO THE STUDY
Malawi gained its independence from Great Britain in 1964. It borders Tanzania, Zambia and Mozambique. The country has an estimated population of 17.7 million people of which 85% live in rural areas (National Statistics Office, 2015). It is classified as one of the least developed countries in the world with a Gross Domestic Capital per Capita is USD 516.80 (FinMark Trust & Genesis Analytics, 2019). Most women are working in agricultural sector which is a backbone of Malawi’s economy. Of those in non-agricultural waged employment, 21% are women and 79% are men and the numbers have remained the same over the years (National Statistics Office, 2015). The root causes points to culture, unequal power relations between men and women, which ensure male dominance over women. The unequal status of women is further exacerbated by poverty and discriminatory treatment in the family and public life (Spotlight Initiative, 2020). The country faces many challenges such as food security, high rates of unemployment, impact of HIV/AIDS, high illiteracy levels, and extreme poverty (National Statistics Office, 2015). The overall mobile penetration is estimated at 45.5%, while internet is 6.5% below the recommended threshold of 19% by International Telecommunication Union (Malanga & Chigona, 2018; Malanga, 2017). About 34.5% of women own a mobile phone, 0.6% own a desktop computer, 1.8% own a Laptop, while just 4.7 % of them have access to the internet (Malanga & Chigona, 2018). The low rate of ICT penetration in Malawi is attributed to the country’s weak economy, high value added tax (VAT) imposed on importation of ICT gadgets and other contextual factors (Malanga & Kamanga, 2019).

2.1 State of microenterprises in Malawi
The Malawi government has long recognised the role of SMEs play in socio-economic development. This was evidenced by passing a Small and Medium Enterprises (SMEs) policy in 1998, which was later revised in 2018 to include microenterprises (FinMark Trust & Genesis Analytics, 2019). In Malawi context, microenterprise is defined as business with less than four employees (Darroll, 2012). Literature indicates that the number of people especially women who cannot find formal employment in the country, find themselves in microenterprises as alternative means to support their livelihoods (Makoza & Chigona, 2012).

Recent study report by FinScope (2019) estimates that about 59% of microenterprises are individual entrepreneurs who are not employers. While the remaining 41% generate employment. Further, 87% of microenterprises are retailers while the remaining 13% render professional and skilled services. Based on location, 85% of microenterprises are located in rural areas and 15 % are located in urban areas. The study further reports that in Malawi, 54% of microenterprises are owned by males while 46% are owned by females. Consistent with previous studies, more males in Malawi are likely to run large businesses, while women are more likely to be individual entrepreneurs (Porter et al., 2020; Makoza & Chigona, 2012).

Despite the benefits associated with microenterprises in the country, their survival is curtailed by a number of setbacks. The challenges stem from limited access to finance, limited access to information, limited access to ICTs, limited access to technologies, inadequate infrastructure and utilities, and lack of business networking (FinMark Trust & Genesis Analytics, 2019; Makoza & Chigona, 2011).
2.2 Formal support institutions for microenterprise in Malawi

Despite the challenges facing SMEs in the country including women microenterprises, Malawi government has been spearheading the establishment of various formal support institutions (FinScope, 2019). Some of the notable ones include Pride Africa, Small and Medium Enterprise Development Institute (SMEDI), Youth Enterprise Development Fund (YEDF), Malawi Confederation of Chambers of Commerce and Industry (MCCCI) (FinScope, 2019). Examples of support programmes and services include business skills training, mentoring, access to credits, loans, business management, etc (Malanga & Kamanga, 2019; Makoza & Chigona, 2011).

3. ANALYTICAL FRAMEWORK

The study was guided by sustainable livelihood approach (SLA) postulated by Department for International Development (DFID) in 2000, and operationalised further by Serrat (2017). The SLA is widely used in the field of development, and increasingly in the context of ICTs based development initiatives (Chilimo & Ngulube, 2011). The use of SLA in this study was useful because bridging the rural-urban digital inequality is not merely about increasing the number of ICTs access and affordability, but it is also about impacting the lives of people such as women microenterprises, and empowering them through ICTs (Serrat, 2017; Sife et al., 2017).

3.1 Concepts of sustainable livelihood approach

The SLA consists of a number of elements which are used to holistically analyse the link between issues and activities within the livelihood. These include vulnerabilities, assets, structures (social relations, organisation and institutions), strategies and outcomes. Figure 1 illustrates the interactions between the various elements of SLA.

![Figure 1: sustainable livelihood framework (Serrat, 2017)](image)

3.1.1. Vulnerability context

Vulnerability is characterised as insecurity in the well-being of individuals, households, and communities in the face of changes in their external environment (DFID, 2000). In this regard, vulnerabilities are simply defined as external factors affecting people’s livelihoods, which lead to hardship (Duncombe, 2006). Vulnerabilities take three forms, namely stress, shocks and seasonality. Stress are long term trends that affect people, such as conflicts, declining natural resources, climate change and social exclusion. Shocks are conditions or events that are sudden and unpredictable, such as epidemics and natural disasters. Seasonality refers to changes in price of commodities and shifting of employment opportunities (Serrat, 2017).
3.1. 2. Capital assets
Capital assets are resources that households have access to and use them to produce goods or services as a means of sustaining their lives. Increased access to assets may lead to more sustainable livelihoods (Chilimo & Ngulube, 2011). There are various forms of assets and they include: (i) Human capital: the knowledge and skills that people have and use to achieve sustainable livelihoods. (ii) Social capital: these include social relations, membership to organisations. (iii) Natural capital: they include land, water, wildlife and biodiversity. (iv) Financial capital: Financial capitals are resources that can be used to establish livelihood activities such as savings, cash and access to loans. (v) Physical capital: resources created through the economic production process e.g. roads, power lines and supplies (Sife et al., 2017).

3.1.3. Transforming structures and processes
Structures are the public and private organisations and institutions that facilitate the attainment and use of capital assets through implementation of policy and legislation, delivery of services that affect the livelihoods (Serrat, 2017). Examples of organisations and institutions are Government Departments, Non-governmental Organisations (NGOs) and Community Based Organizations (CBOs) that deliver services for livelihood to communities including microenterprises owned by women. Processes embrace the laws, regulations, policies, operational arrangements, agreements and societal norms that in turn determine the way in which the structures operate (Serrat, 2017; Chilimo & Ngulube, 2011).

3.1.4. Livelihood strategies and outcomes
Strategies are activities that generate a means to achieve sustainable livelihood. Strategies can be implemented by the household in the form of economic activities, or by the institution coming up with interventions that affects the livelihood of households. These strategies may change all the time to respond to the factors affecting livelihoods (Qureshi & Xiong, 2017). Livelihood outcomes are the results of applying livelihood strategies and use of capital assets. They include increased wellbeing, reduced vulnerability, improved food security, recovered human dignity and more sustainable use of resources (Chilimo & Ngulube, 2011). Besides, livelihood outcomes may further lead long term changes that involve determining the extent to which ICTs can support to mitigate the vulnerabilities and expand or diversify the existing activities of microenterprises (Serrat, 2017).

4. METHODOLOGY
4.1 Research approach
This study adopted a qualitative interpretive philosophical approach. Interpretivism assumes that human beings as social beings are different from physical phenomena because they create meanings that stem from multiple realities (Sanders, Lewis & Thornhill, 2014). Because of the context nature of the study, interpretive approach was adopted to help create new and richer understanding on the meanings that women attached to use of ICTs in their business activities. We employed a multi-case study design (Creswell, 2014). The use of multi-case study helped the researchers to explore in depth and understand the behavioural conditions that women operated their microenterprises on those selected case study areas (Creswell, 2014).

About 25 microenterprises owned by women were targeted and sampled purposively at Uliwa, Nyugwe, and Mlare rural areas of Karonga district in Malawi. Women were targeted from these rural communities because of their high involvement in various business activities aimed at improving their livelihoods and well-being. Semi-structured interviews, filed notes, and observation were used to gather data for the study. These data collection instruments accorded the researchers the opportunity for immediate response from participants and the opportunity to ask immediate follow-up questions (Kumar, 2011). Questions asked to research participants were based on existing
literature (Mbuyisa, 2017; Makoza, 2011; Chilimo, 2008), and were adapted to suite the context of the present study.

4.2 Site Selection: Karonga district
This study was conducted in three selected rural areas situated south of Karonga district: Uliwa, Nyungwe, and Mlare under Traditional Authorities Mwirang’ombe and Wasambo respectively. All these selected areas are situated along the Mzuzu city to Karonga M1 road. The tar marked road provides means of transports and connect women microentrepreneurs from rural markets to markets main townships of Karonga district and the Mzuzu city respectively (MDHS, 2018).

Karonga district is situated 220km North of Mzuzu city and 50km south of Songwe border with Tanzania (Malanga & Kamanga, 2019). It has a population of 365,028 representing 1.3% of the country’s population. Women accounts for 51.7% of the population. Number of households is estimated at 74,953 in the district (MDHS, 2018). The majority of women are involved in subsistence agricultural activities as their main source of household livelihoods. Household ownership includes TVs, radios, landline, satellite dishes, mobile phones, computers and refrigerators, etc (Malawi Demographic and Health Survey [MDHS], 2018).

4.3 Case selection criteria
In terms of selecting the cases, we adapted the criteria postulated by Qureshi and Xiong (2017). The authors suggest a number of criteria that should be taken into consideration when selecting microenterprises as unit of analysis. As indicated in Table 1, we employed similar variables to select research participants for this study.

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing challenge</td>
<td>The microenterprise is facing challenges in operation such as lack knowledge, lack of resources, and lack of skills</td>
</tr>
<tr>
<td>Target</td>
<td>Microenterprise should be owned by a woman/female</td>
</tr>
<tr>
<td>Potentiality</td>
<td>The microenterprise should:</td>
</tr>
<tr>
<td></td>
<td>a. have a business potential to grow and expand her business by usage of ICTs</td>
</tr>
<tr>
<td></td>
<td>b. have enough funds to invest in ICTs</td>
</tr>
<tr>
<td></td>
<td>c. desire to gain access to new markets</td>
</tr>
<tr>
<td>Ownership</td>
<td>The ownership of a microenterprise should be sole proprietorship or partnership</td>
</tr>
<tr>
<td>Scale of the business</td>
<td>The microenterprise should follow the criteria of the general definition of employing less than five employees based on developing countries context</td>
</tr>
<tr>
<td>Years of operation</td>
<td>The microenterprise should exist for more than one year, so that endogenous variables lead to the challenge, e.g., lack of cash flow.</td>
</tr>
<tr>
<td>Geographical location</td>
<td>The microenterprise should be situated in a local or rural setting</td>
</tr>
</tbody>
</table>

Table 1: Case selection criteria adapted from Qureshi and Xiong (2017)

4.4 Research ethics
Permission to conduct the study was obtained from the individual research participants. Research participants were informed that their involvement in the study was voluntary. To ensure that participants’ privacy and confidentiality are protected, all recordings and transcripts were stored securely. Pseudonyms were used to protect their identities. In addition, oral consent was also obtained from their village leaders.

4.4 Data collection and analysis
Thematic analysis was used to analyse the data collected from this study. We used a codebook and smartphone to record the interviews. The codebook was developed based on SLA that guided this study. Thematic analysis was used due to its ability to condense important attributes of large amounts of data, recognize, and analyse patterns of significance and meaning in a data set (Braun &
Clarke, 2006). Thematic analysis was also used because of the ability to describe the themes and produce a report and other additional advantages (Braun & Clarke, 2006). First, we familiarised ourselves with data, generated initial codes, searched for themes based on SLA, reviewed the themes, defined and named the themes, and finally produced the report (Braun & Clarke, 2006). This was an iterative process which involved so many changes. Data was collected between 30th June and 4th August, 2020. Each interview was transcribed into a Microsoft Word document to simplify the process of analysing the data with the aim of identifying themes.

5. RESULTS AND DISCUSSION

5.1 Characteristics of research participants

In terms of demographic characteristics of participants, the findings showed that majority of respondents (56.1% or 14) were aged between 26-35, more respondents’ business ownership was proprietorship (92.3% or 23) compared to business partnership (8.0% or 2) The results also revealed that more than half of research participants (68.2% or 17) had basic primary education, followed by 44.3% or 11 of those who were married, while 36.0% or 9 were single. In terms of semi-annual income level, 60.3% or 15 of respondents earned below 100,000 Malawi Kwacha, while few respondents (8.0% or 2) earned more than 200,001 Malawi Kwacha ($1=Mwk850). Further, the results indicated that 32.3% or 8 of respondents were from Uliwa, 40.0% or 10 were from Mlare, and 28.0% or 7 situated at Nyungwe. With respect to number of years microenterprises were in operation, the results indicated that at least half (52.3% or 13) of microenterprises were in operation between 1-5 years.

5.3 ICTs and vulnerability context

SLA views people as operating in a context of vulnerability. Information on vulnerabilities can be communicated or accessed using ICTs (Makoza, 2011). In this study, it was revealed that the major sources of vulnerability were unemployment, remoteness, price fluctuations, drought, food insecurity, and migration of clients to urban areas. In addition, operating costs, security and inadequate business skills were also identified as internal setbacks affecting their business activities.

“You know, I sell Maize as my business, and being a subsistence business based in rural areas, the number of people who can buy your products is very small. Again, our area receives sometimes little rainfall, and this make the yield very small. As a result, the prices changes regularly affecting the growth our business” (Resp-17). The findings from this study were confirmed with prior studies (Qureshi & Xiong, 2017; Duncombe & Heeks, 2005).

Participants acknowledged that ICTs such as mobile phones and social media helped them deal with family emergencies such as death, injury, or other health issues by calling relatives or close friends. ICTs in this case, facilitated women with information and communication about the vulnerabilities in their business activities. “I use my phone to communicate with my family during emergencies or sometimes when I get sick. “Listening to radios or watching television helps us to understand the weather or the season of the year. This type of information helps us to prepare in advance the type of business activities we need to venture into or forgone” (Resp-12). However, in this study it was noted that information provided by ICTs were not able to mitigate and prevent all the vulnerabilities that women encountered in their businesses. For instance, it was difficult for ICTs to deal with seasonal price fluctuations, unemployment, and migration of clients to urban areas. Hence, ICTs only provided information to women and helped them to diversify or expand their businesses and sources of income (Osman et al., 2019b; Mbuyisa, 2017; Makoza & Chigona, 2012).

5.4 ICTs and utilisation of capital assets

5.4.1 Human asset: The study found the majority women did not have business skills before starting their businesses, but rather acquired their skills through informal training through family friends, business workmates, and co-workers. Such prerequisite knowledge and skills developed with time.
for operating in their businesses. With respect to use of ICTs for business knowledge acquisition, the results found a limited impact. This is what a restaurateur had to comment: “Of course, my phone has both internet and WhatsApp facilities, but I do not know how to use them for my business because I do not have skills. I just know how to make calls to my clients and suppliers” (Resp-10). The findings were consistent with prior study that found no evidence to demonstrate that ICTs were used to acquire business skills for microenterprise in South Africa (Osman, et al., 2019a; Makoza & Chigona, 2012).

### 5.4.2 Social asset
Research participants acknowledged that they belonged to informal social groups such as local village banks, women business clubs, and family business social support. Very few of them belonged to formal organisations such as microloan finances. The problem of not belonging to formal organisations was due to lack of awareness. Other participants indicated that their businesses were not registered, therefore there was no need to belong to such formal support organisations. “Those institutions demand that your business must be registered to join them. My business is not registered, there I don’t see any importance of joining them” (Resp-10, 6, 1). Previous studies have echoed similar sentiments that the majority of microenterprises owned by women operate informally and largely belong to informal organisations operating within their localities (Morrison, et al. 2019; Chilimo & Ngulube, 2011). It was further noted that ICTs such mobile phones and social media helped women connect to informal social networks such village banks and women business clubs. ICTs also helped them access to information on prices of commodities, keep supplier information, and client information. “Mobile phones and WhatsApp help me to communicate with my business customers and suppliers faster than before. I also use these gadgets to communicate with business friends in our group to share business opportunities” (Resp-7, 25). This was in line with prior studies that have reported similar findings (Osman et al., 2019b; Lwoga & Chigona, 2020).

### 5.4.3 Financial asset
Makoza and Chigona (2012) note that financial capital for start-up or business expansion remains a big challenge for microenterprise in developing countries. The findings revealed that participants used their savings, self-financing and re-investment of returns to finance their business. Only a few of them indicated that they had access to informal financial services such as local village banks. Lack of awareness of sources of funding, high interest rates, lack of collateral security were major reasons women could not bother themselves to look for formal financial credit. However, it also emerged that mobile phones helped some women to expand their business through mobile money services. Others indicated that mobile banking helped to save cost such as transport, thereby increasing their income. Similar findings by Chilimo and Ngulube (2011) who found that rural people in Tanzania were using mobile phones to conduct bank transactions, pay suppliers through mobile money and mobile banking.

### 5.4.4 Physical asset
The study found that women needed stable electricity, affordable transport, availability of cheap ICT devices and services such as reduced air time, smartphones, and internet bundles. It was further revealed that apart from physical resources, women stated that they need cheap, timely and relevant information resources required for operating their businesses. Respondents viewed information needs related to business financing, marketing, and promotion and supplier information were needed most. In this regard, participants acknowledged that ICTs such as mobile phones helped them to source supplier information, advertise their products on social media connected to smartphones, store information their customers such as contacts and addresses (Mbuyisa, 2017). It was therefore, evident that ICTs played a limited role on physical assets of women microenterprises. However, what was clear was that there was a need to improve the ICT infrastructure such as establishment of telecentres in rural communities, improve road network and affordable electricity through rural electrification programmes (Qureshi & Xiong, 2017).
5.4.5 Natural asset: The study showed that a large number of women did not own natural assets. This is because they were involved in retail business only. Consequently, use of ICTs had little or no impacts to support both physical and natural assets of women microenterprises. Based on the overall impact of ICTs on strengthening the capital assets of microenterprise, the study showed that capital assets are dependent on each other. For instance, increasing the use of ICTs on human capital assets has an impact on financial assets and vice versa. Therefore, increasing use of ICTs on capital assets of women entrepreneurship should always be taken as a systemic approach (Mbuyisa, 2017).

5.5 ICTs and livelihood structures
The study found that the majority of participants were not aware of such formal support institutions, let alone the policies and regulations that affect their businesses. Only a few of them were aware of policies related to district councils involved in collecting their business operating taxes, SIM registration, and mobile money regulations. These findings were consistent with previous studies (Malanga & Kamanga, 2019; Sife et al., 2017).

It also emerged that women interacted with informal organisations such as village banks, women business clubs operating in their localities. The participants indicated that formal support demanded registration of their businesses. Therefore, participants viewed such formal support organisations difficult and not important to their businesses. “I rarely interact with such organisations because I just think they need a business which is registered and has a lot of operating capital. Yet, my business is very small and this is why I am failing to register it” (Resp-9, 18). The findings were consistent with earlier studies (Osman et al., 2019b; Donner & Escobari, 2010). It was also observed that mobile phones and WhatsApp facilitated social and business communication with informal social groups. However, it also emerged that some respondents were reluctant to join informal business social groups due to their culture and jealous from their husbands. “I have a phone and WhatsApp where I am keeping all contact members in our village bank, do not have problem when we want to meet or share some business information. The only challenge that sometimes I face is that WhatsApp bundle and airtime costs are too high. In addition, as marriage woman, sometimes our husband gives us limits when to use phones” (Resp-14, 17).

5.6 Effects of ICT on livelihood outcomes
It was revealed that women used mobile banking and mobile payments to diversify their business activities. “when I found that TNM mobile money is business opportunity, I went to the operator and registered it. Now it is complementing my business. I get monthly incomeinform of commissions. So, now I have two business complementing each other” (Resp-3,8,11). The study found that ICTs increased business earnings through higher income, improved productivity, improved communication, reduction in cost of transport and time. Besides, the study found that ICTs helped women microenterprises towards greater market participation and diversification to high-value business. Similar studies have found that use of ICTs such as mobile phones and internet provide information that help microenterprises to effective use of assets and structures leading to better livelihood outcomes (Osman et al., 2019a; Sife et al., 2017).

6. CONCLUSION
The main purpose of the study was to understand the contribution of ICTs to support the livelihoods of microenterprises owned by rural women in Karonga district of northern Malawi. First, the study found that ICTs increased financial capital through branchless banking services of women microenterprises. Mobile banking and mobile money channels available in rural areas provided low cost access and remittance facilities for women microenterprise. This further helped women to diversify and expand their business activities.

Second, Women microenterprises were able to use ICTs such as mobile phones to build their informal business social network groups that strengthened their social, political, and cultural capital assets (Afrah & Fabiha, 2017). ICTs provided women microenterprise with key information and
communication channels to support the value chain of their business in rural informal economy. For instance, women microenterprise owners, used mobile phones to access information on prices, buyers and sellers in the local markets and beyond. Furthermore, mobile phones helped women microenterprises to reduce the cost of transactions associated with exchange of information relevant to their business activities. In this regard, dependence on natural or physical capital assets such as roads and transport was reduced. Thus, minimized the travel, administrative and operational costs (Lwoga & Chigona, 2020).

Fourth, the paper found that use of ICTs such as mobile phones enabled women microenterprises increase income revenue and profits; expanding more business opportunities; access to market prices and market information; less dependence on natural/physical capital assets and reduction of risks. Thus, ICTs improved food security at household levels, improved well-being, business growth, productivity, empowerment of women (Noruwana et al., 2018; Mbuyisa, 2017). However, ICT infrastructural, environmental, cultural, personal factors restricted full realisation of livelihood outcomes of the sampled women microenterprises.

Therefore, the findings from this study have both theoretical and policy implications. The use of SLA as an analytical framework, provided empirical evidence on the significant role ICTs play on the livelihoods of women microenterprises in rural setting of a developing country. There is need to improve the ICT infrastructure such as telecentres in rural areas, supported with ICT literacy and business skill programmes tailor-made for women microenterprises. Government should explore alternative sources of power such as solar energy in rural areas. There is need to increase awareness of formal organisations that support SMEs including women microenterprises in the informal sectors. Government should incentivise women microenterprises by offering them free business registration. This will help them gain more access to formal support organisations in the country particularly those that support business management and financing (Lwoga & Chigona, 2020; Sife et al., 2017). The study also has some limitations. Since this study only targeted women microenterprises in one district, it is recommended that similar studies with bigger sample size should be replicated to other parts of the country. Similar studies may employ mixed methods to gain more insights into the study phenomenon. Overall, this study has demonstrated that use of ICTs in microenterprises owned by women vary according to their needs, capacities and opportunities. ICTs can contribute to the business growth, reduction of risks, strengthening capital assets, and improved livelihood outcomes of women microenterprises in different ways. Therefore, developing ICT strategies and tools for enabling women microenterprises to grow must be tailor-based on their business category and the environmental context in which they operate.

REFERENCES AND CITATIONS


DIGITAL GLOBAL PUBLIC GOODS

Johan Ivar Sæbø, University of Oslo, johansa@ifi.uio.no
Brian Nicholson, University of Manchester, brian.nicholson@manchester.ac.uk
Petter Nielsen, University of Oslo, pnielsen@ifi.uio.no
Sundeep Sahay, University of Oslo, sundeeps@ifi.uio.no

Abstract: The purpose of this paper is to define and conceptualize digital global public goods (DGPgs) and illustrate the importance of contextual relevance in ICT4D projects. Recent studies have examined the importance of digital artefacts with public goods traits, emphasizing the significant potential for socio-economic development. However, we know little about the theoretical and practical dimensions of how we can align the public goods traits of such artefacts to create relevance in the context they are implemented. To address this gap we review the literature firstly to develop a definition and conceptual basis of DGPgs and then to illustrate the importance of relevance: how to align DGPgs with context to meet local needs. The illustration draws from a case study of the District Health Information systems (DHIS2). The paper advances both the theoretical and practical understanding of DGPgs in development processes.

Keywords: public goods, digital public goods, global public goods

1. INTRODUCTION

National socio-economic development processes are becoming increasingly intertwined with digital technologies. Digital technologies are flexible and multipurpose by being reprogrammable and based on combinable and reusable components. They are standard based to handle a variety of digital contents and to allow innovation by the many. Many low and lower middle-income countries (LLMICs) have positioned the digital at the center of their reform agendas (Heeks, 2020). In the increasingly complex and interconnected development landscape, digital public goods (DGPgs) are being positioned as the core platform on which to build the digital solutions upon. The UN Secretary-General’s High-level Roadmap for Digital Cooperation defines digital public goods as “open-source software, open data, open artificial intelligence models, open standards and open content that adhere to privacy and other applicable international and domestic laws, standards and best practices and do no harm” (United Nations, 2020, p. 35). The same report states that “digital public goods are essential in unlocking the full potential of digital technologies and data to attain the Sustainable Development Goals, in particular for low- and middle-income countries” (United Nations, 2020, p. 8). A range of associated organizations and initiatives adopt similar definitions, sometimes with a specific normative addition that DPGs should help attain the Sustainable Development Goals (SDGs). One such organization is the Digital Public Goods Alliance, a multi-stakeholder initiative to provide a one-stop-shop on information about DPGs. Digital Square, another such multi-stakeholder initiative, seeks to be a “marketplace” of DPGs for health as “investment opportunities” for global health organizations. These initiatives are influential in setting priorities for digital technologies in international development and raising concerns around ethics, development agendas and funding concerns.

A limitation of the above definitions relates to the simplistic tendency to equate free and open source software with DPG status, which we argue over-emphasizes the production side of the DPG, including the processes of design, development and distribution, whilst not paying adequate...
attention to the demand side and how the DPG meets local needs. To address this gap in the literature, this paper sets out with two aims. The first concerns building an improved understanding and definition of the nature of a digital public goods, which we do by proposing the term Digital Global Public Goods (DGPGs), drawing on concepts of public goods and global public good and unpacking an understanding of the digital in development. Second, we illustrate this definition by drawing on the case of the District Health Information System (DHIS2) software over the last 2 decades.

The remainder of the paper is organized as follows: in the next section we develop a definition of DGPG based on discussing relevant literature concerning DPGs. In the following section, we provide a case study and analysis of DHIS2, a digital platform for public health in developing countries (see www.dhis2.org). We frame our analysis of DHIS2 as a DGPG and base our discussion on published works related to DHIS2 and on the authors’ ongoing and long-term theoretical and practical engagement with the design, development, and implementation of DHIS2.

2. DIGITAL GLOBAL PUBLIC GOODS

In this section, we build a definition and conceptual framework of DGPGs, drawing from three related stream of research - public goods, global goods and digital technologies.

Public goods are non-rivalrous and non-exclusive. Non-rivalry means that consumption by one individual does not subtract what is available for others to consume, and non-excludability means that one cannot prevent anyone from using the good (or it is prohibitively expensive to do so). The concept of public goods originates from economics (Samuelson, 1954) where a prevailing focus is on the undersupply of public goods in a free market. Without prospects of payment, there will be limited economic incentives to provide the good, despite the high aggregate benefit to society. Some coordination of collective action to supply them is necessary, which is typically the realm of the public sector. Typical examples of public goods in the literature include infrastructure (lighthouses and streetlights), environment (clean air and disease control), and public services (immunization, fire stations and national defense). The production of public goods results in positive externalities, i.e. benefits for third parties that did not agree to consume and pay for the good. For example, lighthouses will benefit all seafarers, their families, and customers of the transported goods too. Immunization will lead to herd immunity, which is beneficial also for those not vaccinated. While public goods are by default non-exclusive, technological change may alter this by bringing down the cost of enforcing payment. An example of this is introduction of cost-efficient automatic toll roads where previously the road was free to use.

The concept of global public goods (GPG) represent an approach to capture the global challenges in enabling access to public goods that transcend national borders (Kaul, 2013). It puts emphasis on the related costs and benefits and the accessibility to public goods across geographies, social and economic groups, gender, and generations (Kaul et al., 1999). This concept is widely applied across many areas related to socio-economic development including the environment, international financial stability, peace and security, human rights (Long & Woolley, 2009) as well as the area of global health (Moon et al., 2017; Smith & MacKellar, 2007).

GPGs take an important role in discussions on global agendas, goals and the establishment of governance structures to create incentives for different groups to contribute with their share (Kaul et al., 1999). Even if public goods are global and not produced by a single nation, they can only be realized by several countries taking policy initiatives on national levels and through international cooperation (Kaul et al., 2003). However, critics have raised a concern that there is a tendency to uncritically apply the concept of global public goods to the level that it loses its meaning and becomes a ‘buzzword’ to attract funding (Smith & MacKellar, 2007), which makes the term incoherent and abstract (Long & Woolley, 2009).

How may digital global public goods be conceptualized? Digital technologies (such as open source software or digital platforms) have qualitatively different characteristics than other technologies. By virtue of their nature, they are relatively easier to circulate across time and space compared to
technologies with physical properties e.g. infrastructure and machines. This may make digital technologies easy and cheap to replicate and share, even globally (Yoo et al., 2010). “Digital” therefore implies the capability to re-program, modularize and recombine, build upon, and share digital goods, potentially enabling their appropriation and modification to build relevance in multiple local contexts. This flexibility allows digital technologies to have generativity (Zittrain, 2008) reflected in the success of commercial digital platform ecosystems such as those around iOS and Android, reaping the benefits of positive network effects (Tiwana, 2013). However, Sahay (2019) points out that appropriation of the digital in multiple contexts is not an unproblematic given, but shaped by various “distortions” such as related to knowledge, capacity and local politics. Understanding the nature of these distortions and how to engage with them, helps shape local relevance.

We have so far briefly introduced public goods, global public goods and digital technologies. Public goods points towards market failure and the need for collective action, global public goods does the same on a global scale, and digital technologies have the nature of being inherently flexible for appropriation in a local context. DGPGs represents a combination of these defining criteria. First, they are designed to be available to anyone free of charge without any license costs. Second, they are relevant in local contexts on a global scale by not being prohibitively difficult to learn how to use, implement, and appropriate. We thus adopt a wide understanding of accessibility, to include digital goods being understood, capable of being influenced, capable of being adapted and appropriated. The notion of accessibility thus relates not just to ease of acquisition, but more importantly how easy they are for users to understand, utilize and make relevant in context. There are mutual dependencies between these constituent parts, shaped broadly by the process and capabilities of making the goods locally relevant. In a self-reinforcing cycle, global use adds the contextual diversity necessary to develop for global relevance, but also raises the challenge of the goods becoming too generic and offering a ‘design from nowhere’ (Suchman, 2002). An open source application that is prohibitively difficult to re-program, adjust, or localize, becomes less of a DGPG. A DGPG can as such be understood as a whole which is more than the sum of its parts. We summarize our perspective of DGPGs in the table below:

<table>
<thead>
<tr>
<th>Public Goods</th>
<th>Non-rivalrous and non-excludable by design</th>
</tr>
</thead>
<tbody>
<tr>
<td>Digital</td>
<td>Re-programmable, modularized and re-combinable</td>
</tr>
<tr>
<td>Global</td>
<td>Relevant locally on a global scale</td>
</tr>
<tr>
<td>DGPG as more than the sum of the parts</td>
<td>Relevance on a global scale can only be achieved with adaptability, provided by non-excludable, non-rivalrous, digitally modifiable technologies. Due to these traits, the technologies also display positive network effects, increasing the benefits with increasing scale.</td>
</tr>
</tbody>
</table>

Table 1 A definition of Digital Global Public Goods (DGPG)

3. CASE STUDY: DHIS2 AS A DGPG

The above definition and how the traits may combine into DGPGs are demonstrated in this section illustrated with prior literature on the DHIS2 health information systems platform. We selected a case study as they are “particularly useful in the early stages of research on a new topic, when not a lot is known about it” (Myers, 2001, p. 89). While the history of DHIS2 is reported in many research papers (Adu-Gyamfi et al., 2019; Braa et al., 2007; Roland et al., 2017) and more than 50 PhD theses, we draw upon Braa and Sahay’s (2012) description of the transitions in history of the initiative, which we also updated to current time. To highlight local relevance, we identified and focus on 3 key sets of processes: i) participation of users; ii) building of capacity and local support mechanisms;
and, iii) improving flexibility of the DHIS2 platform. Arguably, these aspects contribute to the development of local relevance, which we define as “the capabilities of the local context to effective use the DGPG platform to meet local needs, while contributing to the global scalability of the platform.”

We first provide a brief overview of the background of the DHIS2 initiative, ongoing over 2 decades, and then discuss the aspects of local relevance over the four identified phases of its evolution.

3.1. A brief overview of the DHIS2 initiative

The DHIS2 initiative anchored within the broader Health Information Systems Programme (HISP) research and development initiative of the University of Oslo, Norway (UiO), has its origins in the South African post-apartheid health reform efforts. The first version of the software (DHIS1) was developed in South Africa and was transformed into the web based DHIS2 platform in 2006. It has slowly grown in maturity with new capabilities and improved functionalities; attracted global attention and funding, and experienced increasing adoption in more than 70 countries in the Global South (see www.dhis2.org). At the time of writing, DHIS2 has the status of de facto global standard for health information system development and is supported by a consortium of global partners (e.g. WHO, Norad, Global Fund, UNICEF amongst others). The design, development and dissemination of DHIS2 is coordinated by the Department of Informatics at University of Oslo (UiO) under the Health Information Systems Programme (HISP), where it represents a key focus of research and education.


Processes of participation: A key component of the African National Congress (ANC) government’s post-apartheid reform agenda was the strengthening of the country’s HIS, particularly in making it more decentralized and integrated. The process of reform was driven by a team of South African activists returning to the country from exile and researchers from UiO immersed in the Scandinavian approach to participatory design and action research. Emancipation of the field level health workers through decentralization was the underlying agenda guiding the technology development process (Braa & Hedberg, 2002). This was the birth of the HISP initiative with the priority to establish an integrated and decentralized health system, and the development of district health information system software became the focal point and the Version 1 (DHIS1) was born. The development progressed as a highly participatory and multi-disciplinary process, driven primarily by national nurses and doctors, who would give requirements and the development team would respond with rapid prototypes, often on a daily basis. Braa and Sahay (2012) describe this process as the technology was used as Lego bricks where the DHIS1 development and reconstruction of the health system took place as mutually reinforcing and inextricably intertwined processes.

Process of capacity building and local support mechanisms: An NGO HISP South Africa was born which was anchored within the School of Public Health at the University of Western Cape. Capacity building was at the core of the local support provision, as the university initiated various short term summer and winter courses, many of which were run by HISP South Africa team members, and thousands of health staff attended the courses (Braa et al., 2004). Additionally, the HISP South Africa team would carry out in-service training for health staff in their work contexts. The software development took place from a base in Western Cape, with strong linkages established between the development, implementation and user teams. The capacity building and support mechanisms can be summarized as taking place in the mode of “for and in the local context” of the country.

Technology development process: The first version of DHIS was open source and built using Visual Basic and Microsoft Access and implemented based on standalone installations in the health facilities. The development team was located at the University of Western Cape (UWC) and consisted of two core software developers and a group of HISP members acting as mediators between users and the developers. Based on rapid prototyping cycles in close collaboration with users in selected health facilities, the software matured, it was scaled to provincial level and finally
as a national standard in all districts. The software developers and public health implementers and users worked closely together in a small and agile team, and their ongoing interactions contributed to the rapid scaling of the systems, till it became a national standard by 2001.

In summary, with respect to local relevance, the initiative was strong in processes of participation, capacity building and local support. While the software was locally relevant in South Africa, it was not globally scalable, as was evidenced in the next phase of evolution.

3.3. Phase 2 (2001 to 2008): Exploring potential of scaling of DHIS1

Processes of participation: Two sets of processes were at the core of shaping participation in this phase. One, there was a process of taking the DHIS1 from South Africa to multiple other countries such as Mozambique, Tanzania, Ethiopia, Malawi, India and Cuba. Participation processes were attempted in different (from South Africa) political contexts and resulted in systemic challenges such as the top down and hierarchical political structure of Cuba that did not accept the bottom up and activist approach of South Africa, leading to the HISP initiative to be abruptly terminated (Sæbø & Titlestad, 2004). Funded by Norad, UiO worked on establishing strong research and education programmes in collaboration with national universities and Ministries of Health (MoH). For example, 6 faculty members from the Universidade Eduardo Mondlane (UEM) in Mozambique enrolled for the PhD programme at UiO working in an action research mode on topics of relevance for the MoH. Simultaneously, a Masters programme in Health Informatics was established in collaboration with UiO. Similar models of engagement were established in Tanzania, Ethiopia and Malawi. These changes firstly strengthened three way links between UiO, the local universities and the MoHs, and the action research mode provided a more academic mode to participatory processes.

Process of capacity building and local support mechanisms: The onus of organizing and managing these processes largely shifted to the settings of the universities, with students at the core within the framework of their research projects. This shift came with its particular strengths and weaknesses. The obvious strength was this process sought to strengthen national institutional processes of tertiary education and health information capacity in the MoH. Such strengthening would contribute to enhanced sustainability of efforts and systems. A weakness of this model was that unlike South Africa where an NGO was responsible for supporting DHIS implementation, and could rapidly respond to user needs, in Mozambique for example, the support was bound in various layers of bureaucracy of their respective universities and the MoH. As a result, support could not be provided in time in relation to the urgency required. This greatly adversely affected the implementation outcomes.

Technology development process: The point of departure for this process was the DHIS1 developed in South Africa. The process of translating this to the country contexts met with multiple design-reality gaps (Nhampossa, 2005). For example, there was the issue of language, as for example to Portuguese in Mozambique. There were different underlying logics of working, for example while in South Africa with the agenda of empowerment and “local use of information”, a primary focus was on the development and use of pivot tools, in Mozambique the users wanted ready-made report generation functionality rather than having to develop it themselves. The technology support for these countries still came from South Africa, and because of the limitations of a standalone system, laptops would need to be sent from Mozambique to South Africa, who would then install the new version incorporating required fixes and send it back to Mozambique. As can be imagined, this was a very cumbersome and time-consuming process, and did not contribute effectively to local technical capacity development.

In summary, with respect to local relevance, longer term and institutionalized processes of participation and capacity building were arguably established, but unlike in South Africa, it was inadequate to meet the short-term implementation needs. The DHIS1 was found to be inherently non-scalable. The result of this was in Mozambique, Ethiopia and Cuba, the HISP projects were
terminated by 2005-06, while in other contexts like India and Tanzania limited pilot projects were initiated.

3.4. Phase 3: (2008 to 2012): Transition to the web-based version

Processes of participation: The initial years of this transition involved building participation around the development of the web-based version DHIS2. Two key conditions shaped this participation process. One, the development process shifted from South Africa to the Department of Informatics at UiO and was now driven primarily by Masters and PhD students. They were then both geographically and culturally distant from the contexts of use. Two, the strong multi-disciplinary approach born in South Africa, was replaced by a primarily technical approach with focus on novel rather than appropriate technologies, which implied losing the public health anchoring. For example, the DHIS2 was based on a stack of Java based technologies, skills for which was relatively limited in many developing countries. There were also infrastructure constraints. For example in the Ethiopian national university, there were severe internet constraints, which meant the local developers could not download the new builds released by the UiO developers. Processes of mutual participation of the UiO and country teams was severely constrained during this process of new technology development.

Process of capacity building and local support mechanisms: Many of the doctoral candidates from countries started to complete their PhDs and go back to their countries and take up positions in their universities or MoH. This helped to strengthen institutional capacities while also participating in teaching of the Masters programmes now established and running well. Some new countries like Sri Lanka and Malawi also established their respective programmes, slowly leading to the development of more global health informatics capacities made relevant to their country contexts. Some other countries, like India, Vietnam and Bangladesh established local NGOs (called HISP groups) to support local implementations, and developed their own means and mechanisms of participation guided by various factors such as political contexts, available resources and capacities, and the agreements they had with their respective governments. While a diversity of participatory processes grew during this period, a common theme was it was becoming increasingly technical and distant from users. The UiO team’s engagement in participation was now largely mediated by the country support structures.

Technology development process: The DHIS2 was born in the state of Kerala in India, jointly developed and piloted in one clinic by a team of UiO and HISP India developers. The web-based nature of DHIS2 made it immediately attractive to governments, and 3-4 states in India and other countries (Sierra Leone and Kenya) initiated processes to pilot and implement DHIS2 in their contexts. As a team of developers from Oslo relocated to Kenya to carry out development in context, some major breakthroughs were achieved, for example Kenya became the first African country to achieve a national roll out of a web based HIS (Manya et al., 2012). There was a rapid evolution of the functionalities of DHIS2 making it more amenable to both local customization and also their global scaling. For example, Gizaw et al. (2016) advanced the concept of “open generification” using examples of how locally developed functionalities (such as for mortality reporting in Ethiopia and category combinations in Tajikistan) could become part of the DHIS2 core and made available to the world at large. The growth of DHIS2 caught the attention of global partners, such as WHO and Global fund, and processes of supporting DHIS2 development were initiated leading to a rapid increase in the uptake of DHIS2 in countries.

In summary, local relevance was some ways compromised with the change in the character of participation, but the use of more modern technologies enhanced its use in multiple local contexts. Local support mechanisms through HISP groups was strengthened as increasingly governments started to rely on the DHIS2, placing pressure on its continued maintenance and support.
3.5. Phase 4: (2013 to current): Dealing with high global and national scaling

Processes of participation: Participation was now organized primarily at two levels. One, country teams (HISP groups) organized their own processes of participation in respective country contexts, with mixed results. While South Africa continued their relative mature modes of participation through secondment of a number of their staff to provincial and national governments, other countries showed relatively reduced levels of engagement with users and a stronger focus on building more technical skills on the DHIS2, which was evolving at a high speed. Two, the UiO team largely engaged with countries through the mediating HISP groups rather than directly with users, which was now no longer possible given the scale of operations (Roland et al., 2017). Further, the models of funding were also rapidly changing, as till around 2012 nearly all development was carried out by students supported through research council funds, now different donor money was being obtained. An implication of this shift was that the priorities of the donors tended to be emphasized over country voices, reducing the impetus on engaging user participation.

Process of capacity building and local support mechanisms: About ten HISP groups were established around the developing world (for example, in India, Mozambique, Uganda, Tanzania, West Africa, Vietnam) and there was increasing focus (and funds) to strengthen their capacities, primarily around the customization and use of DHIS2. A key mechanism for this was through the UiO supported “DHIS2 Academies” arranged periodically in different regions on topics of system development, implementation, server management, app development and so on (since 2011, around 100 academies have had around 5000 participants). The DHIS2 Academies are arranged by the HISP groups in their regions, sometimes supported by UiO core team members. In 2017, a free online academy is also offered on “Fundamentals of DHIS2”, and more such courses are in the process of development. There is also an Annual DHIS2 Conference, where representatives from NGOs, MoHs and researchers share learnings and showcase innovation and best practices. These have contributed to building a vibrant global community of practice and network of practitioners around DHIS2. These activities are at the same time at a distance from users in developing countries. This challenge has been recognized by UiO and various measures are being undertaken to reduce this gap. For example, recently “regional HISP groups” were established in South Asia, East Africa and West Africa, to enable pooling of regional capacities so as to better organize country support.

Technology development process: The technology development processes have rapidly moved towards increased professionalization and specialization, from the early days when students conducted the development. Today there is a professional team of more than 30 developers, distributed globally, and organized on lines of a modern software house with different teams including front-end and back-end. To provide support for the implementation and use in a variety of context and for different use-cases, DHIS2 is based on the newest of technologies and a platform architecture. DHIS2 is a Java-based web application and runs on multiple platforms, and is interoperable with other relevant applications in the domain. It is available in many languages and has support for local contribution to a repository of translations. Participation is also promoted by an online community platform, mailing lists, source code repositories, and issue tracker.

With its generic core and platform architecture, DHIS2 provide interfaces that allows the development of apps to suite local needs and integration with other systems. From being a tool primarily used for collection, aggregation and presentation of aggregate health data, the platform has facilitated new use cases including patient management and individual records. This versatility is also illustrated by the implementation and use of DHIS2 for health commodity logistics management and in agriculture and education. However, taking advantage of the openness and flexibility of the platform requires competence and human capacity (Msiska & Nielsen, 2018). There are different initiatives to support participation including the development of different kinds of boundary resources, such as component libraries, tutorials, and documentation.

In summary, in this phase the focus has been on building global rather than local relevance, which is inevitable given the scale and associated funding mechanisms. The ongoing challenge is to
manage this global scale, while ensuring the successful principles of engagement and support learnt in the South African experience are not lost, but revitalized in the fast changing context.

We have in this case study presented three phases of the development of DHIS2, and below we summarize this in table 2 along three dimensions of local relevance: Participation, capacity building and local support, and technology development

<table>
<thead>
<tr>
<th>Phase</th>
<th>Local Participation</th>
<th>Capacity building and local support</th>
<th>Technology development</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Situated, multi-disciplinary</td>
<td>Local NGO, local university anchoring</td>
<td>Situated, contextualized, custom-made</td>
</tr>
<tr>
<td>2</td>
<td>Trending towards universities as other modes of participation faced systemic challenges</td>
<td>University-based, vulnerable to university priorities and timescale</td>
<td>Desktop version did not scale, increased demand for web-based solutions</td>
</tr>
<tr>
<td>3</td>
<td>Increasing distance between designers and users</td>
<td>Emergence of local and regional support groups (&quot;HISP groups&quot;), establishment of stronger university programs, sometimes by exchange PhD students</td>
<td>Shift to web-based DHIS2. Generification to address increasing scale</td>
</tr>
<tr>
<td>4</td>
<td>Centered on HISP groups. Scale and increased global funding challenge participation further</td>
<td>DHIS2 Academies, growing of a community supported by online fora, platforms, conferences.</td>
<td>Platformization. Professionalized core team and emergent distributed “third party” developers</td>
</tr>
</tbody>
</table>

Table 2 Characteristics of local relevance

4. DISCUSSION AND CONCLUSION

In this paper we sought to build an improved understanding of digital public goods by proposing and defining the term DGPG, and examine the DHIS2 software and associated activities in light of this. The story of DHIS2 shows that the accomplishment of a DGPG is not an absolute, or a process that is ever finished or perfected, but an ongoing mission that takes place alongside ongoing striving for relevance to context. We focused the analysis of the case on three aspects of seeking relevance: local participation, capacity building and local support, and technology development, summed up in Table 2. Our main contribution is thus to shed light on the “demand” side of DGPGs, arguing that digital public goods cannot be made without taking the context into consideration.

The current open source license and the availability of DHIS2 points towards the accomplishment of DGPG status by being non-rivalrous and non-excludable. Its digital nature, of being re-programmable, modularized and re-combinable, is apparent from implementation by a variety of organizations (Ministries of health, NGOs, PEPFAR, MSF etc.) and for different use cases (ranging from routine aggregate data to patient tracking, agriculture and education). Implemented in more than 80 countries, it also shows relevance locally on a global scale. Thus, DHIS2 corresponds to the definition of a DGPG. The careful balance between generification (Gizaw et al., 2016) and local flexibility (Roland et al., 2017) has reaped positive network effects.

The accomplishment of DGPG status was complex and many challenges are still lingering. First, funding of the development is reliant on international donor agencies, and their priorities may change. Compared to more traditional, and material, public goods, the public good nature is not a default but may be changed for instance by the introduction of a license. Second, the tensions emerging with scaling and striving to be relevant both globally and locally, while serving the needs...
of an increasingly diverse user-base, challenges relevance (Nicholson et al., n.d. forthcoming, 2019). DHIS2 shows how the digital and the global nature of DGPGs are intertwined. For example, a platform architecture can allow both shared stable resources and flexibility for specific, local development (Roland et al., 2017). Careful work with boundary resources can lower the bar for local adaptations (Li & Nielsen, 2019). At the same time, the focus on the dual mission of making the technology a globally relevant platform to be used across different use-cases and domains, has implications on the relationship between the developers and the users. While the core developers started out with a very intimate relationship with the users and the context in the early 1990’s, this is the case no more. At the same time, with the platform architecture of DHIS2, local expertise has the flexibility to implement solutions relevant in the local context. The local experts do also have the possibility to change DHIS2 by feeding new requirements, use-cases and innovations back to the core-team. However, this requires them to invest time in understanding whether this is a common requirement across context and describing the use-cases in a way acceptable by the core team. Such initiatives will also be considered in light of what else is on the roadmap, and finally decided by the core team.

The case of DHIS2 and its development over time shows the relationship between the constituents of DGPG and in particular the relationship between accessibility and local relevance. While accessibility in terms of users being able to download a software platform is relatively easy to achieve, developing the skillsets of the users to understand the software, implement it effectively and putting it to use in a way that leads to better decisions is a different story. We argue that the relative success of DHIS2 hinges not only on the qualities of the software and its abilities, but also the global efforts put into building local capacities and regional support mechanisms for its implementation and use.

The paper contributes theoretically by providing a novel definition and conceptualization of DGPG illustrated with the case of DHIS2. The definition contributes analytical support towards improved understanding of the role of DGPGs in socio-economic development in particular a recognition of the importance of the “demand side”. A limitation of the paper is that we do not in depth discuss practical contributions for producers of DGPGs. While this will be the focus of further enquiry, we hope to direct attention to a renewed emphasis on a broader perspective on accessibility and relevance for users. Users and policy makers may draw on the lessons of the case illustrations when considering investment and implementation of DGPGs.

REFERENCES


BUILDING AGILITY IN COVID-19 INFORMATION SYSTEMS RESPONSE IN SRI LANKA: RECOMMENDATIONS FOR PRACTICE

Pamod Amarakoon, University of Colombo, Sri Lanka, pamodm@gmail.com
Jørn Braa, University of Oslo, jbraa@ifi.uio.no
Sundeep Sahay, University of Oslo, sundeeps@ifi.uio.no

Abstract: COVID-19 pandemic tested the capacity of information systems in countries on the ability to rapidly respond to requirements which were not anticipated. This article analyzes the socio-technical determinants of agility in building the IS response to the COVID-19 pandemic in Sri Lanka. We deploy qualitative research methods to explore the case study of implementation of COVID-19 surveillance system in Sri Lanka. Three key recommendations are developed for practice relating to high-level multisectoral governance, use of lightweight digital platforms and leveraging on existing capacities and infrastructure.

Keywords: COVID-19, agile software development, dhis2, surveillance system, health information systems, Sri Lanka.

1. INTRODUCTION
Pandemics are characterized by high levels of uncertainty as they go through unexpected and dynamically changing situations making their responses difficult to predict. What is certain, however, is that timely quality data is important for health services and policy makers to respond optimally. How to best develop information systems (IS) to respond to health crisis as pandemics is the topic of this article, based on an empirical analysis of the COVID-19 IS response in Sri Lanka.

When the H1N1 (swine flu) hit Japan in 2009, the software team applied agile iterative approaches because of the limitations of traditional ‘waterfall’ approaches in addressing rapid changes (Murota, Kato, & Okumura, 2010). Lai (Lai, 2018) emphasized the need to understand the determinants driving agility, and identified four such conditions: i) committed leadership, to help overcome organizational barriers; ii) enabling interdependence to allow coordination across multiple stakeholders; iii) context specific domain knowledge and expertise; and, iv) shared understanding of common goals shaping response.

Uncertainty in pandemics provides unique resources for innovative and swift action. In the context of COVID-19 response, Rigby, et. al. (Rigby, Elk, & Berez, 2020) argue that agile responses does not typically come from a strategic plan, but comes as someone, somewhere identifies an urgent need for action and finds innovative and non-standard solutions. Agile software development methods (Hamed & Abushama, 2013) is one such approach to build IS solutions based on rapid prototyping cycles of software development, release, feedback and improvements. However, arguably this approach is limited to the technical aspects, and there are other socio-technical conditions to consider (Lai, 2018). Given this backdrop, the research question this paper addresses is:

What are socio-technical determinants of agility in the context of IS response to COVID-19, and how can these be best materialized in practice?

We analyze this question is the context of an ongoing successful IS response effort to the pandemic in Sri Lanka. After this brief introduction, we conceptually discuss the notion of agility, followed
by a discussion of the case and its analysis. Finally, some recommendations for practice are presented.

2. CONCEPTUAL FRAMING: SOCIO-TECHNICAL PERSPECTIVE ON AGILITY

Once WHO had declared the 2009 Swine flu a pandemic, Japan set up a task force to work on the IS response, while recognizing the ‘situation caused by the unforeseen virus was beyond the architect's imagination’ (Murota et al., 2010). The management decided to develop a new system (Day 1), and a prototype was rapidly developed following an "agile" approach (Day 4), and following feedback, a next version was developed (Day 8) and on Day 13, the system was ready for national roll-out. The rapid iterative cycles continued through the pandemic to accommodate to the different changes, such as in surveillance policies and pandemic phase transitions. For example, while the initial focus was on identifying all patients and suspects, it subsequently changed to locating cluster incidents with confirmed virus RNA. As the surveillance design was modified for each phase, the IS had to also rapidly evolve in support using agile methods (Lee & Xia, 2010) as traditional waterfall methods were grossly inadequate (Kapyaho & Kauppinen, 2015). Doz et al describes strategic agility as the ability of the organization to renew itself and remain flexible without sacrificing efficiency (Doz & Kosonen, 2008). From an organizational perspective to ensure strategic agility it require sensitivity to environment, resource fluidity and collective commitment.

While agile methods such as SCRUM emphasize individuals and interactions over processes and tools (Agile Alliance, 2001), we argue an important lack is the inadequate attention given to the materiality of the platform itself used for the agile development. We see “lightweight IT and platforms” as an important determinant of agility. (Øvrelid & Bygstad, 2016) contrasts lightweight and heavyweight IT with respect to the knowledge regimes they underpin. Lightweight represents “a socio-technical knowledge regime” driven by competent users’ need for solutions, enabled by the consumerization of digital technology, and realized through innovation processes. Usability, easiness in implementation and ability to quickly follow up pilots are described as key characteristics of lightweight IT. In contrast, heavyweight IT represents a knowledge regime driven by IT professionals, enabled by systematic specification and proven digital technology, and realized through software engineering processes. The focus on knowledge regimes highlights the socio-technical nature of IT.

We combine this notion with that of a platform, described as a “software-based product or service that serves as a foundation on which outside parties can build complementary products or services” (Tiwana, 2013). Tiwana also argues that platforms must be multisided, enabling the coming together of two or more actors such as end users and app developers. The manner in which a platform enables the coming together of different people, technologies and processes represents a platform architecture (Baldwin & Woodard, 2008), which consists of a core with a set of stable components, and complementary components that interact with the core. The wider software platform eco-system is therefore composed by software modules, apps, interfaces between them, developers, users and a variety of stakeholders. Henfridsson and Bygstad (Henfridsson & Bygstad, 2013) suggest the unit of analysis should not be the core of the platform but its boundary resources and the larger ecosystem. We use this perspective for analysing the determinants of agility.

3. METHODS

For this article, we used a case study approach because it helped us to look into the background and complexities of the phenomena – agile growth of HIS in a pandemic situation in an LMIC context like Sri Lanka. According to Darke et al, such a method is useful in younger and less developed research areas, such as the phenomenon studied in this context (Darke, Shanks, & Broadbent, 1998). Our methodology was an analytical inquiry exploring a contemporary phenomenon within a real-life framework – the Sri Lankan health system context, as described by Yin (Yin, 2014).
The basis of the development of the case study is an ongoing 10-year old engagement of the three authors in the strengthening of the national health information systems in Sri Lanka, including in the design and implementation of the COVID-19 IS response. The principal author is a graduate of Masters and Doctoral program of Health Informatics and a key implementer of the IS response to COVID pandemic in Ministry of Health (MoH) Sri Lanka. He conducted most of the field level data collection for the study while engaging in implementation activities. Two other authors are senior professors of the University of Oslo who have been closely engaged in establishment of Masters Program in Biomedical Informatics in the University of Colombo, Sri Lanka and have engaged in academic program of the Masters and Doctoral programs as well as providing mentorship to health informatics implementations in Sri Lanka. For this paper, we focus firstly on the issue of building national health informatics capacity, which provides the context for the analysis of the IS response to COVID-19.

As argued by Yin we used multiple data collection techniques (Yin, 2014). We conducted 10 in-depth interviews from stakeholders at national and district level engaged with the information management on COVID-19. These included 3 health informatics experts from MoH, 2 health administrators from national level, 2 experts in ICT outside the MoH who contributed to the surveillance system, 3 implementers and trainers of the system and 2 district level implementers of the surveillance system. Since some of the writers were closely involved in the planning, creation, and execution of the HIS in question, their lived experiences were recorded in the form of narratives and analyzed. Memos were also compiled from observations made at stakeholder meetings during the setup of the DHIS2-based surveillance scheme. Secondary data was also included in this analysis, including publications released by public health organizations, records delivered at stakeholder meetings, and observations taken at informal meetings with stakeholders. During the study, the authors' own historical accounts of the Masters program's establishment, the graduates’ contributions to the digital health ecosystem, and the development of health informatics in Sri Lanka were also taken into account. However, since this was a retrospective analysis, the data collection for critical stakeholder meetings had to depend on the authors' own recollections and meeting minutes.

Throughout the data analysis process, we were continuously sharing our thoughts and perspectives on the information we had gathered. The case narrative was then collaboratively developed, and thematic analysis methodology was used to define evolving themes, which were then critiqued before being used in the development of this paper, as proposed by Braun et al (Braun & Clarke, 2014). We were able to eliminate any possible bias that could have clashed with our understanding of the case by taking a collaborative approach to data analysis, considering the responsibilities we perform within the phenomena we wish to examine.

4. CASE STUDY

4.1. Building of national health informatics capacity

This process of building health informatics capacity in Sri Lanka started in 2009, and it was of immense significance in building the COVID-19 response.

Sri Lanka provides both health and education free to its citizens, including the highly sought-after medical education. This policy has inspired more than 90% of the medical graduates join the government medical services. Furthermore, the Ministry of Health (MoH) also provides full funding for pursuing postgraduate specialization studies, including in health informatics, at the Postgraduate Institute of Medicine of University of Colombo. In 2009, the Masters in Biomedical Informatics (BMI) degree programme was established with financial and technical support from the University of Oslo, Norway. This programme had a futuristic vision of producing medical specialists with a background of biomedical informatics, so as to develop national sustainable capacity. The collaboration with Oslo and their world leading Health Information Systems Programme (HISP) has helped the BMI students to be educated in modern informatics concepts and build expertise on the DHIS2 platform (see dhis2.org). The unique action research orientation of HISP, was also an
underlying pedagogical principle in the BMI programme and students-built expertise on how to apply DHIS2 to different problem contexts, such as for malaria and TB information management.

On completion of the programme, the BMI graduates reverted to the MoH where they assumed duties as ‘Medical Officers in Health Informatics’ responsible for aspects of health policy, system design, development, implementation and training. These officers, with rare hybrid skills of medicine and informatics, become crucial technical and administrative experts driving the national HIS forward, and were fundamental in building the COVID-19 IS response, now described.

4.2. Design and implementation of the COVID-19 IS response

From January 2020, when there was a rising concern of COVID-19 cases in some East Asian countries, Sri Lanka recognized the threat since it is a country of high tourist traffic and also hosts many Chinese based infrastructure projects. They acted rapidly, setting up a Presidential task force headed by the commander in chief of the army, with key roles assigned to the Minister of Health, Director General of Health Services (DGHS) and the police. The authority wielded by the task force members ensured rapid decisions could be taken on both the health and citizen-based issues, such as on quarantine and contact tracing. The task force reached out to representatives from other sectors such as agriculture, education, immigration and social services, and sub-committees created on implementation responsibilities.

An urgent priority of the task force was to establish a robust IS response to gather information on possible sources of infection and follow up of suspect cases. Immediate bottlenecks was the unavailability of a generic outbreak management IS in the MoH and the long bureaucratic process of procurement. The task force had the authority to subvert the typical bureaucratic processes and decided to adopt a customisable platform as opposed to developing something from scratch. Given the need to share data across departments, a cloud-based solution was mandated.

The MoH selected the DHIS2 platform for building this system, as it met identified criteria and could quickly be configured for use, and because there was existing capacity and experiences with the system. DHIS2 and its developers (HISP Sri Lanka) had the prior trust of the government. Initial discussions between the ministry and HISP Sri Lanka started in 3rd week of January, which identified the initial priority of building a port of entry tracker module. Using the existing DHIS2 “tracker” functionalities, this module was rapidly discussed and presented to the DGHS on 27th January just prior to the country reporting its first case of coronavirus. Permission was obtained for national roll out.

Sri Lanka reported its second COVID-19 case on 11th of March, which was also accompanied with large numbers of nationals returning from high burden countries such as Italy and South Korea, leading to a steady rise in cases, going over 100 in 2 weeks. Confirmed cases were admitted to designated hospitals and tracking of contacts was initiated. The country closed the ports of entry in the third week of March, and the IS response shifted from port of entry to tracking of confirmed and suspect cases from community clinics, quarantine centres and testing laboratories. DHIS2 is a generic platform and a new module for tracking persons during their quarantine period was rapidly developed.

The country reported its first COVID-19 death on 28th of March, and the current total is at 11 cases, including 7 cases in the first 11 days. This surge and increase in number of patients requiring the ICU care were seen as red flags, requiring optimal management of ICU beds. However, the country's critical care IS had not been operational in the last few years, and so the task force required an ICU bed management component to be included to detect availability and proximity of ICU beds. Following this request, a module in DHIS2 to track availability of ICU beds was developed during a hackaton with participants from local software development and volunteer community and with input from healthcare professionals.
Typical Ministry’s capacity building initiatives were based on face-to-face settings which was now not possible. After the declaration of the national curfew on 21st of March, training programmes were mobilized through the Zoom videoconferencing platform, and training content was developed with high graphical content rather than having lengthy training material. This shift in training media and content enabled the Ministry to rapidly scale the system nationally. The training sessions were typically targeted for each district with participation of around 20 users per online training session.

While the overall IS response reflected well the process of local innovations, there were also innovations developed through collaboration with the Oslo global DHIS2 team. Some new requirements could not be addressed locally and required work on the core software, which could be done with the global team. For example, while developing the port of entry module, the ministry required the flexibility to change the registering organization unit of a passenger, a functionality not available in the core DHIS2. The global team then helped modify the codebase and to also help visualize transmission relationship and contact mapping as a graphical network. This example shows the power of global-local collaboration and sharing of expertise. Slowly, as the system started to acquire more generic features, the global team worked towards creating a generic app which is now in use in 20+ countries, including Norway. Additionally, local software development capacity was organized through multisector collaboration between MoH, government ICT agency and the volunteer software developer. A hackathon was organized in the second week of March to develop additional modules and functionalities, such as the ICU bed tracking module mentioned above. The ICT Agency in addition provided infrastructure support for hosting of the solution in the government cloud, internet facilities to hospitals and health facilities as well as provision of workspace environments for collaborations such as “Slack”. Thus, there were multisector engagements across domains at local and international level.

We summarize the above discussion through a table which summarizes the different functionalities/modules developed and implemented using the DHIS2 platform. The speed and variety of development is illustrating the agility involved.

Table 1: Modules of the COVID-19 Surveillance System and Implementation Process

<table>
<thead>
<tr>
<th>Module and date of release</th>
<th>Implementation process around lightweight DHIS2 platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port of Entry Module 27th January 2020</td>
<td>• Rapid approval by task force</td>
</tr>
<tr>
<td></td>
<td>• DHIS2 inbuilt functionalities allowed for rapid customization by local experts and presentation to DGHIS</td>
</tr>
<tr>
<td></td>
<td>• Rapid end user training</td>
</tr>
<tr>
<td>Hackathon &amp; Multisector Discussions 14th March 2020</td>
<td>• Strengthening multi-sectorial collaboration</td>
</tr>
<tr>
<td></td>
<td>• Building and extending existing Web API and Web Apps platforms</td>
</tr>
<tr>
<td></td>
<td>• Global expertise supporting local innovation</td>
</tr>
<tr>
<td>Development of Case &amp; Suspect Monitoring Module 15th March 2020</td>
<td>• Use existing DHIS2 tracker functionality used to quickly customize the module</td>
</tr>
<tr>
<td></td>
<td>• Customization by super users, without core programming expertise</td>
</tr>
<tr>
<td></td>
<td>• Rapid end user training</td>
</tr>
<tr>
<td>Contact Mapping Application &amp; Mobile Tower Location Integration 23rd March 2020</td>
<td>• New functionality developed by extending existing platform.</td>
</tr>
<tr>
<td></td>
<td>• Globalization of local innovations through HISP network</td>
</tr>
<tr>
<td>Quarantine Persons Module 25th March 2020</td>
<td>• Use existing DHIS2 tracker functionality used to quickly customize the module</td>
</tr>
</tbody>
</table>
## 5. DISCUSSION

Our case analysis identifies three key determinants of agility which we first present through the model below and then discuss. In the section that follows, we present recommendations for practice based on the model (Figure1).

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Key Determinants</th>
</tr>
</thead>
<tbody>
<tr>
<td>MyHealth Citizen Information Mobile App 27th March 2020</td>
<td>• Customization by super users, without core programming expertise&lt;br&gt;• Rapid end user training</td>
</tr>
<tr>
<td>Health Sector Resource Monitoring Module 5th April 2020</td>
<td>• Support integration</td>
</tr>
<tr>
<td>ICU Bed Management Web App 11th April 2020</td>
<td>• Customization by super users, without core programming expertise&lt;br&gt;• Rapid end user training&lt;br&gt;• Building and extending existing Web API and Web Apps platforms</td>
</tr>
<tr>
<td>Laboratory Reporting Module 25th April 2020</td>
<td>• Customization by super users, without core programming expertise&lt;br&gt;• Rapid end user training</td>
</tr>
<tr>
<td>Generic Relation Tracing Web App 10th May 2020</td>
<td>• Globalization of local innovations</td>
</tr>
<tr>
<td>Scaling-up implementation May – October 2020</td>
<td>• Training of users and expansion</td>
</tr>
<tr>
<td>More focus on laboratory data collection and custom app for laboratory data management November – December 2020</td>
<td>• Involvement of volunteer developers for laboratory data management app</td>
</tr>
<tr>
<td>Vaccination Tracker January – March 2021</td>
<td>• Collaboration of WHO country office to design COVID Vaccine Tracker&lt;br&gt;• Shared metadata with University of Oslo and DHIS2 community&lt;br&gt;• First country to deploy COVID vaccine tracker&lt;br&gt;• Incorporation of digital certificate</td>
</tr>
</tbody>
</table>
5.1. Socio-technical Determinants of Agility in the Times of Uncertainty

Our model emphasizes that agility is not only about software development methods, but involves a combination of social, political and technical conditions, including: i) high-level and multi-sectoral governance mechanisms; ii) leveraging on historically existing capacity and infrastructure; iii) use of established lightweight digital platform.

High-level and multi-sectoral governance mechanisms: Even before the pandemic had made its entry in the country, a high-level task force was constituted under the leadership of the President’s office and comprising of senior decision makers from different sectors. This governance structure enabled the taking of agile decisions, which were cross-departmental and broke down historically existing bureaucratic structures, such as related to the software procurement process. Similarly, questions of quarantine and lockdowns were decided by representatives from health, immigration and police. The structure enabled multi-sectorial rapid decision-making, with well thought through processes to ensure implementation compliance.

Leveraging on historically existing capacity and infrastructure: Three aspects of history were crucial in building agility. One, concerned the BMI programme which had been in operation since 2009 and had contributed to the education of many doctors who occupied important health informatics positions in the Ministry. Two, was the fact that the DHIS2 was well established through use by nearly 20 health departments. Three, was the HISP Sri Lanka team, comprised of graduates from the BMI programme with high levels of DHIS2 expertise and strong collaborative links with the global DHIS2 team to bring about changes in the core when needed.

Leveraging on lightweight digital platform – DHIS2: The DHIS2 was a well-established digital platform within the Ministry, and over the years had cultivated an enabling infrastructure around it, such as for server hosting. The DHIS2, by design, is a lightweight platform that is flexible and adaptable to different use contexts, and new functionalities can be added relatively easily, without the need for core programming support. While as an web based independent application DHIS2 was easy to implement within the existing infrastructure, integration with other systems such as labs and

Figure 1: Socio-technical determinants of agility in IS response
custom was also easily achieved. The DHIS2 comes with core modules, for example for data analysis, dash boards, spatial analysis etc, which were easily adapted to the specific requirements for COVID-19 surveillance. For features, not currently available in the core, for example related to conducting network analysis, could be developed by enrolling national and global expertise, for example through hackathons.

In summary, agility was ensured through: i) the high-level governance mechanism, which enabled rapid decision making and implementation; ii) the lightweight platform allowed for rapid incorporation of new functionalities as the information demands of the pandemic evolved; and, iii) the existing DHIS2 related capacity which allowed system development and implementation to take place on the fly, without needing to build from scratch..

5.2. Recommendations for practice

Establishing high level governance mechanisms

Many existing problems of HIS in LMICs relate to the absence of effective governance mechanisms to mitigate the technical and institutional fragmentation of systems (Sahay, Sundararaman, & Braa, 2017). This leads to challenges in establishing and implementing standards, promoting fragmentation and the absence of an architecture approach. Pandemic responses by design require cross-sectoral collaboration across ministries of health, finance, home and others, which has been historically difficult to achieve in practice. Our case illustrates, a high-level task force in conditions of crisis can help to ensure such collaboration. In different countries, the models of building such a structure would be different, for example housed in the President’s office (as in this case), or in other departments such as home or health, depending on the political power they wield and their capacity to engage in multi-sectorial collaborative action.

Policy promoting the use of lightweight digital platforms

While there is an implicit acknowledgement of the value of free and open source digital platforms, there is an absence of explicit policy on its implementation. Given the need for sharing data across systems, there is an urgent need for using free software which do not come with licensing encumbrances and have open APIs which are publicly published. For example, in the case presented, the use of free software allowed easy sharing of data between the immigration and health departments, which would have been impossible in its absence. The lightweight aspect of platforms ensures that they can be developed and evolved by super users without core software programming expertise.

Focus on continuous and institutional capacity building

New digital platforms require the development of novel multi-faceted capacities, which take time and effort to build. These capacities cannot be developed through individual training programmes, as is often the case in development projects, but need to be anchored in institutions. The BMI programme at the University of Colombo provided that anchoring and their symbiotic relationship with the Ministry ensured hybrid expertise was developed and rooted in the country. This solid foundation allowed for new capacities to be quickly developed around the new application, and using innovations in training media and content, scale could be achieved. An important policy implication is to develop a strong foundation of capacity anchored in institutions with symbiotic relationships with the Ministry.

6. CONCLUSION

Pandemics by definition are dynamic and evolving rapidly requiring also the IS response to be flexible and evolve in an agile manner. Understanding how such agility can be enabled is thus both a crucial theoretical and practical challenge. Our paper has sought to contribute to building understanding on how to build agility, emphasizing it is not a technical but fundamentally a socio-technical collaborative effort.
REFERENCES


HOLISTICALLY PLACING THE ICT ARTEFACT IN CAPABILITY APPROACH

Mathew Masinde Egessa, Technical University of Mombasa, egessa.mathew@gmail.com
Samuel Liyala, Jaramogi Oginga Odinga University of Science and Technology, sliyala@yahoo.com

Abstract: This paper proposes a framework that holistically places the Information and Communication Technology (ICT) Artefact in Capability Approach (CA). The framework harmonises the different conceptualisations of technology within CA-based frameworks in ICT4D, in order to address the inconsistencies. To illustrate the framework, while simultaneously addressing the highest thematic research gap among post-2015 ICT4D research priorities, the study collected primary data from users of Pay-As-You-Go (PAYGO) Solar Home Systems who reside in rural Kenya. Using the framework, the study revealed that the ICT-artefact can holistically be conceptualised within three of CA’s concepts: under material resources as a capability input; as a new category of conversion factors (technological conversion factors); and as a component within the structural context. The study further demonstrated how the same ICT artefact could play out in the three different conceptualisations, resulting in different development outcomes for individuals. The study finally presents the implications for policy and practice.

Keywords: ICT Artefact, ICT4D, PAYGO Solar, Kenya, Development Outcomes

1. INTRODUCTION

Information and Communication Technology for Development (ICT4D) is an emerging and vibrant field of practice and research, that focuses on the use and design of ICTs in efforts to further (socioeconomic) development (Burrell & Toyama, 2009; Kleine & Unwin, 2009; Stillman & Linger, 2009). ICT artefacts are critical components within ICT4D studies. They include “bundles of hardware infrastructure, software applications, informational content, and supporting resources that serve specific goals and needs in personal or organizational contexts” (Mehdi, 2018, p. 631).

Despite different conceptualisations of development within ICT4D, Capability Approach (CA) has emerged as the holistic lenses to conceptualise development. Over a dozen CA-based frameworks have been developed to operationalise CA in ICT4D studies (Hatakka and Dé 2011; Kivunike et al. 2014; Kleine 2010; 2013; Zheng and Walsham 2008;). However, the ICT artefact, or technology (more broadly defined), is not conceptualised in a consistent way across the different frameworks. There is still no consensus in these frameworks, on how ‘technology’ relates to the core concepts of CA (inputs or ‘resources’, capabilities, conversion factors, functionings, structural constraints and agency) (Haenssgen & Ariana, 2018, p. 99).

This paper makes a case for a re-configured analytical framework that holistically places the ICT artefact within CA. It illustrates the framework using an ICT-enabled, renewable energy intervention, in rural Kenya.
2. LITERATURE REVIEW

2.1. Capability Approach

CA is a normative theoretical framework for the evaluation and assessment of individual well-being and social arrangements; the design of policies; and proposals about social change. Its core idea is that social arrangements should aim to expand people’s capabilities (their freedom to promote or achieve valuable beings and doings).

Sen (1999, p. 75) defines functionings as “the various things a person may value doing or being”. Functionings are the valuable states (beings) and activities (doings) that make up people’s well-being, such as being safe; being calm; working; resting; having a warm friendship or taking part in political decisions. Functionings are related to resources (goods and income), but they focus on what a person is able to do or be as a result.

**Capability** refers to a person’s or group’s freedom to promote or achieve valuable functionings. Sen (1992, p. 40) posits that capability “represents various combinations of functionings (beings and doings) that the person can achieve. Capability is, thus, a set of vectors of functionings, reflecting the person’s freedom to lead one type of life or another… to choose from possible livings”.

In CA, the term ‘resources’ is interpreted in a broader sense than the understanding of the term elsewhere in the Social Sciences. The focus is on material resources: either income and wealth or the consumption that these financial means (or unpaid production) generated. The resources and consumption could be conceptualised as capability inputs. They are means to the opportunities to be the person one wants to be, and to do what one has reason to value doing.

These resources do not all have the same power to generate capabilities. They depend on the individual’s `conversion factors`, as well as `structural constraints`. Conversion factors either filter, amplify or modify the input characteristics. They determine the degree to which a person can transform a resource into a functioning. All conversion factors influence (enable or inhibit) how a person can be or is free to convert the characteristics of the resource into a functioning, yet the sources of these factors may differ.

Conversion factors are often categorised into three groups: personal; social; and environmental conversion factors (Crocker & Robeyns, 2009, p. 68; Robeyns, 2005, p. 99). The three types of conversion factors enable the acknowledgement that it is not sufficient to only know the resources that a person owns, or can use, in order to be able to assess the wellbeing that he or she has achieved or could achieve; rather, there is need to know more about the person and circumstances in which he or she is living.

**Structural constraints** can have a great influence on the conversion factors as well as on the capability sets directly. There is a difference between social conversion factors and structural constraints. While structural constraints affect a person’s set of conversion factors including the social conversion factors that s/he faces, conversion factors only help to convert characteristics of resources into capabilities. Structural constraints affect conversion factors but can also affect a person’s capability set without impacting on the conversion of resources into capabilities (Robeyns, 2017).

Figure 1 depicts a stylised visualisation of the core concepts of CA.
2.2. Choice Framework

The Choice Framework (CF) by Kleine (2010, 2013) is arguably the most widely used operationalisation of CA in the field of ICT4D (Sein et al., 2019; Zelezny-Green, 2018). However, it falls short in remaining consistent with this study’s reading of Sen’s core concepts and terminologies. Figure 2 shows the visualisation of the core concepts and terminologies within the CF.
3. PROPOSED FRAMEWORK

This paper intends to reduce the difficulty in operationalising CA within ICT4D, as well as remaining consistent with Sen’s core concepts and terminologies. It proposes having a reconfiguration and realignment of the various agency-based and structure-based capability inputs of CF into conversion factors in Robeyns (2017) stylised presentation of CA. The paper then harmonises the different conceptualisations of technology within CA-based frameworks in ICT4D. The paper further proposes the explicit and holistic addition of the ICT artefact as a component within the structural context, thus extending Haenssgen & Ariana’s (2018) conceptualisation.

Kleine (2010, 2013) does not use the term ‘conversion factors’ in her CF. However, some of the resources in her individual-based capability inputs are described in a way that fits Sen’s conceptualisation of ‘conversion factors’. If the CF is adopted to evaluate the development outcomes in an ICT4D intervention, the material resources of the intervention become what is ‘consumed’ to generate capabilities and later functionings. The material resources are the physical objects with characteristics that enhance human capabilities directly. All the other resources in the portfolio will only play a facilitative role in the conversion process, that is, if at all they come into play. At the root of the analysis, it will boil down to a material resource that will provide the main ‘generative’ characteristics to achieve a functioning. The material resource could still double up in other places of the CA analysis (as this paper will later demonstrate), but at the core, it will act as the capability input.

To differentiate between resources and conversion factors, working backwards from an achieved functioning, an individual would not have achieved the functioning without the presence of the resource. However, with the absence of a conversion factor, the same individual could still have achieved the functioning, but to a different degree or intensity.

In this study’s reconfiguration of the agency-based capability inputs by Kleine (2013), it is only material resources that are retained as a capability input. The rest of the resources are redistributed into the three conversion factors as described by Sen. Educational, psychological, information, health and financial resources are reconceptualised as personal conversion factors. Time, social and cultural resources are reconceptualised as social conversion factors. Lastly, geographical and natural resources are reconceptualised as environmental conversion factors. The reconfiguration and pairing up of the resources to the categories of conversion factors by Sen, is achieved by matching up their corresponding definitions (ibid).

Within CF, the structures that frame people’s lives are related to the concept of structural constraints in CA. They include: institutions and organisations, discourses, policies and programs, formal and informal norms, as well as technologies and innovations. Contrary to Haenssgen & Ariana’s (2018, p. 101) reading of CF’s structures, and equating them to conversion factors, this study closely associates CF’s structure with the structural constraints in the abstract CA. CF’s structure is related, but not equivalent to conversion factors. It is more equivalent to structural constraints, as Robeyns (2005, 2017) defines it, in relation to CA.

In the proposed framework, ‘structural context’ is conceptualised as an overarching construct that affects and gets affected by almost all the other constructs in the framework. Structural context encompasses both the structure in CF and the structural constraints in CA. However, this study refrains from using the term ‘constraint’ because it connotes an inhibition, yet, the same construct could as well play an enhancement role to the other concepts in the framework.

Overall, this study proposes that the ICT-artefact be holistically placed within three of the constructs in the framework: under material resources as a capability input; as a new category of conversion factors (technological factors); and as a component within the structural context.
First, this paper is in agreement with Haenssgen & Ariana’s (2018) argument that, in most of the operationalisations of CA, ICTs have been conceptualised as an input that enables capabilities, ‘used’ alongside other resources like food, to exploit its particular characteristics. Sen (Sen, 2010, p. 2) argues that the role of the mobile phone is typically ‘freedom-enhancing’ so that, as a resource, it is subject to conversion factors such as computer literacy and infrastructural context. The ICTs such as mobile phones have intrinsic characteristics that can expand human capabilities and therefore fulfil the same purpose as other inputs in CA. This ‘generative’ dimension of the ICT-artefact qualifies it for explicit inclusion as a material resource in CA analysis.

Secondly, in other operationalisations of CA, ICTs are conceptualised in a broader way. They are understood to interact with other conversion factors and influence how inputs are used. Gigler (2004, p. 9) states that ‘ICTs can play an important role not only in their own right, but can act as ‘agents’ for the strengthening of the poor’s capitals in multiple areas’. This operationalisation of CA therefore indicates the ‘transformative’ dimension of ICTs. Likewise, Heeks and Molla (2009, p. 34) contend that apart from being resources, ICTs can fit as conversion factors in CA. For example, technological objects can alter the characteristics (e.g. nutritional content or taste) of other inputs (e.g. food) by modifying them directly (e.g. through a cooking stove).

In agreement with the arguments of Haenssgen & Ariana’s (2018) on the ‘transformative’ dimension that technological objects possess, this study further proposes the explicit addition of another factor (technological factors), to the other three conversion factors (personal, social and environmental). This is necessitated because technological objects do not perfectly fit into any of the other factors, they neither conform to personal, social nor environmental factors.

Thirdly, taking the argument forward, since this study equated structure in CF to the ‘structural context’ in the proposed framework, then technology will also have an explicit place in the ‘structural context’. Kleine (2010, 2013) includes technology and innovations within elements of structure. Zheng (2009) argues that technology (especially ICT) co-evolves with values and choice processes.

This paper’s placement of ICTs within the ‘structural context’ is also in line with Heeks and Molla (2009, p. 34) who also argue that ICTs can act as ‘choice developers’ because they can change perceptions of personal needs and preferences. Figure 3 depicts the proposed framework.

Figure 3: Holistic Placement of the ICT Artefact in Capability Approach
4. ICT-ENABLED SOLAR SOLUTIONS

Topically, ‘e-Environment and Sustainable Informatics’ is considered to have the highest research gap among post-2015 ICT4D research priorities (Heeks 2014). The Sustainable Development Goals (SDGs) have included a specific target (SDG 7.1) solely for ensuring access to affordable, reliable and modern energy for all by 2030. This asserts the key role that access to modern energy services, plays in achieving the other SDGs (United Nations, 2015, 2017). To demonstrate the significance of the developed analytical framework, while equally addressing this topical research gap, this study collected primary data from users of Pay-As-You-Go (PAYGO) solar kits who reside in rural Kenya.

PAYGO denotes to an assortment of technologies, ownership modes, payment arrangements and financing structures that allow a solar kit customer to pay in instalments. The embedded Machine-to-Machine (M2M) connectivity disables the solar kit if a payment is overdue (G.S.M.A., 2016; M-KOPA, 2016). The kit will not discharge power until a payment is made.

At a vendor’s shop, the client normally pays around 30 USD as the initial amount, for a basic Solar Home System (SHS). The SHS consists of a battery and a control unit, a Photo Voltaic (PV) panel, a phone charger, two or three Light Emitting Diode (LED) bulbs, and sometimes other appliances. The buyer then makes regular (daily/weekly) payments, via the mobile phone, of 0.30 - 0.50 USD per day to access the services. After the client pays the full agreed amount, the system automatically switches to free use, requiring no further top ups. The customer then owns the system (BNEF & LG, 2016; G.S.M.A., 2017; M-KOPA, 2015).

5. RESEARCH DESIGN

The study adopted a constructivist ontology and an interpretivist epistemology. The study used the embedded single-case design because within the single-case (PAYGO solar intervention) there are sub-units (different providing companies/brands). The population for the study were the users of ICT-enabled Solar Home Systems who reside in Junju and Sokoke County Assembly Wards in Kilifi South and Ganze sub-counties of Kilifi County, at the Coast of Kenya. Purposive sampling was used to select study participants. For the purposes of both triangulation and transferability, the study used three data collection methods: in-depth semi-structured interviews, observations and document reviews. 24 in-depth semi-structured interviews were conducted with users of 4 different PAYGO solar companies and 4 in-depth semi-structured interviews were conducted with representatives of 4 PAYGO solar companies. The interviews, which lasted between 30 minutes and 1 hour, were audio recorded. The recordings were later transcribed and translated from Swahili to English.

6. FINDINGS AND DISCUSSION

Just like in CF, this study begins the analysis from the right of the proposed framework, coming to the left (Kleine, 2013). In line with Robeyns (2017), the study uses the term ‘development outcomes’, to refer to the achieved functionings, as a proxy to measure capabilities and wellbeing.

6.1. Development Outcomes Arising from PAYGO Solar Kits

For this study, development outcomes are conceptualised as valuable states (beings) and activities (doings) that make up a person’s wellbeing, such as being safe, resting, and being calm. Arising from the in-depth semi-structured interviews, the research participants (RPs) enumerated many states and activities that they valued and had reason to value. They also elaborated on their aspirations. From the analysis of their responses, several development outcomes emerged. This study shall however narrow down to only those development outcomes that were closely linked to the ICT artefacts that are bundled within the PAYGO solar kits. They include: ‘communicating’; ‘having additional study time’; ‘increasing sense of security’; ‘increased income’; ‘making savings’ and ‘being entertained’.

All the respondents valued ‘communicating’ to people in a different location. This development outcome was made possible through the use of mobile phones. By implication and extension, all of
them were happy with the PAYGO solar kits. The kits allowed them to keep their phones charged. Even before acquiring the solar kits, they kept spending cash regularly in order to keep their phones charged. This expenditure on charging their phones, despite their limited incomes, demonstrates the value that they had placed on communication via the mobile phones.

The respondents also valued ‘being in a well-lit environment’ especially at night (RP10, RP15, RP6, RP12, RP9).

“What I perceive as the benefit for me is the lighting. It makes my place well lit…. I do not want this place to remain dark” – Research Participant (RP) 10

“The solar kit is important because without it, there will be darkness yet we are used to bright light, just like during the day…” - RP 6

Being in a well-lit environment is a development outcome that was closely linked to ‘having additional study time’. Most respondents who valued being in a well-lit environment (RP 3, RP11, RP17, RP10, RP2), also demonstrated desire to have their children or siblings, study for longer at night, courtesy of the bright lighting from the solar kits.

“It has helped on the side of my children. Especially at night, they usually switch on the lights and put them on the table for reading. That has really helped me, - RP 3

“It even helps the children to read while at home”-RP 2

The respondents (RP10, RP11, RP12) also valued ‘increasing sense of security’. This is also a development outcome that was also closely linked to being in a well-lit environment. It may be seen as a subsequent development outcome.

“…I keep livestock, so the light has helped because I do not want this place to remain dark. The light enhances security by making this place open” - RP10

Another main development outcome that emerged from the field visits is ‘having increased income’ which is also closely tied to the development outcome of ‘making savings’ on expenditure. Different respondents (RP2, RP3, RP9, RP22) were engaged in different economic activities. Therefore, the development outcome of ‘increased income’ mattered to them because it was linked to the ICT artefacts that come together with the PAYGO solar kits. The ICT artefacts are either ‘consumed’ as a service, in exchange for cash, or they enhance an economic activity that generates cash for the owners.

“I also charge other people’s phones at a cost of only Kshs. 10…..I have some additional income. Before possessing the solar kits, I never used to charge mobile phones for people, which I now do. For the little cash that I get, I am grateful.” – RP 3

“… we have placed here the TV and we charge people to enter to watch the TV. They normally start coming in at about 6.30pm and depart at about 11.00pm” - RP 22

The respondents (RP2, RP3, RP8, RP13) also valued ‘making savings’ on their expenses. This is demonstrated by the enthusiasm that they exhibited when describing the kind of savings that they made on foregoing kerosene purchases.

“In terms of lighting the house, the solar product really helped a great deal because I stopped buying kerosene” – RP13

“whenever you have solar lamps, you do not have to spend on kerosene” - RP 8

Lastly, the respondents also valued ‘being entertained’ or ‘being relaxed’. A number of them would do it by engaging in sporting activities while others liked watching TV. Many of the residents in the villages would pay to enter video viewing shops to watch news and movies. This is demonstrated by RP 15 who liked going to video viewing shops at the market centres to watch news in the evenings. RP 21 and RP 22 operated an establishment that used to charge people to watch
TV. Going by the number of people who flocked the establishment on a daily basis, it shows that the people actually valued getting entertained.

6.2. The Holistic Place of the ICT Artefact in CA

6.2.1. ICT Artefact as a Material Resource

As a material resource, the ICT artefact becomes the means to the opportunities of value, which an individual may want to be or do. In order to achieve the desired outcomes, the individual has to consume the characteristics of the material resource while navigating the structural context to achieve the capability set. The transformation from the resource to a capability will be enhanced or inhibited by conversion factors. The individual will then have to draw from his agency and decision-making mechanisms in order to choose a functioning from his capability set.

From the findings of this study’s field visits, the following artefacts could be conceptualised as material resources – phone charger, TV and radio.

6.2.1.1. Phone Charger as a Material Resource

The phone charger that comes bundled with the PAYGO solar kits can be conceptualised as a material resource. This conceptualisation will fit those who use it for economic purposes. Those who charge other people’s phones as a service, at a cost. To the owners of the PAYGO solar kits (RP2, RP3 and RP9), the accompanying phone charger acted as a material resource that led to the development outcome of ‘increased income’.

The same phone charger in the same conceptualisation as a material resource also resulted in the development outcome of ‘increased savings’ for RP1, RP3 and RP6.

6.2.1.2. TV as a Material Resource

The TV that comes bundled together with the PAYGO solar kits can be conceptualised as a material resource, a means to achieve the different development outcomes. From the field visits, the TV artefact was able to achieve ‘increased income’ for those who were enterprising and who charged a fee, so that others could watch such as RP22.

On the other hand, the TV artefact was also able to be conceptualised as a material resource to achieve the development outcome of ‘being entertained’ or ‘being educated’ by RP12.

Through paying before watching TV at RP 22’s establishment, and also by indications by RP 15 and RP6 relatives, it is implied that they were achieving the development outcome of “getting entertained”

The TV becomes a material resource for a person who watches TV as a means to an end. Either the owner of the PAYGO kit, a member of the household with the TV bundled with the PAYGO, or a patron who has paid to watch the TV.

6.2.1.3. Radio as a Material Resource

Just like the TV, the accompanying radio in the PAYGO solar kits can also be conceptualised as a material resource. It also provides a means for RP18 to achieve the development outcome of ‘getting entertained’. Figure 4 depicts the ICT artefact as a material resource.
6.2.2. ICT Artefact as a Conversion Factor

For this conceptualisation, the ‘transformative’ dimension of the ICT artefact is demonstrated. It alters the characteristics of other material resources by modifying them directly. The ICT artefact as a conversion factor either inhibits or enhances the transformation of the material resource to capabilities. The findings indicate that the phone charger, the controller & the cloud-based system (machine to machine communication device), the TV and the mobile payment service, were the ICT artefacts (within the PAYGO solar kits) that could be conceptualised as conversion factors.

6.2.2.1. Phone Charger as a Conversion Factor

For the phone charger to act as a conversion factor in the analysis, the end goal of the usage of the phone matters. If by using the phone, the individual has achieved a functioning, then, the phone will be conceptualised as a conversion factor.

This conceptualisation was demonstrated by those respondents who only charged their phones and those of their loved ones at no pay and for personal usage.

This conceptualisation can be contrasted with the earlier conceptualisation of the phone charger as a resource. For the previous conceptualisation, the phone charging service has to be used as an income generating venture.

6.2.2.2. PAYGO Controller and Mobile Payment Service as a Conversion Factor

The mechanics of how the controller works was mostly invisible to the interviewees. However, from the interviews with the providers of the PAYGO solar kits and from document reviews, it was apparent that the whole working of the PAYGO model was pegged on how the controller works. It is the core enabler and inhibitor of the usage of the PAYGO solar kits.

Though this conceptualisation seemed invisible to most respondents, it was quite apparent to RP 15 because he encountered problems with his PAYGO solar kit. The problems were able to be sorted
remotely via the controller. This enabled him to continue with the use of the other material resources provided by the PAYGO solar kit such as lighting bulbs and watching TV.

Unlike the controller as an artefact, the mobile payment as an ICT artefact was visible to the respondents. They all knew that they had to make regular payments or else, their electricity would get disconnected. They knew that it was the mobile payment that enabled their getting electricity in order for them to pursue their different development outcomes.

6.2.2.3. TV as a Conversion Factor

The TV artefact in the PAYGO appliances can also be conceptualised as a conversion factor. Just like the phone charger, for a TV to be the conceptualised as a conversion factor, the development outcome matters. There has to be another capability input (material resource) that gets transformed into a capability. The TV has to influence the conversion process from a resource to a capability. The presence of the TV should either increase or reduce the attainment of the development outcome.

The TV was conceptualised as a conversion factor when it was used to enhance attainment of other development outcomes. For the case of RP 22 who owned a traditional bar, the TV was used to attract patrons. The TV used to be left on, till the patrons were done with partaking their palm wine.

Though other respondents who owned traditional bars did not get the TV with their PAYGO solar kits, they indicated similar intentions. They believed that being in possession of a TV would have attracted more customers to their bars so that they could get ‘increased income’ from the sale of palm wine. Figure 5 depicts the ICT artefact as a conversion factor.

![Figure 5: ICT Artefact as a Conversion Factor](image)

From the proposed framework, the ICT artefact can be broadly conceptualised as a conversion factor. This is as an addition to the three traditional conversion factors (personal, social and environmental) (Haenssgen & Ariana, 2018). Conversion factors influence how other material resources are used as means to development outcomes (functionings). In this way, the ICT artefact as a conversion factor is understood to interact with other conversion factors. This conceptualisation is in line with other scholars who have alluded to such a conceptualisation but have not gone ahead to develop a framework that explicitly places it as a conversion factor (Gigler, 2004; Heeks & Molla, 2009; Zheng, 2009).
6.2.3. ICT Artefact as a Structural Context Component

Components in the structural context can have great influence on the conversion factors as well as on the capability sets directly. This is unlike conversion factors which only help to convert characteristics of resources into capabilities. The ICT artefact conceptualised in this way should also have the ability to influence other conversion factors in the conversion process.

The findings indicate that the phone charger, TV and PAYGO controller could be conceptualised as structural context components.

6.2.3.1. Phone Charger as a Structural Context Component

This is the third conceptualisation of the same ICT artefact, in the same PAYGO solar kit, but intended to achieve different development outcomes. The phone charger is conceptualised as a structural context component. This conceptualisation is used when the phone gets to be conceptualised as a conversion factor.

When the phone influences the conversion of other material resources into development outcomes, by the phone charger influencing the working of the phone, then it will ultimately be influencing a conversion factor and therefore fall within our definition of what constitutes a structural context component.

In a case where an individual uses his/her phone to conduct or facilitate economic activities, then, the phone charger will influence the usage of the phone. From the field visits, RP1 and RP6 depend quite a bit on their mobile phones for their livelihood. RP1 is a middleman for selling cattle. He normally gets contacted via phone, whenever there are cattle to be sold. RP6 normally taps palm wine from the palm trees and sells it to the traditional bars. He mostly contacts his clients via the mobile phone, to get orders. He also uses his phone to contact buyers of bananas when they are on season.

In such cases, the phone charger can be conceptualised as a structural context component because it either enhances or inhibits the usage of the mobile phones and in these two cases, the mobile phones are acting as conversion factors in getting to the capability of “increased income”.

6.2.3.2. TV as a Structural Context Component

This is similarly a third conceptualisation of the TV within the proposed framework. The TV will be conceptualised as a structural context component when it alters perceptions and changes preferences. The findings demonstrate that the TV altered behaviour and change preferences. In this conceptualisation, the TV does not come between the material resource and capabilities but influences the choice and agency that occurs between the capabilities and functionings. This demonstrates the alteration in preference formation.

Figure 6 depicts the ICT artefact as a component of the structural context.
In the proposed framework, the structural context is an overarching concept that affects and gets affected by almost all the other concepts in the framework. This is in line with Heeks and Molla’s (2009) argument.

7. CONCLUSION AND RECOMMENDATIONS

Being attentive to the different conceptualisations of the ICT artefact as demonstrated by this study can be of help to practitioners and providers of ICT4D interventions. The providers of the ICT artefacts will be able to consider how the artefacts play out in the development journey of their customers. This will enable them to put in place mechanisms that will enhance the related constructs to help achieve the valued development outcomes.

Additionally, the different conceptualisations demonstrated by the study can be of help to policy makers, especially those seeking to create social policies that enhance people’s capabilities. Having the bigger picture of all the conceptualisations of the ICT artefact will give guidance on what policies to make for greater impact.

For further research, the study recommends the use of other research designs such as multiple case studies. Employment of ethnography could also help bring out aspects about the respondents that this cross-sectional study could not.

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LEGITIMIZATION OF DATA QUALITY PRACTICES IN HEALTH MANAGEMENT INFORMATION SYSTEMS USING DHIS2. CASE OF MALAWI.

Martin Bright Msendema, University of Malawi, mmsendema@poly.ac.mw
Wallace Chigona, University of Cape Town, wallace.chigona@uct.ac.za
Benjamin Kumwenda, University of Malawi, benjkum@gmail.com
Jens Kaasbøll, University of Oslo, jensj@ifi.uio.no
Chipo Kanjo, University of Malawi, chipo.kanjo@gmail.com

Abstract: Medical doctors consider data quality management a secondary priority when delivering health care. Medical practitioners find data quality management practices intrusive to their operations. Using Health Management Information System (HMIS) that uses DHIS2 platform, our qualitative case study establishes that isomorphism leads to legitimization of data quality management practices among health practitioners and subsequently data quality. This case study employed the methods of observation, semi-structured interviews and review of artefacts to explore how through isomorphic processes data quality management practices are legitimized among the stakeholders. Data was collected from Ministry of Health’s (Malawi) HMIS Technical Working Group members in Lilongwe and from medical practitioners and data clerks in Thyolo district. From the findings we noted that mimetic isomorphism led to moral and pragmatic legitimacy while and normative isomorphism led to cognitive legitimacy within the HMIS structure and helped to attain correctness and timeliness of the data and reports respectively. Through this understanding we firstly contribute to literature on organizational issues in IS research. Secondly, we contribute to practice as we motivate health service managers to capitalize on isomorphic forces to help legitimization of data quality management practices among health practitioners.

Keywords: Data quality, Data Quality Management Practices, Legitimization, DHIS2, Isomorphism

1. INTRODUCTION

Within the neo-institutional thinking we learn of the role of legitimacy and isomorphic forces in trying to understand success and changes in organizations which are attained by conforming to constraints within their operating environments (DiMaggio & Powell, 1983). The term legitimacy means a generalized perception or assumption that actions of an entity are desirable, proper, or appropriate within some socially construed systems or norms, values, beliefs, and definitions (Lebballi, 2015). We share the understanding of isomorphism as a constraining process that forces one unit in a population, like an organization, to resemble other units that face same set of environmental conditions (Currie, 2012). The interplay between isomorphism and legitimacy is experienced in such a way that in the process of isomorphism institutions obtain legitimacy (Díez-Martín, Díez-de-Castro, & Vázquez-Sánchez, 2018). The work of Freitas & Guimarães (2007) demonstrates how various isomorphic forces lead to various types of legitimacy in organizations. In their study they found that isomorphism led to cognitive legitimacy in the organization they were studying.
We hence envisage that if Ministry of Health in Malawi legitimize data quality management practices (data collection, processing, reporting, monitoring and use) through isomorphism across the players in Health Management Information System (HMIS), a homogeneous behaviour which is conforming to data quality management practices can be achieved among the stakeholders leading to improvement in data quality for all the players.

The DHIS2 has been designated as a platform to support data collection, analysis, storage and use with the hope of attaining data quality in the Malawi HMIS (Ministry of Health -Malawi, 2018). Data quality is a common discourse in routine health information systems research. Poor data quality is a serious concern in many disciplines including health, where it often leads to the loss of innocent lives (Mettler, Rohner, & Baacke, 2008). Within this debate, the definition of data quality has been one of the interesting topics. There have been different schools of thoughts (Chen, Hailey, Wang, & Yu, 2014 ). Nonetheless, the notion that data quality relates to how the data satisfy the expectations of the user or how it fits with the aims of its use has been hugely accepted among scholars (Harpe & Roode, 2008; Chen, Hailey, Wang, & Yu, 2014 ). This study hence adopts that definition. Although implementation of DHIS2 has contributed to tangible success, recent studies have reported that political, social and cultural issues are among the challenges affecting the successful implementation of the DHIS2 across the developing countries (Dehnavieh, et al., 2018). For this reason, we found that DHIS2 is a compelling example to use when attempting to explain how understanding of the interplay between legitimacy and isomorphism may contribute to actions to improve data quality in HMIS.

Diversity of stakeholders in health information management in Malawi creates a complex HMIS institution that is difficult to manage. In most developing countries, the governments are supported by health partners who have specific objectives and modus operandi creating a battleground (Currie, 2012). In Malawi, within the data processing chain the government (Ministry of Health) is the data owner with its staff (medical, management including ICT support and statisticians). Other actors include health partners who provide technical staff (ICT specialists) and medical staff (programme coordinators). Basing on a definition of institutions as the humanly devised constraints both formal (rules or laws) and informal (norms of behaviour and codes of conducts) that structure human interaction and their enforcement mechanisms (Wang & Ching, 2013), then we can perceive HMIS as an institution; HMIS has its own practices, rules and norms (Kimaro, 2006). However, the challenge with Malawi’s HMIS is that it has multiple players. Such an environment expects all the stakeholders to conform to these constraints regardless that they may each have individual characteristics and expectations.

One of the problems that Malawi is experiencing from having multiple stakeholders in HMIS is that other stakeholders do manage to get the expected quality data while others still struggle to attain high levels of data quality. Among those reported with low data quality problem, studies have shown that timeliness and correctness continue to be their concern (O’Hagan, et al., 2017; Statistics Norway, 2017). Such a problem may lead to other health interventions being successful while others failing as their plans and decisions may not be based on reliable data. In the long run this deprives Malawi of the opportunity to meet the Sustainable Development Goal 3 whose target is ‘Good Health and Well Being for all’ (United Nations, 2017). This makes us contemplate on the legitimization of the data quality management practices among the various stakeholders as one of concepts that could help explain the phenomenon. Our curiosity is derived from the argument that legitimacy is key to successful implementation of difficult polices in organization (Wang & Ching, 2013, p. 523). Researchers in Malawi’s HMIS have pointed at availability of resources and incentives as the reason behind differences in data quality between programmes under health partners and those not under direct interest of the health partners. Much as we appreciate that resources and incentives may influence adherence to data quality management practices, we fear that different norms (formal and informal) among the stakeholders contribute to different ways of legitimization among the players. Hence this study attempts to explain how data quality management practices attain legitimacy in HMIS. We posit that the findings can help practitioners.
to know how to manage the legitimacies towards high data quality across the entire HMIS. Reflecting on the argument that there is dearth of research focusing on how social issues affect success of information systems like the HMIS (Avgerou, The significance of context in information systems and organizational change, 2001; Aqil, Lippeveld, & Hozumi, 2009), we believe the study findings contribute towards a social perspective of actions to improve data quality in HMIS (Avgerou , The significance of context in information systems and organizational change, 2001; Aqil, Lippeveld, & Hozumi, 2009).

From this background, we build on the two important concepts, legitimacy and isomorphism and attempt to answer the question:

*What role do medical professional formal and informal norms play in operationalization of data quality management practices in HMIS that are using DHIS2?*

2. STUDY SETTING

2.1. DEMOGRAPHIC PERSPECTIVE

The 2018 census report indicates that Malawi’s population is near 20 million of which 84% live in rural areas (National Statistical Office, 2019). Within the Southern Africa Development Community (SADC) region Malawi is argued to have the lowest Gross Domestic Product (GDP) of $430. It has an economy is agro based economy f which agriculture contributes about 28% to the GDP (Southern African Development Community, 2020). With the majority of the population living in the rural areas, they rely on free health care service from the government (Makwero, 2018). HIV and Aids, Tuberculosis, and malaria remain a significant challenge to health serving delivery with HIV leading on major causes of death at around 25% of the deaths. Malawi is probably one of the most donor supported health system with donors funding 80% of its development expenditure which in 2019 was about USD135 million (UNICEF, 2017; Ministry of Finance, 2019).

2.2. MALAWI HEALTH SYSTEM

Malawi follows a primary health care approach which is a whole-of-society approach to health and wellbeing centered on the needs and preferences of individuals, families and communities (Makwero, 2018; World Health Organization, 2019). The health system has a four-level structure comprising of community level, primary level, secondary level and tertiary level. Beyond the service delivery levels are Directors of Health and Social Services (formerly District Health Officers) who are responsible for management of health services and facilities including providing direction at the district. The Ministry of Health Headquarters is the central government’s agent for policy making, standards setting, quality assurance, strategic planning, resource mobilization, technical support, monitoring and evaluation and international representation (Ministry of Health, 2016).

2.3. Health Management Information Systems in Malawi

HMIS implementation structure for Malawi has five levels: Community, facility, district, zone and national. This reflects on the national administrative organization of the health system structure (recall Section 2.2). The need to include informal sources of data as advocated by researchers such as Kanjo, Kaasboll and Sahay (2012) has seen data collection starting from the community (village) level, which is the first level of the five in the health system. Health Surveillance Assistants (HSAs) entrusted with data collection at this level, collect data manually from all possible health indicators on services acquired in the local community. After the community level, there is the facility level (health center). Data clerks and focal person collect data at health centers and hospitals, see Figure 1. The focal persons (who are nurses or clinicians) and data clerks (statisticians) compile the data manually on paper forms. At district hospital final reports consists of data from both the hospital and from all the health centers in the district (Chikumba, 2017). After reports are compiled, they are captured into DHIS2 and at each district level, there is an HMIS officer who oversees data management issues.
THEORETICAL FRAMEWORK

We start the theoretical framing of the study on the premise that “the idea of legitimacy is key to successful implementation of difficult policies and that any institution is legitimate when a large part of its target population recognizes and obeys the normative incentives set out by this institution” (Wang & Ching, 2013, p. 523). Within institutional theory it is argued that legitimacy must be granted by the governing institutions like the Ministry of Health and the Health Partners or local members of the environment like the HSAs. This can be achieved if the stakeholders realise instrumental value of organizational activities (pragmatic legitimacy), recognize the activity as morally good or there is ethicality of organizational activities (moral legitimacy) or acceptance of an activity as essential or permanent part of their behaviour (cognitive legitimacy) (Randrianasolo & Randrianasolo, 2017) (Bridwell-Mitchell & Mezias, 2012; Randrianasolo & Randrianasolo, 2017).

Now to ensure a large part recognizes the legitimacy, institution theory further provide mechanisms called isomorphic forces. Isomorphic forces / pressures are pressures or decisions by organizational actors that lead the organization to adopt structures, procedures, systems and terminology shared by other organizations of the same type (ECDPM, 2005). They are forces that lead to heterogeneous behaviour among stakeholders but all resulting into the legitimateness of data quality management practices. These forces are coercive (from rules, regulations), mimetic (occurring from uncertainties where behaviors are just imitations) and normative (from established patterns, policy, standards or training) (Currie, 2012).

Through these institutional theoretical concepts (legitimacy and isomorphism), we argue that isomorphic forces could play crucial role in helping us understand how the target population in HMIS, see Table 1, get to legitimize data quality management practices under the influence of isomorphism (Sampaio de Freitas & Guimarães, 2007).

STUDY LOCATION AND PARTICIPANTS

This is part of a longitudinal study which started in November 2020 and is expected to finish in May 2021. We first collected data in Lilongwe which is the central administrative district and later in Thyolo district. The study participants were drawn from four groups: (i) HMIS Technical Working Group (TWG), (ii) Hospital/facility Managers, (iii) Data Managers and (ii) Medical practitioners. The specific composition of the participants is presented in Table 1.
3.2. STUDY APPROACH AND METHODS

This was a qualitative case study and used observation, semi structured interviews and study of artifacts as data collection tools. There was no specific sequence but multiple sources helped to triangulate and validate the results. Semi structured interviews involved members of the HMIS TWG at the Ministry of Health Headquarters, District Health Administrators including HMIS Officer, Data Clerks and Health Facility In-charge. This is a strategic level group and the focus was supervision and feedback, training and support and relationship in the various roles. Despite the COVID-19 pandemic we conducted face-to-face interviews while following the COVID-19 prevention guidelines. This was similar in the facilities and at the district where the primary method was observation. Through the field participant observation, the first author gathered first-hand information and particular attention was given to work environment (offices), work processes (procedures), data collection tools and report forms, use of support technology, data use, and supervision. Active engagement with the participants helped to get in-depth understanding of the data quality management practices, see Figure 2.

<table>
<thead>
<tr>
<th>Group</th>
<th>Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>HMIS Technical Working Group</td>
<td>CMED(1) , DHO(1), HMIS OFFICE(1)</td>
</tr>
<tr>
<td>Facility Managers</td>
<td>Health Center In-charge (2),</td>
</tr>
<tr>
<td>Medical practitioners</td>
<td>Focal Persons (nurses, Clinicians -3), HSAs (10)</td>
</tr>
<tr>
<td>Data Managers</td>
<td>HMIS Officer, Data Clerk(2)</td>
</tr>
</tbody>
</table>

Table 1: Specific composition of the study participants

Observation and study of artefacts happened from the Village Clinics run by HSAs, Health Centres to Hospital at the district. The study of artefacts included performance reports from DHIIS2, health passport books, health registers, reporting forms both for capturing into DHIS2 and use at the facility. In the study of artefacts attention was on condition of HP book, actions being taken when there is a problem, care of the registers, records clarity and correctness. We did a random assessment of the previous reports submitted between December 2020 and January 2021 to validate the correctness and check the clarity of data. This helped to ascertain what the participants were saying against what they were actually doing.
3.3. DATA ANALYSIS
The study used qualitative data analysis applying both inductive and deductive strategy where codes were based on institutional theoretical constructs, legitimacy and isomorphism. We based on three types of legitimacy: pragmatic, moral and cognitive (Freitas & Guimarães, 2007; Bridwell-Mitchell & Mezias, 2012). On isomorphism we used coercive, normative and mimetic isomorphism as our initiating codes (Currie, 2012; Kezar & Bernstein-Sierra, 2019). However, we also acknowledged the interesting emerging codes. We used a frequency table to help us determine important codes basing on frequency. However, pertinent codes were not just being left out regardless of their low frequency. Later we analyzed the relationship among the codes to build themes. These provided us with concepts of legitimacy as being experienced by the stakeholders in HMIS. After this we used the three isomorphic mechanisms to code isomorphic pressures being exerted in the HMIS. Again, by analyzing the relationship among the second group of codes, we established themes constituting the isomorphic pressure being experienced. Finally we analyzed the relationship between the legitimacy and isomorphic themes, see Table 2.

<table>
<thead>
<tr>
<th>Isomorphic</th>
<th>Legitimacy themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normative</td>
<td>Moral</td>
</tr>
<tr>
<td>Mimetic</td>
<td>√</td>
</tr>
<tr>
<td>Coercive</td>
<td></td>
</tr>
</tbody>
</table>

**Table 2 Classification and relationship of themes**

4. FINDINGS
In regard to legitimacy we identified two sets of themes relating to data quality management practices. First meso level, which related to District Health Office and District Health Information System Office. Second, the micro level which related to medical facilities: Hospital, Health centers and Village Clinics which are manned by Health Surveillance Assistants. Table 3 presents the legitimacy themes which were further classified into three: pragmatic, moral and cognitive.

<table>
<thead>
<tr>
<th>Thematic Set</th>
<th>Legitimacy Type</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>1- Meso Level</td>
<td>Pragmatic</td>
<td>i. Significance of data</td>
</tr>
<tr>
<td></td>
<td>Cognitive</td>
<td>ii. Implementation mechanisms</td>
</tr>
<tr>
<td>2- Micro Level</td>
<td>Pragmatic</td>
<td>iii. Individual conviction</td>
</tr>
<tr>
<td></td>
<td>Cognitive</td>
<td>iv. Shared responsibility</td>
</tr>
<tr>
<td></td>
<td>Moral/ Pragmatic</td>
<td>v. Significance of data</td>
</tr>
<tr>
<td></td>
<td>Cognitive</td>
<td>vi. Capitalizing existing structures</td>
</tr>
</tbody>
</table>

**Table 3 List of legitimacy themes recognized in the findings**

We identified three isomorphic themes which were classified into two: mimetic and normative, see Table 4. We noted that these three themes relating to isomorphic forces played a role in helping legitimizing the data quality management practices. These are (a) policy and contractual obligations, (b) peer influence and (c) individual conviction.

<table>
<thead>
<tr>
<th>Isomorphic Force Type</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normative</td>
<td>Policy and contractual obligations</td>
</tr>
<tr>
<td>Mimetic</td>
<td>Peer influence</td>
</tr>
<tr>
<td></td>
<td>Individual conviction</td>
</tr>
</tbody>
</table>

**Table 4 List of isomorphic themes recognized in the findings**
4.1. LEGITIMACY THEMES

The subsequent subsections provide a detailed explanation of the themes relating to legitimacy attributes stakeholders experienced in data management practices.

i. SIGNIFICANCE OF DATA

Observations of the health service delivery process showed that participants value and use data in their work process. Notable observations include determining proper advice to mothers basing on their children’s growth graph. Other instances include determining next schedule for women vaccine. “You were not supposed to come today for vaccination, come on 18th March”. These observations were made from two health centres and including two village clinics in each of the health centres. It involved under five and family planning clinics. “Data is very important, it help us is our programming”. This theme was prevalent at both the meso and micro level.

ii. IMPLEMENTATION MECHANISMS

The findings showed that stakeholders through government, Ministry of Health, have put in place structures to support data quality management practices across these key levels in data collection. Key are establishment of positions to support data management like Data Clerks both in Health Centres and Hospitals, and Health Management Information Systems Officers at district level.

iii. INDIVIDUAL CONVICTION

It was interesting to see personal effort among the participant especially among Data Clerks and Health Centre In-charges. “I have never done training since I left school, but I just put effort to learn how to use these registers and produce reports”. “It is painful that at times we have to use our own resources to buy internet data so that we can send reports. They promise to reimburse but two months ago we were not reimbursed up to now” The same was noted among Health Surveillance Assistants, who had said that they rarely get supervised but always attempt to ensure proper record management arguing “Its inhuman not to do the right thing just because you are not being supervised, that’s spiritually immoral”.

iv. SHARED RESPONSIBILITY

Unlike the rest of the themes, this theme was based on a code with less frequency. This, we noted, was due to the diverse approach used by the Health Centres in report generation. However, it was interesting because with the team approach, we recognised among the participants, the will to criticise and correct each other in attempt to ensure that they submit reliable reports. “We try to avoid queries from the district and if queries come we take the blame on us all”.

v. CAPITALIZING EXISTING STRUCTURES

This theme was drawn from two observations; the use of Health Surveillance Assistants (HSAs) as primary data collectors and positioning of data collection points (Data Clerks) within the medical process of diagnosis and prescription. For instance, Data Clerks were usually positioned between Clinicians and pharmacies. Similar observations were made in maternal health sections where In-charge of sections were made Focal Persons for data collection and reporting.
4.2. ISOMORPHIC THEMES

This subsection explains in detail themes relating to isomorphic pressures being exerted on stakeholders who are involved in data management practices. As illustrated in Table 4 these we classified into mimetic and normative isomorphism.

i. POLICY AND CONTRACTUAL OBLIGATIONS

The theme was drawn from two observations, first to do with establishment of structures which are supporting the data management in medical facilities like Data Clerks and HMIS Officers which is seen in government policies. Second was among Focal Persons who work with Health Partners in various programmes. The finding showed that the Focal Persons were obliged to satisfying contract obligations they had with the Health Partners in respective programmes.

ii. PEER INFLUENCE

In one of our Village Clinics visit, we appreciated the role that Senior Health Surveillance Assistants played in guiding others into ensuring proper record management. “Mr X, during our last meeting we discussed well these same shortfalls but it seems that here we are experiencing the same problems. When we assigned a role to oversee data collection in this catchment area, we recognised your potential and trusted that will help manage these problems”. Similar observations were made in other areas and another notable one was at Centre Y where the reports were being generated during a meeting. Members would query each other and clarifications or corrections were being made.

iii. INDIVIDUAL CONVICTION

From the HSAs, Data Clerks to Health Centre In-charge we noted a personal will to ensure data was collected, processed and sent in time. Despite the challenges which they complained like lack of training and support, they all in their own way made sure they produced and submitted the reports. Each of them individually or as a group had a workaround. “I orient myself”, “we just train them on job”, “I sometime end up using my own airtime but not often”, such were the common responses.

5. DISCUSSION AND CONCLUSION

The demand for quality data has been a long time aspiration in health service delivery in Malawi both at operational and strategic levels. Deliberate policies have been implemented over the past decade to support actualization of data quality management practices and subsequently realization of quality data (Ministry of Health -Malawi, 2018). Much as we appreciate the progress realized so far, this study contributes towards those efforts by explaining how the existing practices in the medical profession are contributing towards legitimization of the data quality management practices from health centers to districts.

5.1. LINKING ISOMORPHISM AND LEGITIMACY

Researchers have attempted to answer the question whether isomorphism leads to legitimacy (Freitas & Guimarães, 2007). The findings in this study are similar to prior studies and agree to those findings which suggested that that isomorphism play a role in legitimacy (DiMaggio & Powell, 1983). Although there is a continued debate on whether legitimacy leads to adherence, in this paper we will discuss our finding regarding the how isomorphic forces lead to legitimacy of data management practices in HMIS. Figure 3 illustrates the link between these two concepts.
Data quality management practices guide those involved in managing the data; they are defined in policies and standard operating procedures. However, these practices are finding users who are already used to their own ways of working and having their own focus of attention. In case of health care delivery the focus is inevitably treatment of the patients. Bringing these data quality management practices may come in as intrusive in their working behavior. However, environmental conditions may help the players to accommodate the practices, such that over time the practices become socially accepted within the members’ working culture. That’s becoming legitimate (Randrianasolo & Randrianasolo, 2017). This legitimacy, from our findings trickles down from top to bottom, for example, the Ministry of Health created Data Clerk positions (establishments) as one of the organizational fields which were positioned within the health service delivery chain. We argue that by establishing the role of Data Clerk it signifies the acceptance of this role as an essential role within the ministry and within care delivery in particular. This we recognized as cognitive legitimacy realized through availability of implementation mechanisms, see Table 3. Further to this when these Data Clerks execute their duties, they are bound to work within their job descriptions as specified in the originating policies. We hence posit that a kind of normative isomorphism comes into play to influence the legitimization of this organizational field (Data Clerk) as these and practitioners like Directors of Health and Social Services (DHSS), formerly District Health Officers (DHOs) are bound by policy to ensure the roles expectations are met. The same kind isomorphism is seen in legitimization of data quality management practices among Focal Persons who are bound to adopt these practices in an attempt to satisfy contractual obligations agreed with Health Partners in their various programmes, see Table 4.

The narration above would be similar to capitalization of existing structures as form of Cognitive legitimacy. A good example is where we see the use HSAs or Clinicians as Focal Persons for data collection. What we see is that by using existing roles it is made easy for the data management practices to be embedded within their working practices. With this in mind we notice some form of normative isomorphism since these are obliged to work within some predefined norms or standards.

We then discuss significance of data as a kind of moral legitimacy first among HSAs who deliver community health care services mostly in village clinics and end up developing relationships with the community members. To them they see it that they ought to have quality data so that they can deliver quality services to the members of the community. They have demonstrated that they use the data in their day to day activities and that they find it rather inhuman to deprive a fellow human a proper service just because they did not keep proper records. Hence as they work they do their best, regardless of challenges, to ensure they collect data and use the data. Although others may argue otherwise, we see some kind of mimetic isomorphism just because this is more or less personal conviction than based on some kind of standard or regulation. On the other hand, we see significance of data as a pragmatic legitimacy which is being driven by some form normative isomorphism. This
time we relate it to the HMIS Officers and the DHSS who are pressurized through policy and operating standards to produce reports to support their planning and performance in their management of health care service delivery within their districts.

We finish our discussion of the link between legitimacy of data quality management practices and isomorphic forces with a reflection to the HMIS Officers and the DHSS who are pressurized through policy and operating standards to produce reports to support their planning and performance in their management of health care service delivery within their districts. In this, we envisage a mimetic force emanating from peer pressure as individuals try to avoid letting down others. In the long run, we see that through team working data management practices become part of their work.

This understanding of the link between legitimacy and isomorphic pressure in HMIS using DHIS2, we argue can help to determine actions aimed at improving data quality. Our understanding is similar to the work of Rabearivony, Eloi, Jules, & Thorstrom (2008) who emphasized the importance of understanding informal institutional environment arguing that it is crucial in reaching to objectives, which in our case is quality data for improving health service delivery.

5.2. DATA QUALITY AND LEGITIMACY
We have argued in Section 5.1 that isomorphic forces play a role in legitimization of data quality management practices. Further, in Section 1 we defined data quality as how data satisfy expectations of the users, we further pointed out that among the dimensions of data quality, the study opted to focus on correctness and timeliness. Basing on this understanding we now explain how legitimization of data quality management practices by institutions may lead to data quality as illustrated in Figure 4.

Firstly, we look at how the legitimization leads to correct data (correctness) among HSAs. We state that through shared responsibility which we related to pragmatic legitimacy, the HSAs correct or validate their data especially when they are producing reports. The reports in turn help to satisfy their expectations, for example they highlighted getting the right vaccine and family planning doses. The HSAs indicated that they have to give correct information because it affects the supplies which are based on their reports. During the study, we noted the HSAs strived to make sure they were as correct as possible specific data. For example, these are indicators for vaccine: quantity received, quantity administered, and quantity damaged.

Secondly, we look at capitalization of existing structures which we related to cognitive legitimacy. In this we see the Health Partner engaging nurses or clinicians as Focal Persons in reporting. In turn, the Focal Persons are forced to satisfy the contractual obligations and in the long run the Health Partners get their reports in time for timely decision making. These in essence shows that legitimacy may help to meet some of the characteristic of data quality like correctness and timeliness.

6. CONCLUSION
Existing health professional practices and structures provide two isomorphic forces (mimetic and normative) that are contributing to legitimization of data quality management practices in health

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management information systems. Subsequently, the legitimization leads to achieving data quality especially correctness and timeliness. However, study findings did not establish presence of coercive isomorphism. This we attributed to the sideling of key regulatory bodies in the medical field: the Nurses and Midwives Council of Malawi (NMCM) and the medical Council of Malawi (MCM). We hence argue for further studies to explore how these influential bodies can play a role in influencing legitimization and adoption of the data quality management practices. Their presence we posit can help to go beyond mere legitimacy to accountability of key players in data quality management within HMIS hence increasing data quality in routine health information especially those using DHIS2 platform.

This study is part of a longitudinal study and the field work only involved one of the two districts earmarked for the entire study. As such, the findings may lack a comparative view of the experiences in the other areas. However, we feel that the findings of the study provide a foundation to explore further the issues of legitimacy and isomorphism and indeed their application to data quality management practice in HMIS. Another concern was that some of participants who participated in the study were newly recruited and may have less experience to share, nonetheless, we are content that the wider pool of participants helped to mitigate the shortfalls from this concern.

REFERENCES AND CITATIONS


A PROPOSED FRAMEWORK FOR THE COMPREHENSIVE SCALABILITY ASSESSMENT OF ICTD PROJECTS

Gugulethu Baduza, Rhodes University, g.baduza@ru.ac.za
Caroline Khene, De Montfort University, caroline.khene@dmu.ac.uk

Abstract: The scalability of ICTD projects is an imperative topic that has been neglected in the field. Little has been written or investigated about the assessment of the scalability of ICTD projects due to factors, such as the lack of proven business models for success, the high failure rate of projects, undefined aspects of assessment, and the small number of projects that have scaled. Therefore, there are various factors that should be taken into consideration to alleviate the challenges experienced in the process of scaling up. This research study is guided by an investigation into how can the scalability of an ICTD project be assessed using a comprehensive evaluation approach that considers the impact and potential sustainability of the project. This research study proposes a Comprehensive Scalability Assessment Framework (CSAF), using systems theory and amplification theory to guide the theoretical analysis and empirical investigation. A theorizing approach is used to develop the framework, which is structured around three components: assessment guidelines and proceeding domains of evaluation; four scalability themes (stakeholder composition, models feasibility, resources sustainability and resilience) and judge scalability.

Keywords: ICTD pilot projects, Comprehensive Scalability Assessment, Stakeholder

1. INTRODUCTION

Social pilot programmes that are targeted at societal development, according to Toyama (2015), usually have no impact because of their nature and are scaled when they should not have scaled, usually for three reasons. These are bad program design which, firstly, includes ‘a problem with the theory of the intervention’; secondly, with ‘how the theory was implemented’; and the third reason relates to faulty implementation which would result in the project failing at scale (Toyama, 2015). All these reasons provide the greatest motivation as to why a project should be evaluated before the project proceeds to scale. In the Batchelor and Norrish (2007) framework for the assessment of an ICT pilot project, the outcomes and data from the project purpose assessment provide a base on which questions can be asked as to how scale will happen under similar conditions in the next environment.

Scaling up has multiple definitions, but it is generally agreed that scaling up means the expansion, adaptation, replication and sustaining of desired policy, programme and practice changes (World Bank, 2012; Walsham, Robey and Sahay, 2007; Gerhan and Mutula, 2007; Batchelor and Norrish, 2007). Implied in the definitions of scaling up is the assumption that we scale up in order to expand valued outcomes, such as poverty reduction, or meeting the goals of the country and community, and any World Bank strategies (World Bank, 2012). Up-scaling also implies increasing benefits to other communities, where they can access the services provided by the up-scaled project. A participative ICTD approach makes a difference when scaling-up, this is the case when it involves
people based on the identification of their needs and a collaborative assessment to monitor the outcome of the project (Gerster and Zimmermann, 2005).

2. COMPREHENSIVE SCALABILITY ASSESSMENT OF ICTD PROJECTS

The process of conducting a scalability assessment is a process that determines whether a project should be scaled-up or not. Theorizing, according to Weick (1989), is a process that assists in developing a disciplined approach to structure the imagination of the people or person developing the theory, as it allows for more options to strengthen the process of theorizing. The key elements of this process to strengthen theorizing are entrenched in being able to identify and understand the relationships, interdependencies and the connections in the subject being investigated (Weick, 1989). The process involved three stages which are problem formulation, thought trials and selection criteria which informed the process.

The results of the theorizing process, where guided by a criteria that is in table 1.1. The development of the ‘Comprehensive Scalability Assessment Framework’ is based on the review of 9 frameworks that are aimed at conducting a scalability assessment in fields which contribute to ICTD. Critical themes such as stakeholder composition, resource sustainability, resilience and model feasibility have been identified as key points in the assessment process, and have contributed to the development of this proposed framework. The concept of comprehensive evaluation becomes almost non-existent in reference to ICTD pilot projects. The focus of such ICTD pilot projects tends to be on the broad outcomes of the initiative, in relation to the tangible and quantifiable indicators that are pleasing to the external stakeholders. The need for a comprehensive evaluation of ICTD pilot projects has increased so as to ascertain the outcomes of the project and their scalability or replicability to the existing project or to a new contextual environment.

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Focus is on conducting a scalability assessment</td>
<td>The framework should focus on assessing if a programme or project is scalable and should indicate what methods were used to determine if it is ready to scale.</td>
</tr>
<tr>
<td>2. Indicates what is assessed in the project</td>
<td>The aspects that are assessed are mentioned and the methods to access them are available. This will assist in identifying possible themes and how they are assessed.</td>
</tr>
<tr>
<td>3. Components can possibly be adapted and applied in ICTD and local context</td>
<td>Although grouped into categories, the approaches or frameworks have relevance to the ICTD field and can assist in its being applicable to the context and relatable to ICTD.</td>
</tr>
<tr>
<td>4. Approach or framework meets criteria in Table 1.1</td>
<td>The approaches or frameworks can be analysed based on the template in Table 6.4 that will be used to analyse the selected approaches or frameworks.</td>
</tr>
<tr>
<td>5. Evidence of mixture of theoretical propositions and case study application</td>
<td>As theory will be proposed in the approach or framework, it will inform the themes considered, but the practical application in a case study will provide insights into lessons learned, tools, responses, etc, that will contribute to the proposed framework.</td>
</tr>
</tbody>
</table>

Table 1.1 Criteria used for selecting approaches or frameworks to be analysed

Crucial to the comprehensive evaluation of ICTD pilot projects is the basis of understanding the need for such a program through the form of a needs assessment, in order to solidify the motivation.
for having such a project in relation to the prototype and to the social agenda of the project. The comprehensive evaluation needs to encompass a programme theory assessment, process assessment and outcome assessment in order to contribute to a clearer scalability assessment that encompasses these elements. The focus of this paper will be to introduce a proposed approach to conduct a scalability assessment based on a comprehensive evaluation of an ICTD pilot project. Enabling this focus will involve unpacking the structure and the composition of the framework.

A scalability assessment aims to review various areas and elements in a programme to determine if the programme is ready to scale (Cooley and Kohl, 2012). The desired outcome of the process is for the review of the various frameworks to work towards developing aspects that could contribute to the framework. As indicated by Weicks (1999), it is a trial-and-error process that is necessary, in the theorising process, to develop a commonality amongst the concepts of assessing for scalability. The review of middle range theories supports the process of thought trials that assist in the development of a scalability assessment framework. Table 1.2 is a review of the frameworks that were selected and reviewed in the development of the Comprehensive Scalability Assessment Framework.

<table>
<thead>
<tr>
<th>Category</th>
<th>Approach or Framework</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social Programmes</td>
<td>Framework 1: Scaling Up: From Vision to Large-scale Change, A Management Framework for Practitioners (Cooley and Kohl, 2012).</td>
<td>This scaling management framework is based on a three-step ten-task approach, which aims to facilitate effective up-scaling based on theory and practice from the field.</td>
</tr>
<tr>
<td></td>
<td>Framework 2: Institutional Approaches and Organizational Paths To Scaling Up (Hartmann and Linn, 2008).</td>
<td>This framework is aimed at enabling the key dynamics that allow the scaling-up process through exploring the possible approaches to scale, drivers of replication, space to be created for scaling, and the role of careful planning and implementation.</td>
</tr>
<tr>
<td></td>
<td>Framework 3: Lessons from Practice: Assessing Scalability (Holcombe, 2012).</td>
<td>The framework aims to establish proof of innovation impact and scalability, and sufficient information to assist in the process of determining if the project should be scaled up or not.</td>
</tr>
<tr>
<td></td>
<td>Framework 4: Scaling-Up the Impact of Good Practices in Rural Development (Hancock, 2003).</td>
<td>The framework is centred around identifying and classifying the information based on what has worked, and what has not worked, according to the evidence that is available to the reviewers.</td>
</tr>
<tr>
<td>IT/IS Programmes</td>
<td>Framework 5: Information Infrastructures (Rolland and Monteiro, 2002).</td>
<td>The aim of the theoretical framework is to guide the development of Information Infrastructures which are interconnected and integrated and which use comprehensive modules of Information systems to extend operations across many contexts.</td>
</tr>
<tr>
<td></td>
<td>Framework 6: A framework for the Evaluation and Justification of IT/IS (Gunasekaran, Ngai and McGaughey, 2006).</td>
<td>The aim of this framework is to provide an IT/IS justification process that would assist e-businesses to make well considered decisions which take into account the goals,</td>
</tr>
</tbody>
</table>
Framework 7: Project Success, A Multidimensional Strategic Concept (Shenhar, Dvir, Levy and Maltz, 2001).

The framework is based on defining and assessing project success in order to align the short-term and long-term goals of the organisation in order to enable the strategic development of technology projects.


The aim of the framework is to conduct M&E for pilot projects, to assess developmental purpose and proof of concept, and to provide recommendations that enable scale based on the assessment.


The aim of the framework is to conduct a comprehensive evaluation of rural ICT projects, through an iterative process and through various domains, in order to evaluate the project.

Table 1.2 Approaches and Frameworks Selected

2.1. THE STRUCTURE OF THE COMPREHENSIVE SCALABILITY ASSESSMENT FRAMEWORK

As shown in Figure 1, the framework is designed in a cyclic manner that has various components attached to it. Keeping in line with systems theory, the framework can be viewed as a system with subsystems. The framework is divided into three main areas which are the assessment guidelines and preceding domains of evaluation, with the four themes and judge scalability as the final stage. The assessment guidelines are placed on the outside of the inner circle, because they are meant to guide every action that is taken in the various subsystems. This is the same for the preceding domains of evaluation, which is a process of providing proof that the project has been evaluated and providing insight into what the outcome of each assessment was. The second part of the framework is the composition of the four stages that work towards the judge scalability component. These themes lead to each other and cannot be executed in isolation of each other, as they work in a cyclic manner to contribute to judging scalability, as shown in the diagram. These themes are the stakeholder composition, model feasibility, resource sustainability, and resilience. The dashed lines mean that fluidity between the stages is possible, and flexibility is encouraged, especially when the process of judging for scalability has started.
These themes are the stakeholder composition, model feasibility, resource sustainability, and resilience. The dashed lines mean that fluidity between the stages is possible, and flexibility is encouraged, especially when the process of judging for scalability has started. All these factors are driven by the concepts of systems theory and amplification theory, which influence the design of the framework. This includes incorporating factors that present a real-world view in a holistic manner and take into account the environment in which the system operates. Additionally, contextual factors that influence the viability of the system are considered, in line with amplification theory. Systems theory allows us to understand how a system functions to achieve a goal in a complex situation with diverse stakeholder involvement and various objectives and goals. Amplification theory supports a deeper investigation to understand what existing forces in the system enable the various subsystems to function so that the system operates on a daily basis.

2.2. CONDUCTING A COMPREHENSIVE SCALABILITY ASSESSMENT OF ICTD PROJECTS

The process of conducting a scalability assessment is a pragmatic judgment process that aims to review the suitability of a model and the factors in the larger context which affect the success of the implemented project (Cooley and Kohl, 2012; Keijdener, Overbeek and España, 2017). The implication of this pragmatic process is that it is dependent on comprehensively evaluating the application and impact of the selected model.

2.2.1. Assessment guidelines

Assessment guidelines guide and contribute to the overall application of the framework. These guidelines determined key areas that needed to be adhered to prior to the application of the framework. These are the application of a comprehensive evaluation, the stakeholder relationship and ethical considerations.

- **Application of Comprehensive Evaluation as the Base of the Scalability Assessment Framework:** In order to provide credible evidence and to commence a scalability assessment, proof must be given to relevant stakeholders of the viability of the project and the impact it
has had. This means that various evaluations of the project need to be conducted on all aspects of the project.

- **Stakeholder Relationships:** Stakeholder management is a concept that has been addressed by many ICTD studies and is usually highlighted as one of the elements that ‘make or break’ projects, depending on how well or how badly their role in a project is emphasized (Pandey and Gupta, 2017). Stakeholder engagements usually start off with stakeholders being consulted on a decision affirming point and not being actively involved in making the decisions of the project.

- **Ethical Considerations:** It is important that ethical guidelines are presented to all stakeholders to ensure that the actions conducted within the study are not seen as improper, unlawful and unacceptable in the community (Traxler, 2012). Transparency, communication, and feedback should govern the process of engaging stakeholders in the scalability assessment of ICTD projects. It should also be communicated clearly to the various stakeholders what benefit the assessing of scalability provides for them, thereby making it their choice to be part of the assessment.

### 2.2.2. Preceding Domains of Evaluation

There are a number of domains of evaluation that need to be conducted which will then provide comprehensive information on the status of the programme and how, if possible, it can be scaled-up. Therefore, the decision to scale is not to be taken lightly, and cannot be decided based solely on the information conducted from an impact assessment but from other domains which informed the setup of the project during its inception, and should incorporate the progress made throughout the project.

These are some of the evaluation domains which should be considered and be used to inform the development and implementation of the scalability assessment framework:

- **Baseline study:** The baseline study aims to understand and determine the existing status of the community in relation to its socio-economic status and its ability to be part of the new envisioned programme (Pade-Khene and Sewry, 2011; Batchelor and Norrish, 2007). In the process of a scalability assessment, such information would inform the possibility of different future phases or staggered implementation that could be done in the community, based on various factors such as capacity and skills. If no baseline study is available the use of previous studies, household surveys or other suitable socio-economic studies might be used.

- **Needs Assessment:** A needs assessment is referred to as a process of investigation into the various needs and priorities of the intended community, which are demand driven, with the aim of providing suitable interventions or approaches that might be taken to deal with these needs and priorities (Pade-Khene and Sewry, 2011; Rossi, Freeman and Lipsey, 2004; Pandey and Gupta, 2017; Mthoko and Khene, 2018). In a pilot project, the aim is to address a specific problem that exists. This assessment informs the scalability assessment of other aspects that might need to be expanded on in future and what needs and priorities it might try to address in future.

- **Programme Theory Assessment:** The aim of the programme theory assessment is to provide a plan or a blueprint of the planned intervention based on the needs assessment and to evaluate its suitability towards meeting the needs of the intended beneficiaries (Pade-Khene and Sewry, 2011; Rossi, Freeman and Lipsey, 2004; Pandey and Gupta, 2017; Mthoko and Khene, 2018). It is important for the scalability assessment to take into account the planned model for intervention and to review and verify if it will work in its scaled-up version. Moreover, this assessment would need contextual factors to be incorporated into the plan to scale.
- **Process Assessment**: This assessment assesses and evaluates how the planned programme is being implemented, and evaluates the processes and activities to see if they work towards solving the targeted problem (Batchelor and Norrish, 2007; Gigler, 2004; Pade-Khene and Sewry, 2011; Rossi, Freeman and Lipsey, 2004). In the process of planning a scalability assessment, there needs to be a review of the various processes and activities currently in place to make the project function. This would involve assessing the various resources, skills and capacity to conduct the same activities in a different context, or assessing how the activities and processes would be adjusted to ensure that similar results can be achieved in a different context.

- **Outcome and Impact Assessment**: The process entails ascertaining the intended and unintended effects of the implementation of the programme and contributes to the outcomes and impact assessment of a programme (Pade-Khene and Sewry, 2011; Mthoko and Khene, 2018). It is a process that contributes greatly to understanding how the programme could potentially benefit other contexts for them to reap similar rewards in their own context.

- **Efficiency Assessment**: The aim of this assessment is to assess the various ICT intervention costs associated with projects effects or impact (Pade-Khene and Sewry, 2011; Pandey and Gupta, 2017). This was also a strong contributor to the aspect of assessing for scale in terms of reviewing costs that would be incurred internally and externally.

The outcome of the combined domains of evaluation contributes to the process of answering the how, why and when of the aspects relating to the scalability assessment. Moreover, these contribute to the guidelines and preliminary measures that need to be put in place before the scalability assessment framework is implemented.

### 2.2.3. Judge Scalability

#### 2.2.3.1. **Stakeholder Composition**

Assessing scalability, in terms of stakeholder composition, is a process that aims to understand which key and contextual stakeholders are needed for the project to work effectively and deliver the desired results in the selected type (vertical or horizontal) of scaling. To assess and review stakeholder approaches by various frameworks, literature has utilised various approaches, namely descriptive, normative and instrumental, with each having its weakness which renders it impractical (Bailur, 2006). The approach that can be utilised is the concept of Actor Analysis, which aims to provide a high-level view of the various stakeholders in the project at the initial exploration phase (Enserink, Hermans, Kwakkel, Thissen, Koppenjan and Bots, 2010).

#### 2.2.3.2. **Resource Sustainability**

The process of assessing resource sustainability aims to interrogate the various forms of resources that can be sustained before the process of scaling up. The aim is to assess whether there are sufficient resources and if they are sustainable, to ascertain if the project will continue. However, keeping in mind the rigorous debate of the topic of sustainability, the aim is to assess the suitability of the resource sustainability to the context of the project going forward. As the theme is broad, in order to assess it, there is a need to review the various types of resource sustainability in relation to the project and its context. For the purposes of this research, the various types of sustainability will be termed sub-themes and are assessed in relation to other themes which all contribute to the final judge scalability aspect. Heeks (2005) provides an approach to reviewing various aspects of sustainability within the project by utilising capacity, utility and embedding to assist in reviewing the various sub-themes. Capacity focuses on understanding if there are the skills, data, funds or technology available to continue the project, after the pilot phase (Heeks, 2005; Toyama, 2015). Utility is usually a key determinant which focuses on the usefulness of the project to the community, based on the reviewed aspect of sustainability (Heeks, 2005; Ali and Bailur, 2007). Embedding focuses on understanding if the project has become routine and institutionalised within the
community (Heeks, 2005). When taking into account the context, the variations that exist within communities, and the considerations of achieving bricolage to assist sustainability, a fourth element to reviewing sustainability can be added. Contextual leverage is added as an element that focuses on reviewing what other aspects of the project and the context can be used to the advantage of sustaining the project (Ali and Bailur, 2007).

2.2.3.3. Resilience

Resilience is a concept that is not too far from the concept of sustainability and bricolage. Resilience is understood to be the ability of a system to adapt and recover from the shock that it experiences from internal and external factors (Walker and Salt, 2012; Heeks and Ospina, 2018). It is linked to key factors which illustrate resilience as the ability to experience stability, agility, flexibility, adaptation and transformability of the system based on the changes that affect the system (Walker and Salt, 2012; Marias, 2015; Heeks and Ospina, 2018; Chen, 2015). The process of assessing resilience in order to determine scalability should be based on understanding the resilience of the community. Walker and Salt (2012) recommend that there are three aspects to understanding resilience, which include describing resilience, assessing resilience and managing the resilience of the system. For purposes of this research, the focus would be on assessing for resilience; however, that cannot be done without understanding the system’s composition and describing the resilience of the community. Therefore, for purposes of assessing for scalability in this framework, it is further broken down into three stages: Resilience Foundation, Assessment of Resilience and the Effect of Resilience on Scalability.

2.2.3.4. Model Feasibility

Assessing the verification, feasibility and transferability of the implemented model is a process that relies heavily on the linkage between the programme theory assessment, process assessment and the outcome and impact assessment (Cooley and Kohl, 2012; Holcombe, 2012). The implemented model would need to be broken down into various parts in order to view each element, with its functions and how they are related, to understand how they work together in a holistic manner, to conclude the project. This means each structure of the model needs to be understood in terms of what structures enabled it to work, which stakeholders were involved in the process, what the environment was that led to the success of the project, and so forth.

2.2.3.5. Judge Scalability

The aim of this stage is to provide feedback on the entire process of assessing for scalability and compiling a report that can be used to determine, based on the information provided, if the project can be up-scaled or not, or if certain factors should be implemented differently for the project to be considered scalable. The report should be provided to all stakeholders including the intended beneficiaries. As this is the final stage, the assessment of the scalability of the project would have been a consultative process, incorporating the various views of all crucial stakeholders (Pade-Khene and Sewry, 2011; Batchelor and Norrish, 2007). The assessment of each theme would be available at this stage, and the outcome would provide evidence of the possibility to scale or not. The interpretation of the outcome is the point where there would need to be a negotiation or consensus of, ‘is this enough evidence to scale the project or not scale the pilot project?’
3. CONCLUSION

The process of assessing scalability in ICTD projects should be conducted in a comprehensive manner which takes into account the importance of evaluation, making decisions with the input of all stakeholders, considering all contextual factors, and the assessment of the project. The Comprehensive Scalability Assessment Framework is developed based on a critical review of the field and its frameworks. This proposed framework is structured in a manner that uses assessment guidelines throughout the assessment process, incorporates the results of the comprehensive evaluation and then sets in motion a scalability assessment plan that contributes to the final scalability judgement. At the centre of the proposed framework are the four themes which make up the scalability assessment, namely ‘Stakeholder composition’, ‘Resource sustainability’, ‘Resilience’, ‘Model feasibility’, and with ‘Judge scalability’ as the end process of the framework. A systems analysis diagram is the main output of the judge scalability stage and is interpreted in order to make a decision to scale the project or not. The proposed framework, therefore, aims to provide a comprehensive report that decides on the scalability of the project based on the information and evidence gathered, to actively decide with all stakeholders if the project should be scaled-up or not. In order to have a clear view and understanding of the suitability, practicality and shortcomings of the proposed framework, it is important to apply the framework in a real-life setting and to use the results of the implementation to revise the proposed framework.

REFERENCES


MOMENTS IN THE PRODUCTION OF SPACE: DEVELOPING A GENERIC ADOLESCENT GIRLS AND YOUNG WOMEN HEALTH INFORMATION SYSTEM IN ZIMBABWE

Rangarirai Matavire, Itinordic AS, matavirer@gmail.com
Jørn Braa, University of Oslo, jbraa@ifi.uio.no
Shorai Huwa, Zimbabwe National AIDS Council, shuwa@nac.org.zw
Lameck Munangaizwa, Zimbabwe National AIDS Council, lmunangaizwa@nac.org.zw
Zeferino Saugene, Eduardo Mondlane University, zsaugene@gmail.com
Isaac Taramusi, Zimbabwe National AIDS Council, itaramusi@nac.org.zw
Bob Jolliffe, University of Oslo, bobjolliffe@gmail.com

Abstract: With global targets to end AIDS by 2030 and to eliminate new HIV infections, Adolescent Girls and Young Women (AGYW) are seen to be particularly vulnerable, especially in Sub Saharan Africa. Numerous nations have therefore rolled out interventions to provide services to remove the determinants of vulnerability, such as limited education, early marriage, poverty, domestic violence, and exposure by male partners. Within this context, subpopulations such as sex workers increase the vulnerability amongst AGYW and are also supported through prevention programming. This study follows a project to develop a generic health information systems solution to provide a means to monitor and evaluate the successes of the AGYW initiative in reducing new infections. It borrows theoretical ideas from Henri Lefebvre’s theory of moments to describe the process in which the space for the development of the solution is produced.

Keywords: Health Information Systems, DHIS2, Production of Space, Henri Lefebvre, Zimbabwe

1. INTRODUCTION

With AIDS-related illness continuing to be among the leading causes of death and the social impact of new and existing HIV infections evident, particularly amongst women in under-privileged societies, recent advances in medicine have spawned an emergent vision to end AIDS by 2030. One such intervention aims to reduce and eliminate new infections among Adolescent Girls and Young Women (AGYW). According to UNAIDS (2019), "three in four new HIV infections among 10–19-year-olds are among girls" with a markedly high incidence amongst Key Population (KP) groups such as sex workers, and prisoners. The government of Zimbabwe, through the National AIDS Council (NAC) is part of a 13 nation Sub-Saharan Africa initiative aimed at reducing HIV incidence among AGYW. AGYW are classified as females between the ages of 15 and 24 years of age, which includes their male partners (UNAIDS, 2016). NAC was established by an act of parliament in 1999 and is responsible for coordinating the national multi-sectoral response to HIV and AIDS in Zimbabwe.

NAC monitors a number of HIV prevention programs, many of which the organisation has a coordinating role at the district level. Below the districts, several implementing partners are coordinated by NAC to provide services at the community level. The implementing partners are a group of organisations, both private and public, who implement NAC’s programs across the 60+
districts in Zimbabwe. NAC itself implements prevention programs directly in some of these districts. In addition, NAC also operates within the broader context of the Ministry of Health and Child Care (MoHCC) which runs 1600+ health facilities nationwide and provides HIV services such as testing, counselling, treatment, and other community interventions in the respective catchment areas. Within this context, some of the implementation partners are directly involved in initiatives specifically targeting AGYW, such as the Determined, Resilient, Empowered, AIDS-free, Mentored and Safe (DREAMS) program.

1.1. The AGYW Initiative

1.1.1. Background

AGYW in Zimbabwe are 14 times more likely to get a new HIV infection than their male counterparts (Saul, Bachman, Allen, Toiv, Cooney & Beamon, 2018). As a component of a broader global goal to end AIDS by 2030, AGYW interventions are constituted of a set of partnerships aimed at reducing the incidence of new HIV infections amongst females who are 15-24 years old through a multi-pronged and multi-stakeholder approach. The partnerships target the determinants of new HIV infections such as poverty, inequality, biomedical and structural issues. This is done by first identifying girls in a community within this age group, assessing individual risk and subsequently enrolling vulnerable girls for age-appropriate interventions. As highlighted earlier, NAC’s main role is to coordinate the HIV and AIDS activities of the multiple stakeholders operating in Zimbabwe. NAC itself is implementing a number of prevention programs in some districts. Among these are initiatives aimed at subpopulations which have generally higher incidence of HIV. For example, female sex workers in Sub Saharan Africa have up to 21 times greater incidence of the infection than the general population (UNAIDS, 2019). Female sex workers, as with other Key Populations (KPs), also constitute a subpopulation that can be found among AGYW.

A cornerstone of the intervention is a functioning Monitoring and Evaluation (M&E) system for clinical decision support at the service point and for calculation of indicators (measures) at different points of the hierarchy for decision making. At the onset of this work, there was no integrated M&E system to provide reports on globally reported indicators for AGYW in NAC, and this was the basis for the project described in this paper. However, as mentioned earlier, other organisations had implemented the DREAMS initiative in some districts under an International non-governmental organisation called INGO. This study therefore constitutes the moments in a process to scale up the DREAMS work nationwide, under NAC with the added aim to develop a generic AGYW system. With this background, the initiative under the watch and implementation of NAC has in some discussions been referred to as the Modified DREAMS initiative. A background on DREAMS, which constituted the installed base in Zimbabwe, is given below. The installed base is the pre-existing configuration of people, technologies, process, and systems (Hornnes, Jansen & Langeland, 2010).

1.1.2. Determined, Resilient, Empowered, AIDS-free, Mentored and Safe

Given the complex interplay of factors involved, intervention by a single player cannot be effective in reducing the incidence of new HIV infections among AGYW (Saul et al., 2018). To address this issue, DREAMS consists of a package of interventions targeted at the individual girl or woman, her family, the community, and her male partner(s). The package consists of biomedical, social and economic interventions which include services in the areas of educational subsidies, HIV testing and counseling, parenting/caregiver programs, domestic violence reduction and male partner circumcision among others. Zimbabwe is among the 10 African countries which began the DREAMS initiative in 2015 given that new HIV infections among AGYW from these nations constitute about half of those occurring globally. A key aspect of the DREAMS initiative in Zimbabwe was its use of the District Health Information Software (DHIS2) for its case-based surveillance. This software has also been in use as the national HMIS for routine data since 2012.
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and for case-based surveillance in a number of programs such as for the national malaria program since 2014 (Matavire, 2016).

1.2. Research questions and goals

This study attempts to describe and explain the process of evolution of the health information system by highlighting the global and local collaborative efforts and their results through different phases. The aim of the study is to theoretically step back from the actual health information system as a product, and to understand the social relationships through which it emerges. This is in line with Lefebvre and Nicholson-Smith (1991, p. 113) who contend that, “it is never easy to get back from the object (product or work) to the activity that produced and/or created it. It is the only way, however, to illuminate the object’s nature, or, if you will, and reconstitute the process of its genesis and the development of its meaning”. It is in this regard that our primary research question is, ‘How can we understand the activities implicated in the development of the generic AGYW system in Zimbabwe?’. The theoretical goal is to reveal the underlying struggles in the process of systems development and implementation with the intention of creating possibilities for users to appropriate the technology. This goal contrasts with merely imposing systems on behalf of dominating actors and constellations to the detriment of users, developers and implementers (Read, de Laat-Lukkassen, & Jonauskis, 2013). It is in this context that Henri Lefebvre’s theory on the ‘production of space’ is found to be a fertile ground for the development of a theoretical and practical understanding of the phenomenon under study, as will be demonstrated in the proceeding sections.

2. THEORETICAL BACKGROUND

There is an understanding that most health information systems (HIS) initiatives fail in some way (Heeks, 2006). This extends beyond the realm of HIS, even beyond the IT world, to fields such as sociology, economics, politics and philosophy where questions of what the world is constituted of, that is ontology, and what constitutes knowledge, that is epistemology, are pursued. Notwithstanding, we posit that many studies in the IS discipline overlook the interplay between mental, social and physical spaces as a basis to understanding success and failure of interventions (Matavire, 2016). Instead, there has been a proliferation of studies which use theories such as Structuration Theory (Orlikowski, 1991) and Actor Network Theory (Braa, Monteiro & Sahay, 2004), among others, where for example the relationship between agency and structure, and the subjectivity of the agent are scarcely problematised, respectively. In this sense, information systems researchers have not adequately illuminated the way knowledge serves as an instrument in the hands of power. It is within this context that Lefebvre’s theory on the ‘production of space’ (Lefebvre & Nicholson-Smith, 1991) is particularly exciting in trying to describe the phenomenon of HIS production.

2.1. Production of space

In general, what Lefebvre states is that the concept of space is increasingly important in understanding everyday life. He argues that while researchers utilise the word space in their descriptions, they take it for granted by often privileging one space, often the mental, over all others such as physical and social, and vice versa. In this way, much of the domination of one space over the others is not only taken for granted, but rather is deliberately concealed. A core concept in understanding the production of space is ‘abstract space’. This is a space that is produced by capitalism and neo-capitalism and includes “the ‘world of commodities’, its logic and its worldwide strategies, as well as the power of money and that of the political state. This [abstract] space is founded on the vast network of banks, business centres and major productive entities, as also on motorways, airports and information lattices” (Lefebvre & Nicholson-Smith, 1991, p. 53). Consequently, Lefebvre developed a theory of space to explain and describe the genesis of spaces, such as this abstract space and other myriads of spaces in everyday life.
To Lefebvre, space is a product of the pervading mode of production. In the contemporary world, capitalism therefore produces its own space. In this regard, other alternative modes of production such as socialism consequently have not produced their space, and hence have not been successful projects. In contrast, differentiated spaces have emerged to counter the abstract homogenised space of capitalism, yet still within it. In this context, some societies produce their own space, to counter the homogenising effects of the abstract space of capital, and to signify its impermanence, through class struggle. In the context of technology development, it is therefore possible to look beyond the artifact, and understand the relationships through which its space is produced. To understand this, Lefebvre develops a theory for the moments of production as elaborated on below.

### 2.1.1. Moments in the production of space

Every society produces its own space, or else it remains in the level of ideas with no concrete existence (Lefebvre & Nicholson-Smith, 1991). Space is produced through the moments of i) **spatial practice (perceived)**, which denotes the reproduction of the social relations of production, ii) **representations of space (conceived)** which are “in thrall to both knowledge and power” (Lefebvre & Nicholson-Smith, 1991, p. 50), and iii) **representational spaces (lived)** which are limited to works and other symbolic aspects of life. Lefebvre makes a distinction between product and work, where a work is related to art and product is related to reproduction. Conceived space is the space of planners such as the producers of standards and generic software tools; Perceived space is that which subsumes the social relationships through which activities proceed; Lived space is the actual social practices, everyday use and life of a space which somewhat escapes grasp of planners as it is constituted of meaning, beliefs and superstition. Rather than seeing these in isolation, Lefebvre sees the three as constituting the ‘moments’ in the production of space (Lefebvre & Nicholson-Smith, 1991).

### 3. METHODOLOGY

In essence, this study is part of an ongoing series of work which started with the implementation of the DHIS2 system in the health ministry of Zimbabwe in 2012. Underlying this work is an action-oriented approach inspired by the Scandinavian tradition of Action Research (Baskerville, 1999). The study is also influenced by Grounded Theory methodology (GTM) (Glaser & Strauss, 1967), albeit not in the sense of a rigorous application of its principles such as coding techniques, or the role of theory, but in the sense that the study aims to develop theory which can be applicable across diverse terrains where similar technologies are implemented. In this context, Eisenhardt’s (1989) ideas on developing grounded theory from case studies are adopted in the study. The combination of principles from diverse research methods, so called mixed methods, is not novel to this study but is in fact common in information systems research (Matavire & Brown, 2013; Baskerville & Pries-Heje, 1999).

There are two meanings to the term “grounded theory”, the first being the result of a study and the second being the methodology. In the first, a ‘grounded theory’ is the conceptual outcome of a study, that is the theory that is developed through a known procedure or technique. In the second, we refer to the methodology as developed originally by Glaser and Strauss (1967), with its subsequent erosion and/or elucidation through further works such as Strauss and Corbin’s (1997) Straussian GTM, Charmaz’s (2006) constructivist GTM, Baskerville and Pries-Heje’s (1999) or Eisenhardt’s (1989) Mixed GTM, and the use of analytical techniques from GTM such as open coding without adopting the tenets of any one flavour such as is common in information systems research (Matavire & Brown, 2013). In this context, this study aims to reflexively (Alvesson & Sköldberg, 2000) develop a ‘grounded theory’ to explain the researched phenomenon by using a case study oriented approach as envisaged by Eisenhardt (1989), through participation and action (Baskerville & Pries-Heje, 1999). All the authors of this paper have been actively involved in the development and implementation of the system.
The case is developed through an analysis of various source documents and communications which have characterised the intervention from system conceptualisation to production. These include documents from global partners, data entry forms, discussions among stakeholders, meetings with developers, user feedback, contracts, project reports, and various ceremonies and occasions marking transitions in the process of development. As mentioned previously, the researchers are themselves part of the initiative, consequently reflections on the journey, with necessary clarifications sought from the stakeholders, with their divergent and convergent interests, have contributed to the emergence of the case. A hermeneutic approach (Klein & Myers, 1999) to understanding Henri Lefebvre’s theory of moments has been important in constructing the case. There has consequently been an iterative process involved in the construction of the case in relation to the chosen theory. The authors collectively have a rich understanding of the empirical domain, consequently a theoretical framework has been necessary for gleaning the case from the source material and the experiences of the researchers. The suitability of Henri Lefebvre’s theory on the ‘production of space’ to explain the phenomenon in health information systems is part of an ongoing project for some of the authors, yet the focus on ‘moments’ has been novel to this study and marks a key point in the development of the framework.

4. THE CASE OF THE DHIS2 AGYW/KP INITIATIVE

An international NGO, which we can refer to as INGO, was tasked with developing a Monitoring and Evaluation (M&E) system for the DREAMS program running in a few districts in Zimbabwe prior to 2018. In this context, the DHIS2 Tracker module was customised by INGO for their ‘DREAMS’ project which targeted various AGYW HIV/AIDS services and providers in the community. DHIS2 is a customisable web-based software that enables the collection of both aggregate and case-based health data across regions for storage and analysis in a centralised repository at local, administrative, and central levels as illustrated in Figure 1., below. The system can also capture data at a community level offline on mobile devices. It is widely used in the Global South, with over 80 nationwide implementations. DHIS2 Tracker is the case-based module within the system which enables the collection of individual level data that might include identifiable information like names and surnames, and event-based data such as encounters at the facility, in a manner similar to a typical Electronic Medical Record (EMR) system. It was this module that was implemented by INGO to track and monitor AGYW interventions across providers.
4.1. Unique Identification of AGYW

Within many developing nations, there is a wicked problem of unique identification of beneficiaries of services given that there is often no fully functional nationwide identity system in place. A key innovation in INGO’s implementation was the issue of a reliable client identifier. AGYW is implemented across services and providers, at the community level, where unique identification of clients can be difficult, also given the offline collection of information which often occurs on paper forms. In this context, a client who is registered for a particular service, let us say an ‘educational subsidy’ under provider X, needed to be uniquely identified if they accessed another service such as ‘HIV counselling and testing’ at a government facility. This is part of a layering of services within a package so as to permit the generation of indicators such as ‘number of girls who received an educational subsidy who also had a negative HIV result’ within a period. To address this pertinent issue, INGO created a demographic identification system, which can be generated on paper and offline using some predefined rules and applied across different providers and for different services. The system works by taking parts of a client name, surname, their contact, date of birth, gender and gender identity to construct a 11-character identifier for the beneficiary. While in some cases the same identifier can be produced for more than one beneficiary, it has been largely successful in unique identification, with some modifications in progress to decrease the possibility of clashes.
4.2. From DREAMS to a Generic AGYW product

In 2018, recognising the success of INGO in implementing the set of DREAMS packages in some districts for AGYW, NAC engaged its international partners and donors in order to scale up the initiative nationwide. At the global level, partners were also in discussion on how to scale up the initiatives into other countries. In this context, the Health Information Systems Program (HISP) in the University of Oslo was contracted to scale up the initiative in Zimbabwe with NAC and its partners. HISP was also tasked with developing generic features in the core of its software to better support the AGYW use case. In addition, HISP was tasked with also developing a set of information products, that is generic customisations, on its platform to help other countries to adapt and implement in their diverse contexts based on the Zimbabwe use case.

4.2.1. Collaboration agreements amongst partners

Initially, HISP developed a comprehensive proposal on the development and implementation of the system, with a focus on a generic AGYW solution, to be implemented in 30 of Zimbabwe’s 60+ districts. INGO had previously existing agreements with HISP to support its activities in different use contexts on which they were actively collaborating. Consequently, there was a strategy with the HISP team to learn from, build upon, support, and scale up existing INGO work on the AGYW initiative in Zimbabwe in a collaborative manner. Numerous calls were scheduled between the stakeholders, at both local and global levels, to initiate the collaboration between INGO and HISP as implementers and developers of the Zimbabwe AGYW system. Also, the aim of the collaboration was to develop generic AGYW features in the core DHIS2 software which INGO would benefit from in scaling into other regions in which DREAMS was implemented.

At a global level, in July 2018, 4 international HISP consultants, including one from INGO who had designed the DREAMS DHIS2 implementation in Zimbabwe planned a mission to meet stakeholders and to conduct an analysis of the existing system and produce a plan of implementation. 3 of the consultants are co-authors of this paper. The mission included visiting the implementing districts in Zimbabwe to learn about the AGYW intervention. This involved meeting with community leaders, observing implementation of domestic violence support programs, visiting schools to understand AGYW educational support, meeting with Ministry of Health and Child Care (MoHCC) officials, and finalising the plan for presentation to responsible departmental heads. Discussions between HISP and INGO were also scheduled to agree on the roles of the different actors in the emergent implementation. Also given the existing collaboration between HISP and MoHCC which had begun in 2012 on the nationwide DHIS2 system, meetings and discussions were also held between the two organisations. The mission visit was concluded, and a preliminary plan and schedule had been developed, and roles agreed.

Globally INGO expressed an interest and commitment to be collaborating as partners with HISP as part of the existing arrangements. A key meeting between the local office of INGO, NAC, and HISP was held in March 2019. Before the meeting, the funding partner had shared the comprehensive proposal, plan and roadmap on the implementation of the Generic AGYW system which had been developed by HISP after the earlier field visit for discussion. Issues such as the hosting location of the existing DREAMS servers, the hosting arrangement of the new Generic AGYW implementation, the roles of the different organisations, such as the local INGO team in relation to the HISP team, timing and alignment of activities were discussed among the stakeholders. INGO in particular needed to consult with its international office as it had its own proposal, funding, scope and timing in the scaling up of DREAMS in the NAC intervention.

HISP updated the Global INGO office on the progress made in April 2019 where the local office of INGO also agreed to subsequently share documents on its own roadmap for expanding the DREAMS initiative within NAC. A multiplicity of interests needed to be aligned, both amongst local organisations and global collaborators in the different areas and periods of intervention. In addition, INGO had a pre-existing collaboration with NAC. The INGO roadmap was used as the basis of collaboration, with HISP working to integrate its work in the proposed timeline of activities.
The work of integrating the roadmap continued through May 2019. The component of the work to be conducted by HISP was shared with the funders of the project. A set of deliverables were agreed in the conduct of the work. These included tasks around integration, mentoring and training, system reviews, and the development of generic AGYW tools. Agreements on the objectives and roadmap led to the signing of the contracts in December 2019, paving the way for HISP’s intervention to begin.

4.2.2. Re-aligning roles and scope

In February 2020, HISP organised its 1st mission on the project, with an objective to initialise the activities of the work on the ground. One of the consultants, also co-author on this paper, attended the inception meeting on behalf of HISP during this period. The meeting was coordinated between NAC, its local implementation partner, a United Nations agency (UNAgency), and HISP. Several points were discussed and agreed upon with the leadership of both UNAgency and NAC. The key point was that the customisation and set up of the system should proceed from analysis of the legacy system in NAC, not necessarily on the DREAMS configuration, and implemented in agreement with NAC M&E requirements onto the DHIS2 platform. This gave HISP a more prominent and demanding local role on the project than had been originally anticipated. There were now uncertainties on the scope of collaboration between INGO and HISP at the local level. Access to the pre-existing configuration remained important but limited through other moments in the evolution of the solution.

Focus shifted to pre-existing arrangements at the global level between INGO and HISP. A key deliverable for HISP to the funder was a generic AGYW solution, and INGO had already been involved with the global HISP to support specific features of their DREAMS work in Zimbabwe, among other countries. Within HISP, various actors were discussing with INGO on features that were important for analysing the layered data in DREAMS. The HISP team working on the NAC project joined into these conversations to facilitate development of generic AGYW. These were constituted of weekly meetings all the way into July of 2020. Meanwhile, the analysis and customisation of the NAC system was ongoing. A team had been created after the meeting earlier in February and had started collaborating on the customisation. Within this context, the Covid-19 pandemic had already begun, with all planned travel cancelled.

4.2.3. Customisation and piloting

A team consisting of M&E officers and IT staff from NAC and DHIS2 specialists from HISP was constituted following the stakeholders meeting in February 2020. NAC had been in the process of re-aligning their data entry formats and had ongoing planned activities in that vein. As soon as the redesigned data collection forms had been available, they were shared online with the HISP team for analysis and implementation. The initial version of the forms was shared in March, and the next in May 2020. The required customisation consisted of two main aspects, the first being routine aggregate disease surveillance, and the other being case-based surveillance. Within NAC, aggregated information is collected on a quarterly basis into a consolidated form. This includes aggregate data from diverse program areas working at community level and reporting to the districts. The customisation of these forms was conducted from March 2020, through to early 2021. The aggregated forms were also successfully piloted and by the time of this report, approaching rollout.

Meanwhile, as the aggregate surveillance system was being customised, work was also being undertaken to implement the data collection forms for 9 program areas which included support groups, key populations, gender and AGYW. Weekly calls were held with HISP, who were customising the system, and NAC, who were testing and providing feedback. With all programs created and workflows developed, the HISP team started to work on the generic AGYW solution with the internal DHIS2 developers. The concept was developed, based on experiences with the NAC customisation, and as part of it, into a generic AGYW product. This was also shared with NAC and the funder for comments. At the point of writing this article, customisation of the AGYW...
system, based on initial feedback and the availability of additional information, including the integration of the generic concept, was underway so the pilot could be initiated.

5. DISCUSSION
In our context, the generic AGYW solution was to be developed as an artifact for the Zimbabwe case that could be reproduced in another location. The space of representation (lived space) in the context of this project is constituted of the locations of the diverse stakeholders, both global and local, who through a process of alignment occurring in the abstract space, come together (physically and online) to define and agree on the scope and roadmap of the intervention, that is representations of space (conceived space). This is the space of the planners, and it is revealed in the initial step within the intervention, where alignment of goals, plans, is sought. In this first moment, a space for collaboration, itself pre-existing as abstract space, forms plans to define the scope of the intervention. This is a moment of planning, when actors in abstract space come together, and discuss the goals of the initiative, and the steps to realise it, and the people who will execute this plan. However, it must be mentioned that INGO, as a unilateral NGO, had underlying conflicts with UNAgency, and HISP which are generally multilateral. As illustrated, this space of representation is itself evolving, as the goals change, so is its constitution. In the context of this study, the moment of the space of representation has been largely dominant, with underlying conflict.

The moment of the spatial practice can be seen as at least constituted within the testing and feedback phase, where users of the system participate in the development process through testing and feedback. In this phase, users take the system into their locations and attempt to navigate across the system, learning about its operation through a mentorship approach. In learning the boundary of the system, applying known pathways to check on the fit to the context, there is an emergence of the spatial practice into clearer focus, that is the who’s who of the initiative. As can be noted, the feedback between HISP and NAC to iteratively improve the technology constitutes a dialectic between the moment of the space of representation and the spatial practice. Lefebvre and Nicholson-Smith (1991) have in their work demonstrated the essential role of the dialectic between the different moments in the production of space. This also fosters a sense of ownership of the emergent spatial practice for the users.

In the case of the representational space, in lived space, the space of the users, a space of ethnographers, where meanings take stage, there is a sense that this was displaced and ineffectual. While users have been actively involved in the testing of the system, their day-to-day lived realities with the system were not adequately explored, also given some difficulties of travel during the study. The location of the actors in Zimbabwe and Norway, builds upon the pre-existing abstract space where the North develops the system and the South consumes it. However, with the case-based system emerged a need for mobile devices. Mobile devices can constitute another lived spatial moment of the users of the technology. Issues with electricity and connectivity as well require that the moment of lived space be adequately analysed in future.

6. CONCLUSION
We have applied Lefebvrerian concepts to analyse key moments in the production of a space for the development of a generic AGYW solution. In this instance, the moments of Lefebvre’s spatial triad were applied in describing the process through which a generic health information system is produced. The theory of the production of space has enabled us to analyse the process in which a novel intervention is produced, and the reproductive moments which are essential for its emergence. The usefulness of Lefebvre in analysing such phenomena can be seen in the way in which his theory of moments reveals how mental ideas are brought into physical space to intervene and shape it, and indeed produce it. Using this conceptualisation we can question the success of the intervention by looking at what it is that is lacking to enable that a differential space is produced, not dominated by abstract space. Further work will aim to follow this intervention, to the point of it being moved from site to site, and how this impacts on the produced space. In addition, it will be important to delve
deeper into the concept of production of space to find out what it can offer information systems research.

REFERENCES AND CITATIONS


DECONSTRUCTING THE DICHOTOMOUS RELATION BETWEEN “IT ANALYSTS AND END-USERS”: A CASE OF IMPLEMENTING STANDARD INDICATORS IN CAMEROON

Flora Asah, Department of Informatics, University of Oslo, florana@uio.no
Jens Kaasbøll, Department of Informatics, University of Oslo, jens@ifi.uio.no

Abstract: Différance and supplément are post-structuralist concepts for analyzing language in text and are most often associated with the work of Jacque Derrida. The findings after the implementation of standard health indicators in Cameroon show that staff at the peripheral level encounter multiple challenges, including lack of participation during the implementation process, and tension between staff at the peripheral level and IT staff at the central level, which result in non-use of the system. We use deconstruction to understand the root cause and the findings reveal that IT professionals and end-users are embedded in a relation of domination. That is, IT professionals are différance from end-users and end-users are supplément of IT professionals. Although end-users are portrayed as supplementary, they are supposed to manage the system, which is contradictory. This led to IT professionals having more privilege and authority over end-users. This dichotomous relation is a derivative of the organizational structure. The notion of portraying IT professionals in charge and having more authority over end-users is an avenue for conflict. The paper concludes that a HIS organizational structure where decision-making is centralized is a ground for conflict and a major roadblock of building local capacity and providing infrastructural support at the peripheral.

Keywords: interpretive phenomenological approach, différance, supplément, standard health indicators, health information systems, Cameroon, deconstruction

1. INTRODUCTION AND BACKGROUND

The need to provide comparable and accurate data to report on the Millennium Development Goals (MDGs) indicators compelled Cameroon to adopt and implement strategies to harmonize the national health information system (HIS) (MINSANTE-WHO, 2018). An example is the adoption of the District Health Information Software version 2 (DHIS2)¹ and the design and implementation of standard information tools. These tools include the list of standard health indicators and data collection tools known as Monthly Reporting Activity (MRA) (MINSANTE-WHO, 2018). Standard health indicators are core elements of data analysis and the standard-setting instrument used to measure the performance of healthcare services. Standards are agreed-on health information procedures (i.e., the way data are collected). They also refer to the content of HIS (i.e., the metadata and indicators) (Jacucci et al., 2006). In this study, we refer to these tools as standard information systems (SIS). An important outcome of implementing SIS is that it should build infrastructural support and resources (i.e., human capacity, and competencies) at the peripheral level (Jacucci et al., 2006). The findings of a study conducted in Cameroon show that following the implementation of SIS, staff at the peripheral level encountered multiple challenges, including a lack of skills to analyze data and non-involvement, rendering them incapable of using the system (Asah et al., 2021). Non-

¹ The DHIS2 is an electronic platform that facilitates data analysis and comparison. It is a web-based system that users at all levels can access provided they have Internet access and access to the platform.
involvement during participation and a lack of adequate skills to use SIS could lead to resistance and non-compliance among IS users (Dwivedi et al., 2015). In IS literature, researchers and practitioners have identified these factors as major problem shaping the use of IS (Braa et al., 2002). The implementation of IS requires the active involvement and participation of all stakeholders, particularly end-users whose involvement and participation is critical to successful implementation (Grudin, 1991; Berg et al., 2003). However, participation of end-users in the IS implementation projects appears to have been less than successful (Beirne and Ramsey, 1988), due to conflicting interests, tensions, the distribution of authority (Newman and Robey, 1992), and power play (Markus, 1983; Dwivedi et al., 2015), among IS staff particularly in centralized organizational structures (Markus, 1983). Studies show that the relationship among staff during the implementation of IS leaves much to be desired (Beath, 1991). Discussions within organization on the distribution of authority mainly center on centralization and decentralization of resources as IS practitioners tend to assume that, as technical experts, they have the more power to control IS resources (Beath, 1991). While there is a large body of literature on conflicts during IS implementation of IS, little of it has addressed them from the perspective of the end-users at the peripheral level (Lin et al., 2018; Warne, 1998). In this article, we examine the relationship among IS staff during the implementation of standard indicators. Focusing on end-users, the study seeks to explore the power relation between IT professionals and end-users, and bring to the fore the meaning of their experiences. IS are socio-technical artifacts designed for local adaptation, therefore, understanding the root causes of the tension is beneficial as this could enable these issues to be addressed (Fiorelli et al., 1993), hence improving implementation and hence, the use of IS, which is one of the goals of ICD4.

The empirical setting for the study is the implementation of standard health indicators in Cameroon’s health sector. The IS implementation process is one of the times that both IS groups come together and is thus an appropriate time to examine their relationship. We draw on the concepts of supplément and différance to under the relation.

2. DEFINITION OF CONCEPTS AND CONCEPTUAL BACKGROUND

2.1. The term ‘end-user’ has been used differently but in this case; it refers to potential users or anyone in the organization who will directly or indirectly use the system. This is based on the notion that the end goal of developing a system is that it is going to be useful to the consumers. An example in this case is the HIS and the end-users are staff at the peripheral level who generate, collate, analyze, and capture routine data on the IS. IT professionals are the designers, developers, and implementers design the IS. In this case, they are staff of the CIS 2 who also have the decision-making powers.

2.2. Implementation of IS has been a topic of discussion amongst researchers in the fields of IS. Two schools of thought exist. The first views IS implementation from a pure technological stance. The main concern of this school of thought is how to offer technical solutions to integrate the systems of different backgrounds to cater to technological needs (Bostrom and Heinen, 1977). This conception is, however, criticized by the other school of thought that holds that social and organizational aspects play an equally important role in IS development. This group conceptualizes IS implementation as a socio-technical process, highlighting the need to address organizational and social issues during the development and post-development of technical issues (Bostrom and Heinen, 1977). The socio-technical approach offers a broader understanding of HIS implementation that implies that the process of implementing IS involves incorporating the technical tools and associated procedures into existing organizational routines.

2.3. Concepts différance and supplément. When computers were first introduced for common use within the organization, there was an expectation shared among many observers that they would

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Footnote:

2 Know by the French acronym, Cellule d’Information Sanitaire
tend to centralize organizational power (Pichault, 1995). Thus, information was equated with power and the information processing capacity of computers was seen as an extension of managerial control. The dissemination of computers in the organization was accompanied by ideas that engendered a reconceptualization of managerial and organizational process, explicitly emphasizing the importance of control over IS (Bloomfield et al., 1992). This thinking has often been associated with technocratic ideas and further strengthened the feeling that computers and IS would pave the way for enhanced centralization in organization activities (Bloomfield et al., 1992). This power relation is a post-structural approach (Chiasson et al., 2012), and we use the concepts of *différance* and *supplément* explain this in our context.

*Différance* is a term coined by Derrida to unveil the fundamental conceptual oppositions inherent in Western philosophy (Chiasson et al., 2012). *Différance* means both difference and an act of deferring. It is used to characterize how linguistic meanings are created rather than given (Norris, 1991). According to Derrida, concept(s) are understood by comparing them to similar concepts that one is familiar with. For example, one is able to distinguish colors such as blue and red because of how different each is relative to the other (Chiasson et al., 2012). In most cases, one focuses on conceptual distinction by contrasting a concept with the one that appears to be orthogonal to it. Examples are good/evil, masculine/feminine, and speech/writing (Cooper, 1989). Derrida argues that while the two elements are placed in such a dichotomous relationship that they may seem to be in simple opposition, *différance* suggests that, in practice, one element of the dichotomy is often privileged over the other (Chiasson et al., 2012). The element appearing first often masks a relationship of superiority over the other. The first element is considered a primary member of the pair, while the other is considered as secondary, and often undervalued (Derrida, 1985). An example, in this case, is IT professionals/end-users. The IT professionals are considered superior while end-users are considered secondary. To “deconstruct” the opposition is to explore the tensions and contradictions between the hierarchical ordering assumed in the concept and other aspects of the concept’s meaning, especially those that are indirect or implicit (Chiasson et al., 2012).

*Supplément* is defined as "an inessential extra added to something to complete itself" (Cooper, 1989). Going back to the explanation of *différance* and how we attach more importance to words that appear first, exaggerating the differences between two words leads us to ignore their common roots and to undermine what may be inherently inseparable (Cooper, 1989). In such a case, the privileging of one side conceals the often critically important compensating role of the other. From our example of IT professionals/end-users, using this concept, the end-users are *supplément* of IT professionals. The interdependency of two opposing elements in a dichotomy can often be seen as the privileged element's reliance on the supplemental one for its meaning. To deconstruct, Derrida argues that if something is complete, there is no need to add any *supplément*. *Supplément* is used to compensate for the inherent inadequacy or incompleteness of the privileged element (Beath et al., 1994; Chiisson et al., 2012). Going back to our example, one would say that if IT professionals are complete, there is no need to have end-users as *supplément*.

Deconstruction is an interpretive approach used to study language (Jones, 2003) and is considered a post-structural (Agger, 1991) approach. As an analytical strategy, it is a tool for “de-constructing” or taking things apart, including philosophical arguments, literary text, or understandings of lived experiences (Miller, 1976). It is used to examine cultural artifacts with “an eye sharply trained to look for contradictions” (Norris, 1991, p. 137), and contradictory ideas about something or someone. Contemporary social scientists who work to deconstruct text often draw on the work of Derrida\(^3\) (Agger, 1991). Derrida sought to establish a set of rules that could be applied in the reading, writing, and interpretations of text to unearth their historical, cultural, and social construction (Agger, 1991). Deconstruction’s strengths lie in revealing implicit meaning and unacknowledged biases that exist

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\(^3\) The most celebrated and principal exponent of deconstruction
in groups of individual such as cultural, class, or gender differences, and can be used to understand the relation between IT staff and end-user in the IT domain in Cameroon. They have also been used to explore the gray areas between two groups and what can result from those perceived differences. Using these concepts highlights the social divide that is prevalent but not discussed in the IS domain.

3. RESEARCH SETTING AND METHODS

3.1 Research Setting

The empirical setting for this research is Cameroon, a low-income country located in Central Africa with a population of about 24 million in 2018. The country has a hierarchical organizational structure characterized by centralized decision-making, much bureaucracy, and poor communication channels (WFP, 2018).

3.1.1 Cameroon’s Health Information Systems

Routine data management in Cameroon has a long history but the country started developing its national HIS around 2013. Prior to 1995, routine data was collected and managed haphazardly, that is, each parallel health program had its own IS (ADF, 2000). For example, the North-West and the South-West regions had two projects, SESA\(^4\) and OCEAC\(^5\). Each had its HIS, list of indicators, data collection forms, and computer (ADF, 2000). In 2013, the Ministry of Public Health (MoPH) made its first attempt to develop a national HIS. A presidential decree was signed that created a national department of IS, named the CIS. The CIS is charged with the responsibility of designing, implementing, and disseminating health information throughout the country. As noted previously, Cameroon has a hierarchical organizational structure that is characterized by centralized decision-making, much bureaucracy, and poor communication channels (WFP 2018). In 2017, the country adopted the DHIS2. Routine data is compiled weekly, monthly, or quarterly depending on the program, then aggregated, and recorded in the MRA booklet. The booklets are sent to the district office for validation by the information team and it is then captured on DHIS2 platform. Thereafter, those with access to DHIS2 can access the data. At the health centers, end-users have poor access to information because the books are out of date, there is no access to journals and the Internet, and the information available is not appropriate for the local situation. Many studies describe the IS as dysfunctional (Nkoa et al., 2009; Ngwakongnwi et al., 2014; Asah et al., 2017).

3.2 Methods

This paper is based on an interpretive phenomenological (IP) approach (Heidegger 2010). An IP approach was used as the objective of the phenomenological method to describe experiences rather than to test hypotheses (Larkin et al., 2006). Phenomenological studies are conducted when a researcher wishes to explore the perceptions and experiences of the participants from their point of view. This approach seeks to understand the meaning that individuals ascribe to their lived experiences and the researcher aims to interpret this meaning in the context of the research (Smith, 1996). Phenomenologists are concerned with understanding phenomenon from the perspective of the participants involved (Larkin et al., 2006; Van Manen, 2016). The phenomenon studied is the relation between IT professional and end-users. Pichault (1995) explains that, those actions or behaviors that lead to conflicts occur most often when IT professionals are not aware, thus, they go unresolved or undiscussed. Heidegger (2010) argues that phenomenology does not have as it object that which is visible and clearly defined, rather, it is those phenomenon that remain hidden somehow disguised which are of interest. Using IP approach enables us to interpret the meaning of the relation between both parties. Such an approach allows researchers to put themselves in the shoes of the end-

\(^4\) Child Health in the South and Adamaoua

\(^5\) Organization of Coordination for the Control of Endemic Diseases in Central Africa
users to understand their subjective experiences (Creswell, 2007), while describing the experiences as accurately as possible, and refraining from subscribing to any pre-given facts, but remaining true to the facts. Since a basic phenomenological assumption is that all human experience is structured and has meaning, the need to force a priori structured is eliminated (Larkin et al., 2006). A semi-structured interview method, as described by Colaizzi (1978) was selected as that most appropriate and powerful for obtaining current and retrospective data from participants. 25 interviews were conducted with staff in their chosen locations. Using interviews allow participants to narrate their accounts as they lived it while not limiting the researcher to the rigid format of structured interviews.

<table>
<thead>
<tr>
<th>Staff interviewed</th>
<th>Code</th>
<th>No.</th>
<th>Brief description of Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>District information officer</td>
<td>DIO</td>
<td>3</td>
<td>DIO manages information at the district level</td>
</tr>
<tr>
<td>Facility information officer</td>
<td>FIO</td>
<td>6</td>
<td>FIO manages information either at a General/regional hospital</td>
</tr>
<tr>
<td>Manager of IHC</td>
<td>M-IHC</td>
<td>7</td>
<td>M-IHC &amp; MDH manage data at a health facility</td>
</tr>
<tr>
<td>Manager of District Hospital</td>
<td>M-DH</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Monitoring and evaluation officer</td>
<td>M&amp;E O</td>
<td>4</td>
<td>Information manager from parallel programs</td>
</tr>
<tr>
<td>Program Manager</td>
<td>PM</td>
<td>3</td>
<td></td>
</tr>
</tbody>
</table>

**Table 1: List of staff interviewed**

Interview schedules with broad questions were used to collect data from April to September 2017. The participants were selected on the basis that they attended the implementation workshop and are directly involved in the management of information at their respective health facilities. The questions focused on exploring the nature of their role and experiences during the implementation of SIS. This includes support they receive from the CIS staff, and their involvement in the implementation process. This enabled them to describe their personal and subjective experiences as freely as possible in their own words. Where necessary, the interviewer asked additional questions for clarification and elaboration.

Before the start of each interview, time was dedicated to building trust and rapport that helped to set the tone for the rest of the discussion. The aim of the study and the interviewee’s rights were clarified and written informed consent was obtained. The interviews were held at the participant’s office and each lasted for about 50 minutes, and was audiotaped, and transcribed verbatim. The researcher kept a diary to record comments and describe the context and behavior that may not be captured through audio recording.

Data analysis began during data collection. At the end of each day, the researcher organized the data collected and developed impressions and issues. The researcher relied on Braun and Clarke’s (2006) thematic analysis to aid analysis. Data analysis was cyclical, with the researchers going back and forth, i.e., from the data to the analysis and from the analysis back to the data to refine the interpretations and to gain in-depth understanding of what the participants were saying to truly understand the world from their perspective. The researcher read each interview transcript separately to get an overall sense of the participants’ lived experiences and to obtain a sense of immersion in the data. It should be noted that this paper is based on a large PhD research project that focuses on the challenges that staff experience following the implementation of SIS. However, this paper reports on the relationship among staff, which is part of the overall research project. For this paper, which scrutinizes the relationship between IS professionals and end-users, the researcher identified statements within the data that seemed most likely to achieve this objective. We identified decision-making around HIS and the organization of IS implementation and development of training content and training. The next step was to analyze the text by identifying sections that might reflect différance or supplément.
4. FINDINGS AND ANALYSIS

This section presents the findings supported by verbatim quotations as well as our interpretation. Reading the transcripts, we identified two factors that characterize the relationship between IT professionals and end-users.

4.1 Organization of SIS implementation workshop

The CIS unit makes all decision concerning the design and implementation of IS nationwide. In this era where information is a powerful resource and CIS, being the custodian of information-related activities making it a strategic and powerful. In terms of organization hierarchy, CIS is at the top of the organization structure; they have the power of command. Therefore, the hierarchical position and organization context bestowed on CIS staff make them more powerful. As a consequent, they do not want to engage in mutual negotiations (Pichault, 1995) with the end-users. This is a technocratic reasoning as technocrats believe that information is a powerful resource that many people value in any organization (Pichault, 1995), therefore, implementing IS could create a conundrum in respect of power and control (Warne, 1998).

The implementation of SIS took the form of training workshops with staff at the peripheral level. The workshops were held in the regional health delegations but were organized, supervised, and facilitated by CIS staff. For example, a series of workshops organized at the Littoral Delegation of Health were attended by end-users (district offices and program managers) from the Littoral, Northwest, and Southwest regions.

We take as a general conviction the importance of involving staff at the peripheral level throughout the design and implementation of IS. The World Health Organization (WHO) emphasizes that the process of implementing IS should be highly participative in order to generate consensus (WHO, 1995). However, in practice, the CIS makes all decisions. As shown below, this has created a paradox that has left the end-users in an indefensible position with little or no opportunity to participate in mutual negotiations.

4.2 The distinction between IT professionals and end-users - différence

Decision-making - Despite stated commitment to and recommendations on the value and participation of end-users, a close examination of the dynamics during implementation suggests a contrary interpretation. We found that, rather than creating an atmosphere to foster joint participation, the CIS’ decisions limited end-users’ involvement during implementation. The end-users stated that they were delighted that the CIS is seeking to strengthen the IS by introducing a standard list of health indicators. However, they expressed the desire to be more involved in the process; for example, in designing tools because many of those who design the system do not know the context and how data is collected:

"...the CIS people sit in Yaoundé and design tools to be used by someone working in Limbe [on the ground] for example, without them knowing how data is collected on the ground. ... when it comes to information, the central level seems to impose tools" (PM).

The fact that the CIS designed the tools and then invited end-users to the workshop without allowing them to be involved in the design and planning, highlights a distinction between the two categories of staff and illustrates a relationship of superiority. The IT professionals have control and authority, while the end-users are subordinates. The health care sector includes partners and stakeholders with different information needs. The national list of indicators should, to some extent, accommodate the needs of the different partners (Sapirie and Orzeszyyna, 1995), hence the need for stakeholders to participate. When a single body makes the decisions, as in this case, the list of indicators is not representative or comprehensive. The program managers reported that the MRA is not comprehensive because the indicators represent the information needs of the managers at the central level. This exclusive decision-making by the CIS illustrates their supremacy in IS implementation.
Reinforcing the CIS’ superiority over staff at the peripheral level was the title of the workshop, namely "END-USERS WORKSHOP ON DHIS2 IMPLEMENTATION". Another way of illustrating dominance was how the staff were grouped. For example, CIS staff, i.e., computer programmers, and data analysts are known as “IT professionals” and staff at the peripheral levels are grouped as “end-users”. It is interesting that in the IS domain, staff are acknowledged as 'professionals' while there is no acknowledgement that many so-called end-users may also be professionals in their respective domains. For example, the peripheral level includes professional nurses, medical doctors, monitoring and evaluation specialists, and program managers who are all professionals in their respective domains. Consistent aggregation of end-users across the disciplinary and hierarchical levels to create a homogenous end-user category facilitates stereotyping and emphasizes différance. Furthermore, the use of the term end-user depicts them as technologically naïve, and suggests passivity as those who consume, rather than those who can manage and take control of the IS.

Reaffirming the distinction between IT professionals and end-users is the separation of activities. The DIO reported that CIS staff facilitated all sections of the workshops while the end-users were participants who sat down to be taught how to manage the system. Other qualified and experienced staff at the peripheral level could have been involved, but were not among the facilitators. This distinction validates the separation between the two groups. Similarly, it depicts end-users as lacking technical knowledge, and as inexperienced consumers who play a passive role while the IT professionals are technocrats with technical expertise to build IS.

**Training content** – The end-users reported that the training primarily focused on operational aspects of using the DHIS2 platform and did not cover areas that were relevant to most staff. FIO explained:

“The training focused mainly on operational aspects of the new data collection tools; and how to capture data, report generation on the DHIS2 platform. They did not teach areas that were relevant to program managers such as data analysis” (FIO).

It is obvious that the training end-users received was not what they needed. Had they participated in the planning process, they would have had an opportunity to explain their training needs. Instead, the IT professionals imposed what they considered would be appropriate for end-users, giving them no room to negotiate. Such practices illustrate the superiority tendencies of CIS staff over end-users and reiterate différance - a difference between IT professionals and end-users.

4.3 **End-users are a supplement to IT professionals - supplément**

The data presented above shows that the CIS staff and end-users are different. That is, the CIS staff teach and provide guidance to the end-users on how to manage health indicators at the peripheral level, portraying the end-users as lacking knowledge. Focusing on these differences set the rationale for why CIS staff make all decisions on the implementation of SIS. The end-users’ dependence reaffirms the power of the CIS and legitimates the condescending attitude towards end-users, but also creates a contradiction when it comes to those responsible for managing the IS at the peripheral level. At the peripheral level, end-users such as facility information managers have to ensure that data is adequately and accurately collected and submitted on time. A manager explained:

“...it is the responsibility of facility managers to train on health indicators, data quality assessment, data use to all staff responsible for data management activities at the health facilities, and on HIS” (FM).

Another manager added:

“At the facility, we [managers] are responsible for ensuring adequate data quality. We have to review data, validate, and sign off on it....” (MHIC).
If end-users are portrayed as *supplément* to IT professionals, the tasks end-users perform are not supplemental. End-users play a very significant role that is almost equivalent to that of the IT professionals. If data is not properly managed at the peripheral level, managers and decision-makers within the healthcare system will not have accurate data. Considering end-users as *supplément* to IT professionals while, at the same time, expecting them to manage the IS, is contradictory. This is because, on the one hand, they are considered as passive and technologically naïve, while on the other, they are recognized as managers who are supposed to train staff on data management-related activities and to manage the IS at the peripheral level.

5. DISCUSSION

This study aimed to explore the relationship between IT professionals and end-users. Focusing on the process of implementing SIS within a centralized, hierarchical structure, we found evidence of contradictions and logical inconsistency in their relation. Despite the emphasis on the importance of end-users’ involvement and joint participation, in terms of decision-making, distribution of tasks, and responsibilities during implementation, we identified ambivalence regarding the degree to which end-users can be expected to be true co-agents with IT professionals. The heavy emphasis on joint participation during the implementation of IS, is contradicted by the actual procedures recommended to engage end-users. Pichault (1995) explain that from the IT professional perspective, IS implementation creates a conundrum in respect of power and control in the organization because the political structure of the organization is affected (Warne, 1998). While from the end-users’ perspective, the actions and behavior of the IT professionals are equivocal in their commitment to participate, and ambivalent, reinforced by the dichotomy set up between the groups. These contradictions were expressed by employing différance and supplément. In terms of différance, end-users are portrayed as naïve and passive, while the IT professionals are presented as more knowledgeable and professional, i.e., IT professionals are in charge and end-users are supplementary staff.

Using the concept of supplément, we showed that this privileged dichotomy is not sustainable in that the end-users are expected to be responsible for the outcomes of the IS. That is, they have to manage the system. This contradiction illustrates the deep confusion surrounding the relationship between IT professionals and end-users. It leaves both end-users and IT professionals in an untenable position, with end-users submissive while IT professionals are in charge of the implementation of SIS. We suggest that these characterizations are likely to undermine mutual interactions between IT professionals and end-users, and, in an interesting twist, disable end-users, leaving them ill-equipped when negotiating with IT professionals and even using the IS as in this case. As a result, end-users do not have the necessary skills and resources required to manage the IS. These findings may shed light on end users’ recurrent lack of skills and resources to use IS at the peripheral level, which has been well-documented in the literature (See: Asah et al., 2021; Njuguna et al., 2019; Lippeveld, 2017; Nicol et al., 2017; Nutley et al., 2013).

Using deconstruction is valuable in exposing inconsistency and the contradictory actions and behaviors embedded in the organization where the two groups (IT professionals and end-users) interact on a daily basis. Such behaviors or actions are often not detected and hence tend to remain undiscussed or unexamined (Beath et al., 1994). In this case, deconstruction helped bring to light the dominance and contradictory relations that exist in the management of HIS. These actions or behaviors do not exist in a vacuum; they are derivative of the institutional context, which includes industry-wide structures of historical patterns of resource allocation, as well as the norms on how and where institutions operate.
In every organization, there is a relationship of interdependence between different professional groups. These relationships are often complex and tend to be managed by dominance and are sustained by the particular structures of power and norms that constitute the organizational structure (Giddens, 1984). This could lead to one interest group having more privilege and authority over another by being assigned greater legitimacy and resources, which are the same means through which dominance is perpetuated. Similarly, in the management of HIS, the interdependence between IT professionals and end-users depicts a relationship of dominance. The very notion of end-user portrays CIS staff as naturally in charge and having the authority to decree the participation of end-users. Therefore, the process of implementing SIS in Cameroon is one in which some staff is designated as IT professionals and others as end-users, with the IT professional having more power and control over the end-users.

6. CONCLUSIONS
This study examined the relations between IT professionals and end-users. In theorizing these relations, we found that IT professionals and end-users are embedded in a relationship of dominance exercised through actions and behaviors similar to that of différance and supplément. These actions are derivative of the technocratic ideas HIS and the hierarchical organizational structure of HIS in Cameroon, which tends to privilege one group, IT professionals over end-users.

From a theoretical point of view, the study feeds into the discourse around IS implementation and ICT4D by illustrating a novel way of examining relations within IS management and brings to light a new factor that could explain non-use of IS at the peripheral level. In addition, using a hermeneutic phenomenological focus and the concepts, différance and supplément to scrutinize the relations between IT professionals and end-users is also novel. These concepts are generally used to deconstruct published text. Using them to deconstruct unpublished text makes the analysis unique and innovative. The paper concludes that the technocratic thinking and centralized decision-making in HIS is a major roadblock to the successful implementation and use of IS and a barrier in building local capacity and providing infrastructural support at the peripheral level in centralized organizational settings.

This study has several limitations. First, deconstruction has often been used to analyze printed and published text. Second, we only interviewed end-users and the study focused on the two English-speaking regions (formerly known as Southern Cameroons). These regions have lower levels of socio-economic development than other regions in the country. Third, fieldwork was conducted amidst political unrest in the English-speaking regions of the country. Fourth, using the hermeneutic phenomenological approach, the findings presented gives the account of the participants’ interpretations and the researcher’s interpretation of social reality. Another researcher could have a different interpretation. While this is one possible approach to theorize the case in point, further research is required on alternative approaches.

AUTHOR’S CONTRIBUTIONS
FN led the interviews, transcribed and analyzed the data, and kept a reflective diary throughout the process. FN is a Cameroon and a knowledge broker who has worked with healthcare providers at the peripheral level. The impact of an existing professional relationship between the interviewer and interviewees was taken into account during data analysis through the researcher’s reflexive diary entries. Throughout the analysis, the themes identified were discussed with JK and he gave critical input to the manuscript.
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ARTIFICIAL INTELLIGENCE IN THE GLOBAL SOUTH (AI4D): POTENTIAL AND RISKS

P. J. Wall, ADAPT Centre, Trinity College Dublin, Ireland, pj.wall@tcd.ie
Deepak Saxena - BITS Pilani, India, deepak.saxena@pilani.bits-pilani.ac.in
Suzana Brown- SUNY Korea, South Korea, suzana.brown@sunykorea.ac.kr

Abstract: Artificial intelligence is becoming more widely available in all parts of the world. This has created many previously unforeseen possibilities for addressing the challenges outlined in the Sustainable Development Goals in the Global South. However, the use of AI in such contexts brings with it a unique set of risks and challenges. Among these are the potential for Governments to use such technologies to suppress their own people, and the ethical questions arising from implementing AI primarily designed and developed in the Global North into vastly different social, cultural, and political environments in the Global South. This paper examines the key issues and questions arising in the emerging sub-field of AI for global development (AI4D) and the potential and risks associated with using such technologies in the Global South. We propose that although there are many risks associated with the use of AI, the potential benefits are enough to warrant detailed research and investigation of the most appropriate and effective ways to design, develop, implement, and use such technologies in the Global South. We conclude by calling for the wider ICT4D community to continue to conduct detailed research and investigation of all aspects of AI4D.

Keywords: Artificial intelligence, AI, technology, Global South, AI4D

1. INTRODUCTION

The term Artificial Intelligence (AI) is generally accepted to have been first used at a conference in 1956. Over the years there have been many definitions of AI, with perhaps the most widely accepted being by Rich (1985) who posited AI as the study of how to make computers do things which, at the moment, people are better. AI typically uses pattern recognition, reasoning, and decision-making under complex conditions, and often deals with noisy data, uncertainties, ill-defined problems, and the need for in-situ solutions (Venkatasubramanian, 2019). AI has been used in many fields over the last three decades including the natural and physical sciences, computer science, engineering, natural language processing, and medicine. It is widely accepted that AI is advancing rapidly, and there is currently a great deal of interest in the commercial potential of AI. The impact of AI will undoubtedly be significant and highly disruptive in many industries including finance, healthcare, manufacturing, retail, supply chain, logistics, and agriculture.

AI is also likely to have a significant impact on the Global South, providing new and unforeseen opportunities to address many of the problems in healthcare, education, and social services common in such resource-constrained environments. The aspiration in many low-income countries is to leverage AI in order to achieve transformation by changing underlying systems of development and

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1 https://courses.cs.washington.edu/courses/csep590/06au/projects/history-ai.pdf

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towards inclusion by addressing both the symptoms and causes of inequality. These technologies are bound to have the potential to empower individuals and communities, leading to greater social change, an improved quality of life, and strengthened public health and education systems.

However, the increased use of AI in the Global South is also likely to bring with it many potential risks and challenges. Among these risks are that Governments will use such technologies inappropriately to monitor and suppress their own populations, perhaps even going so far as to use AI-based weapons for conflict and war. In addition, ethical questions are bound to arise as AI designed and developed in the Global North is expected to be used in hugely different social, cultural and political contexts in the Global South. This is likely to raise concerns around the potential to exacerbate digital inequalities and further embed notions of digital colonialism in the Global South (Kwet, 2019).

The main purpose of this paper is to initiate a discussion about the potential and risks of AI in the Global South. The objective is to present a broad overview of the topic which will provide a starting point for future discussion and research on what is bound to become a key sub-field in ICT4D over the coming years. The paper proceeds as follows: Firstly, we discuss the potential of AI and associated technologies in the Global South. This is followed by consideration of the risks associated with such technologies in this context. We conclude with our thoughts on the current state of the AI4D sub-field, and we make a call for additional research in order to expand our knowledge on this important topic.

2. THE POTENTIAL OF AI IN THE GLOBAL SOUTH

The increasing use and potential of AI in the Global South has been predicted for many years (e.g. Wall et al., 2013; Zheng et al., 2018), with a variety of emerging potentialities for AI and other advanced technologies which should be embraced (Walsham 2012). AI may be envisaged as a system’s ability to interpret data, to build learning models from such data, and subsequently use these models to achieve specific objectives, incorporating flexible adaptation (Kaplan & Haenlein, 2019). AI does influence a large part of modern life in the Global North, having daily impact on who we interact with on social networks, the movies and TV we watch, the music we listen to, and the route we take when driving to work or school. Such AI does not work in isolation; they collect data using other advanced technologies and complement others with their decision-making capabilities. Beyond technology, the use of AI is influenced by human actors and policy/regulatory infrastructure. In that sense, AI may be seen as complex socio-technical assemblage (Cantrell & Zhang, 2018).

One of the most controversial uses of AI is in unmanned aerial vehicle (UAV) or drones. Applications of drones in the Global South are mainly restricted to delivery vehicles in agriculture and healthcare. However, drones are being increasingly used as weapons and tools for monitoring and surveillance in both international and domestic law enforcement. However, drones can also be used for wildlife preservation and scientific research. Another potentially AI-related advanced technology gaining use in the Global South is the Internet of Things (IoT). The IoT is an interconnection between the physical object and the digital world. Kevin Ashton defined IoT in 1999 as a set of ordinary objects combined with the sensors and Radio Frequency Identification Technology (RFID), which provides an infrastructure to uniquely identify and link physical objects.
to their virtual representations on the Internet\(^2\). The IoT is an integral part of the future Internet ecosystem which is likely to have a huge impact on healthcare and education in the Global South over the coming years.

Perhaps the most important potential of AI-enabled technology in the Global South is in the area of smart or precision agriculture for increasing crop productivity (Ampatzidis et al., 2020). This is especially important for countries where a large portion of people earn their living from agriculture. Drones can be used for aerial observation, sensing, and the spraying of pesticides, and various IoT sensors can provide real-time data on farms that enable farmers to make informed decisions regarding farm inputs usage. The data thus collected can be uploaded to the cloud for further analysis regarding the suitability of a crop in a particular region at a particular time of the year. Drones can also be used for surveying and mapping forests and biodiversity and can therefore help in conservation, as well as the accurate prediction of potential fires or floods based on the analysis of past data. For instance, Dutta et al., (2016) analyse data from various sources and provide a highly accurate estimates on bush-fire incidence in Australia. Such estimates can be used in planning mitigation and early evacuation, with the potential of this technology being particularly relevant in the Global South.

Also of relevance is the way AI is being used in intelligent energy management. IoTs can help in managing the entire energy lifecycle including power generation, power transmission, power distribution, and demand side management (Zhou et al., 2016). The data collected from various IoT devices (e.g., power grid equipment, GIS, weather sensors) can be uploaded to the cloud where power generation companies can run complex simulations and forecast power requirements. Data collected from IoT sensors may also be used for fault detection, electric device health monitoring, predictive maintenance, and power quality monitoring (Zheng et al., 2018).

Widespread adoption of these AI-based technologies will be facilitated by the roll out of fibre and 4G networks which is currently taking place across much of the Global South. This, combined with cheap and powerful smartphones built specifically for the African market, raises the possibility that AI has the potential to become more ubiquitous in such resource-constrained settings. Over the coming years advances in this technology will mean that AI will be able to do more, with this being particularly true in the field of healthcare where remote diagnosis of various medical conditions and diseases, faster and more reliable transfer of larger amounts of data, more sophisticated monitoring and control of data and the ability to conduct a variety of advanced medical scans with a mobile phone becoming a likelihood. An example of this is the acceleration sensors inbuilt within the phone which will enable patients and health workers to interact more closely, and mobile apps with the potential to produce and manage considerable amounts of data by using the camera and various other measuring and sensing devices to automate the logging of personal health states (Benferdia & Zakaria 2014). It is also suggested that future possibilities for AI and healthcare in the Global South include remote diagnosis and crowd sourcing for health (Latif, Rana et al. 2017), more big, open, and real-time data, the use of field sensors and embedded computing, more social media, more crowd-sourcing models, and 3D printing (Heeks 2014).

\(^2\) https://www.rfidjournal.com/that-internet-of-things-thing
3. **RISKS OF AI IN THE GLOBAL SOUTH**

Despite the huge potential of AI in the Global South, there exists a less pleasant future agenda which Zheng (2018) refers to as the “dark side” of ICT4D. This involves AI being used for surveillance and control, which includes big data, social media, and cloud computing. Such applications of the technology will further enhance the capacity of authorities and commercial entities to access a wide variety of personal data. Zheng (2018) makes the claim that there has been little discussion on this important issue to date, and on the implications of AI4D which may be controlled more frequently by capital and commercial interests in future. In addition, there is the possibility that such technology will be used by governments to enforce their ideologies and maintain control of populations in a variety of ways. This is particularly relevant as the application of AI may have a dramatic effect on many countries in the Global South (Zheng et al., 2018).

Furthermore, although AI is potentially beneficial, it is currently expensive to develop and implement. This cost of implementing such advanced technologies is the biggest risk for resource-constrained countries in the Global South. While AI has the potential to help in precision agriculture and forest preservations, the initial infrastructure cost is huge when compared to the cost of more traditional methods. This is where the role of technology companies and transnational organizations comes into play; such organizations may need to provide some basic infrastructure to support low-income countries in the short run to create a market in the longer run.

Another example of potential risk is the implementation of AI-based sensors, robots and other devices on farms that may cause harm to farm animals and external wildlife (Ryan, 2019). These devices could upset, injure, or even kill livestock and local wildlife. Many of the devices also have the potential to emit toxic material, fumes, and waste into their surrounding environment. An additional concern is that AI algorithms may exclude the land external to the farm and therefore cause adverse effects to the general environment (Antle, et al., 2015) such as an encroachment on habitats or general pollution. Therefore, the ecological and social effects of AI implementation in agriculture are significant (Kosier 2017) and should not be ignored.

In addition, many AI algorithms are opaque and often beyond human understanding (Hagras, 2018; Mackenzie, 2019). Undifferentiated use of such AI, particularly AI which has been trained on data from countries in the Global South, may result in the loss of opportunities (e.g., rejection of a mortgage or a parole) for some in the Global South. Moreover, drones have the potential to cause injuries and damage to people and properties if used incorrectly or unethically. This is partly due to the absence of a legal and governance framework across the Global South. Even in the Global North, where there are some guidelines (e.g., EU guidelines on trustworthy AI), these risks persist.

4. **DISCUSSION AND CONCLUSIONS**

The transformative potential of AI and other advanced technologies, combined with the existing critical mass of technological infrastructure, might inspire some to be optimistic about the prospects for AI in the Global South. However, many are pessimistic as it has previously proven to be difficult to implement, sustain and scale any type of technology for global development projects. Indeed, Heeks (2018, p. 103) goes further by claiming that “most ICT4D projects fail”. Furthermore, many such projects prove to have either limited or unsustainable impacts on development (Chipidza & Leidner 2019). Similar issues are bound to apply to implementing, using, sustaining, and scaling AI in the Global South.
This raises the obvious question as to how it might be possible to successfully design, develop, implement, and use AI and other advanced technologies in the Global South. Considering AI as assemblage, one way to achieve this may be through the adoption of a transdisciplinary or multidisciplinary perspectives in AI4D research (Walsham, 2017, Zheng, et al., 2018). Such an approach involves welcoming other disciplines with open arms (Walsham, 2012) and with respect (Walsham, 2017). This is important because it will expand the ICT4D field of study into many non-traditional settings (Walsham, 2012). According to both Zheng and Walsham, such linkages should be developed between ICT4D and the fields of computer science, development studies, ethics, anthropology, human geography, development economics and rural development. These links are needed as the nature of the sub-field of AI4D and the technologies being used are dynamically evolving, with social media, AI and the IoT (Zheng et al., 2018), as well as mobile sensing devices to automate the logging of personal health states (Benferdia & Zakaria, 2014), crowdsourcing for health (Heeks, 2014; Latif, Rana et al., 2017), increasing amounts of big data, open data and real-time data becoming more common in the Global South.

Also of relevance to this discussion is the claim that there has been a significant amount of reinvention of the wheel in ICT4D research (Zheng, et al. 2018), with new entrants to the field tending to neglect earlier research simply because technologies have changed rapidly. This is a mistake which should not be repeated in our work with AI4D. Taking stock of ICT4D research and capitalising on existing knowledge would appear to be vital and may also enable the AI4D field to move forward quicker without repeating earlier pitfalls (Zheng, et al., 2018).

Based on what we have presented in this paper we conclude that although there are many risks associated with the use of AI and other advanced technologies in the Global South, the potential benefits of these technologies are enough to warrant us to be cautiously optimistic. However, we recommend proceeding with caution so as not to repeat previous mistakes which have resulted in most ICT4D projects failing or underachieving. We are hopeful that this will be achieved by adopting the transdisciplinary and multidisciplinary perspectives as espoused by Geoff Walsham and others.

We conclude this short paper by making a call for the IFIP WG 9.4 community, as well as the wider ICT4D community, to continue to conduct detailed research and investigation of all aspects of AI4D. In particular, the emphasis should focus on a study of the most appropriate and effective ways to design, develop, implement, and use AI and other advanced technologies in the Global South, and the broader ethical implications associated with the use of such advanced technologies in this context.

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EMPIRICAL STUDY OF SUSTAINING THE ACTUALIZED VALUE PROPOSITIONS OF IMPLEMENTED E-GOVERNMENT PROJECTS IN SUB-SAHARAN AFRICA

Yusuf Ephraim Chidama, American University of Nigeria Yola, yusuf.chidama@aun.edu.ng
Chidi Gerard Ononiwu, American University of Nigeria Yola, chidi.ononiwu@aun.edu.ng

Abstract: Governments in sub-Saharan Africa have implemented e-Government projects. Actualizing the value propositions and sustaining such values are becoming problematic. Some scanty studies on the value propositions of implemented e-Government projects did not consider actualization of the values. Besides, such studies lack theoretical underpinnings, the identification, and measure of what constitutes actualized values. Neither did they capture what mechanisms could sustain the actualized values nor the contextual conditions enabling its sustainability. Consequently, using a concept-centric systematic review, we identified the value proposition of such implemented projects. By drawing from theories of affordance actualization, realist evaluation (RE) theory, self-determination theory, and sustainability framework for e-Government success. We conducted a RE of the implemented e-Government projects in Rwanda using RE as a methodology in three phases. In phase one, we developed the initial program theory (IPT), in phase two, we used contingent valuation as a quantitative approach and realist interview as qualitative method to validate the IPT. Lastly, in the third phase, we synthesized the results of the two investigative case studies to develop the actualized values sustainability framework. Such framework encapsulates, the actualized value propositions, mechanisms and enabling conditions in interactions to sustain the value propositions discovered in the e-Government investigative contexts.

Keywords: e-Government, Value Propositions, Realist Evaluation.

1. INTRODUCTION

There is an increasing scarce resource at the disposal of governments in emerging economies (Heeks, 2002; Heeks, 2017), and citizens’ expectations for quality service delivery is continuously rising. Government plays pivotal role in delivery of efficient, effective and prompt services (Rose, Persson, Heeager, et al., 2015). With the pervasive and emergent role that information and communication technologies (ICTs) play in disruptive quality service delivery; governments in emerging economies are adopting ICTs projects in public sectors in the form of e-Government (Lessa & Tsegaye, 2019). Thus, robust and quality e-Government value propositions that improve service delivery to citizens are increasing in sub-Saharan Africa (Nkohkwo & Islam, 2013). Value propositions in this study identify how public organizations by use of e-Government fulfils citizens’ needs across different roles (e.g., class, gender, ethnic, demography and business concerns). Examples are the Rwandan e-Government initiative known as Irembo, (meaning “access” in local language) and various e-Government initiatives in Nigeria such as the Immigration e-passport service. But sustaining them are becoming problematic (Klischewski & Lessa, 2013). Besides, value propositions are perceived to be a means of accommodating all dimensions of e-government’s
performance to prove its relevance to stakeholders. Such value propositions are also anchored on the capability of e-Government projects to actualize the different needs of stakeholders and deliver services they value most. Thereby legitimizing and sustaining the implementation of such projects (Twizereyimana & Andersson, 2019). Sustaining e-Government projects here is leveraging the existing structures, processes and resources associated with the implemented e-Government projects to continue to deliver the envisaged value propositions to the citizens (Pang et al., 2014). This is done over time, in a given context for the benefits of the stakeholders, which include citizens and donor agencies and to build local capacities (Pluye et al., 2004). Consequently, sustainability of such projects takes the shape of strengthening the system to constitute a resilient ICT4D project. Considering the presence of constrains in the developing economies’ context of the sub-Saharan Africa where the system is operationally situated. Such constraints include cultural and political challenges as well as huge financial constraints. They also include widespread corruption, poor infrastructure, high inequalities, fragile democracies and information poverty within the context the innovation is embedded (Heeks, 2003, 2017). Besides, a large number of e-Government projects in developing countries have failed to enhance governance or underutilized by the host countries (Twizereyimana & Andersson, 2019). Despite huge resources committed with expectations dampened (Heeks, 2002; Heeks, 2017; Heeks & Bailur, 2007). Thus, sustainability of e-Government projects could be considered as resilience, where both concepts refer to the state of a system or feature over time. While focusing on the persistence of that system under normal operating conditions and in response to constraints, setbacks and changes (Ahern, 2013; Anderies et al., 2013; Pang et al., 2014).

On one hand, value propositions of e-Government projects can be created by the host countries to assume the service provision segment of e-Government value propositions (Grimsley & Meehan, 2007; Hui & Hayllar, 2010; Omar et al., 2011; Twizereyimana & Andersson, 2019). While on the other hand actualization of such created value propositions assumed the service consumption segment of the implemented e-Government projects of which it has proven difficult to sustain by the citizens (Verkijika & De Wet, 2018). Consequently, actualizing values propositions is the motivations and capabilities of the citizens to exploit, appropriate, and use the already implemented e-Government projects to access government services. This is done in an efficient and effective manner to enhance citizens’ participation in governance, engage in civic responsibilities as well their general well-being.

Some scanty attempts by literature to uncover the sustainability of the actualized value propositions of the implemented e-Governments has meet stiﬀ oppositions that hinder the advancement of research in this area (Bannister & Connolly, 2014; Heeks & Bailur, 2007). Such oppositions include: (1) lack of theoretical underpinnings (Bannister & Connolly, 2014; Heeks & Bailur, 2007), (2) the identiﬁcation and measure of what really constitute the actualized value propositions by the citizens (3) what mechanisms could be in place to sustain the actualized values and lastly, under what contextual conditions could such sustainability be possible. Thus, to overcome these oppositions, we deem it ﬁt to conduct an evidence-based theory driven realist evaluation of such projects (Mukumbang et al., 2016; Pawson & Tilley, 1997). Evidence-based here suggests that the study obtains empirical evidence on the relative operational effectiveness of the implemented e-Government projects. This should be across various stakeholders and what the technology holds for each stakeholder in their respective contexts of use. To do this, we pose the following research question: “How can the actualized value propositions of implemented e-Government projects in sub-Saharan Africa be sustained and under what conditions, and why?”

To answer the research question, we draw from multiple theories of affordance actualization (Strong et al., 2014), realist evaluation theory (RE) (Pawson & Tilley, 1997), Self-determination theory (SDT) (Deci & Ryan, 1985), and Sustainability framework for e-Government success (Lessa et al., 2015). This is done in the Rwanda’s implemented e-Government projects as the investigative
contexts. This is because no single theory could be used to delineate the actualized values, its sustenance and in what contextual conditions. We got to know this from the initial empirical evidences collected when matched with the tentative theoretical concepts of the aforementioned theories in an abductive manner (Ononiwu et al., 2018). Each theory represents a version of the phenomenon in question (Ononiwu et al., 2018). Thus, to “develop deeper levels of explanation and understanding” (McEvoy & Richards, 2006, p. 69), we need such theories to afford a more compelling accounts of the actualized value propositions of implemented e-Government projects, its sustainability and under what conditions.

The remainder of this paper is structured as follows: Section 2 provides the systematic literature review adopted for the study. Section 3 presents the theoretical foundation. In section 4, we discuss the realist case study research methodology, while Section 5 holds the findings. The discussion is in Section 6, while Section 7 holds the theoretical and practical contribution of the study. We conclude our study and highlight the future research endeavor in Section 8.

2. LITERATURE REVIEW
To identify the value propositions, we conducted a concept-centric systematic literature review (Cram et al., 2017; Okoli, 2015; Schryen et al., 2017; Vom Brocke et al., 2015; Webster & Watson, 2002) followed by thematic coding analysis as advocated by IS researchers (Aksulu & Wade, 2010; Bandara et al., 2015; Inuwa & Ononiwu, 2020; Roberts et al., 2012). We conducted a keyword search in titles, abstracts, and references of researches archived in PUBMED, Wiley online, Emerald, Springer, Elsevier. Also, Taylor and Francis, (AISeL) and the latest version of e-Government Reference Library (EGRL) version 15.5. The keywords we used were; “e-Government value proposition, public value of e-Government, e-Government evaluation, ICT enabled public administration, sub-Saharan Africa, Affordance actualization”. Our initial search turned up 14,921 articles. After applying our inclusion criteria, which include: (a) published peer-reviewed articles, (b) articles written in English language, (c) articles published from 2005-2019, (d) theoretical articles or articles that tested and validated models and frameworks, (e) conceptually rich articles. The exclusion criteria are: (a) articles not written in English language, (b) articles published before 2005, (c) a-theoretical papers that are conceptually weak, and (d) research in progress as well as working papers. We were left with 136 articles; 61 duplicates were removed leaving 75 articles. After snowballing the articles, 6 more papers were added, having a total of 81 articles, 5 articles were not found and 76 articles were found to be relevant to the study. This leads to the emergence of our value propositions of implemented e-Government projects as shown in Table 1.

<table>
<thead>
<tr>
<th>Value Propositions</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Service Delivery</td>
<td>(Agbabiaka, 2018; Alruwaie et al., 2012; Ashaye &amp; Irani, 2019; Bai, 2013; Bonina &amp; Cordella, 2009; Castelano &amp; Simonetta, 2008; Cook &amp; Harrison, 2014; Deng et al., 2018; Flak et al., 2009; Golubeva &amp; Gilenko, 2018; Golubeva et al., 2019; Grimsley &amp; Meehan, 2007; 2008; Grimsley et al., 2006; Gupta &amp; Suri, 2017; Hellang &amp; Flak, 2012; Karkin &amp; Janssen, 2014; Karunasena &amp; Deng, 2010; Karunasena et al., 2011; Omar et al., 2011; Pang et al., 2014; Persson et al., 2017; Rose, Persson, &amp; Heeager, 2015; Rose, Persson, Heeager, et al., 2015; Scott et al., 2016; Sundberg, 2019; Twizeyimana &amp; Andersson, 2019)</td>
</tr>
<tr>
<td>Effective Public Organizations</td>
<td>(Agbabiaka, 2018; Alruwaie et al., 2012; Ashaye &amp; Irani, 2019; Avdic &amp; Lambrinos, 2015; Bai, 2013; Bonina &amp; Cordella, 2009; Castelano, 2013; Chu et al., 2017; Cook &amp; Harrison, 2014; Deng et al., 2018; Golubeva et al., 2019; Gupta &amp; Suri, 2017; Harrison et al., 2012; Hellang &amp; Flak, 2012; Jussila et al., 2017; Karunasena &amp; Deng, 2011; Karunasena et al., 2011; Persson et al., 2017; Rose, Persson, &amp; Heeager, 2015; Rose, Persson, Heeager, et al., 2015; Savoldelli et al., 2013; Scott et al., 2016; Srivastava, 2011; Tsohou et al., 2013; Twizeyimana &amp; Andersson, 2019)</td>
</tr>
</tbody>
</table>
We now briefly discussed the value propositions of the implemented e-Government projects gleaned from literature and categorized into themes. Such themes include (a) Quality service delivery, which reflects avenues for generating value propositions through delivery of better services (Bannister & Connolly, 2014; Castelnovo, 2013). (b) Effective public organizations as it delineates the e-Government capacity to improve efficiency of public organizations through cost cutting, achieving synergy and synchronizing public organizations (Heeks & Bailur, 2007). Efficiency in public organizations ensures that there is a reduction in duplicate tasks, effective prompt delivery of services and easy access to services (Pang et al., 2014). (c) Open government and democratic values. Within our literature review, we realized that IS scholars seek to refocus attention to a broader array of values. Most especially those concerning open government (OG) and democratic value (Deng et al., 2018; Harrison et al., 2012). The foundation of OG idea is the optimism over that which can be achieved through the use of e-Government open data initiative. The essence of OG is to avail information and decision-making processes of government accessible to the public for scrutiny and input (Deng et al., 2018). In so doing, citizen’s social and political engagements are facilitated through e-participation in developing and executing government policies. (d) Finally, social value and wellbeing: IS scholars always advocate that the expectations of e-Government go beyond mere citizen satisfaction, but they should encompass a desire for much broader social outcomes (Grimsley & Meehan, 2008; Karunasena & Deng, 2012). Such social outcomes include social inclusion, community development, well-being and sustainability (Harrison et al., 2012). Besides, general wellbeing that are encapsulated in the form of quality of health care, threshold standards of education, and access to civil and criminal justice should not be left out (Castelnovo, 2013).

3. THEORETICAL FOUNDATION

As stated earlier, the theories adopted for this research are theory of affordance actualization (Strong et al., 2014), realist evaluation theory (RE) (Pawson & Tilley, 1997), Self-determination theory (SDT) (Deci & Ryan, 1985) and Sustainability framework for e-Government success (Lessa et al., 2015). Affordance actualization theory (Strong et al., 2014) grounded in realist evaluation theory (Pawson & Tilley, 1997) guided us in investigating the process through which e-Government affordances were actualized to produce value propositions as outcomes. Thus, the integration of affordance actualization and realist evaluation theory enable us a five-fold understanding of the affordance actualization process: affordances, context, mechanisms, actualization actions and outcomes theory (Pawson & Tilley, 1997; Strong et al., 2014). Besides, actualization actions reveal the human agencies’ (citizens) choice to use the technology, their motivations and capabilities to exploit, appropriate and use the affordances offered by the implemented e-Government projects. Consequently, the study introduced the Self-determination theory (SDT) (Deci & Ryan, 1985; Ryan & Deci, 2002). SDT is an eclectic theory of human motivation that examines how individuals interact with their environment; in this case, the environment is the implemented e-Government projects (Deci & Ryan, 1985; Ryan & Deci, 2002). SDT aided us in specifying the nature of

| Social Value and General Wellbeing | (Agbabiaka, 2018; Alruwaie et al., 2012; Ashaye & Irani, 2019; Chireu, 2008; Golubeva & Gilenko, 2018; Golubeva et al., 2019; Harrison et al., 2012; Hellang & Flak, 2012; Hu et al., 2019; Hussein, 2018; Karunasena & Deng, 2012; Raus et al., 2009; Rose et al., 2018; Savoldelli et al., 2013; Scott et al., 2016; Sigwejo & Pather, 2016; Twizeyimana & Andersson, 2019; Uppström & Lönn, 2017) |
| Open Government and Democratic Value | (Agbabiaka, 2018; Ashaye & Irani, 2019; Avdic & Lambrinos, 2015; Bai, 2013; Chu et al., 2017; Cook & Harrison, 2014; Flak et al., 2009; Golubeva & Gilenko, 2018; Golubeva et al., 2019; Grimsley & Meehan, 2007; 2008; Grimsley et al., 2006; Harrison et al., 2012; Hellang & Flak, 2012; Hu et al., 2019; Hussein, 2018; Karunasena & Deng, 2012; Karunasena et al., 2011; Omar et al., 2011; Pang et al., 2014; Persson et al., 2017; Rose et al., 2018; Rose, Persson, & Heeager, 2015; Rose, Persson, Heeager, et al., 2015; Savoldelli et al., 2013; Scott et al., 2016; Subbiah & Ibrahim, 2011; Sundberg, 2019; Twizeyimana & Andersson, 2019; Wihlborg et al., 2017) |

Table 1 Value Propositions and the Corresponding Authors
individual competence and performance within the experiences of choices that determines their actions. Such determinants are autonomy, competency and relatedness (Deci & Ryan, 1985; Ryan & Deci, 2002). Autonomy is viewed as a need to feel free and possess self-directed cognizance in the environment, which signifies one’s sense of control and agency (Ryan & Deci, 2002). Competency is a feel of being effective, broadly, a feeling of being competent with task, activities, and engagements (Ryan & Deci, 2002). While relatedness is outlined as a feeling of being included and affiliated with others. We used the sustainability framework for e-Government success (Lessa et al., 2015) to reveal the generative mechanisms to sustain the value propositions as outcomes from the affordance actualization process.

The sustainability framework for e-Government success (Lessa et al., 2015) provides rich concepts that characterized sustaining e-Government project. This is in terms of innovation continuation considered as mechanisms. Such mechanism concepts include: (a) developing a sense of national ownership (b) continuously meet available resources (c) independence from donor agencies/external assistance (d) continuous monitoring and evaluation (e) institutionalizing e-Government projects with local context (f) strong political support and leadership (g) availability of institutional, administrative and coordinated capacity (h) meeting stakeholders needs (Lessa et al., 2015).

We operationalized the sustainability of the implemented e-Government project into five dimensions. Such dimensions include: (a) endurance of the identified actualized values (Slaghuis et al., 2011). (b) persistence of routinization or institutionalization of the initial e-Government projects (Akaka et al., 2017). (c) continued adaptation within the context the innovation is embedded (Buchanan et al., 2006). (d) evolutionary growth through configuration (Fleiszer et al., 2015), and (e) maintenance and appropriation with local capacities over time (Heeks, 2005). Furthermore, the program theory of RE originally designed by Pawson et al. (2005) and modified by Mukumbang et al. (2016) was deployed as the methodology to uncover the actualized value propositions, what mechanisms could be in place to sustain the actualized values and under what contextual conditions could such sustainability be possible.

4. RESEARCH METHODOLOGY

Being a RE approach, this study is anchored on the six stages iterative process of RE in a multiple case study environment. These stages are: (1) development of a preliminary program theory; (2) search strategy and literature search; (3) study selection and appraisal; (4) data extraction; 5. data analysis and synthesis; and (6) program theory reformulation and recommendations. However, following Mukumbang et al. (2016) the six stages are encapsulated in three phases and adopted as the methodology to answer our research questions as shown in Figure 1.
In Phase 1, we conducted a systematic literature review as well as documents review related to value propositions of implemented e-Government projects as noted earlier. Then gathered initial empirical evidence to support our initial program theory (IPT) development as shown in Figure 2. In doing this, we conducted face-to-face interviews with managers of Irembo, and e-Procurement. We triangulated the interview data with (1) literature (2) participant’s observation (3) archival document analysis (4) scoping review of affordance actualization guiding the understanding of the human-IT interaction and extractions of the value propositions outcomes seen as product in process (Layder, 1998). These data from the primary and secondary sources were used to develop the IPT. We anchored this process of IPT development through abductive data analysis that aligned with Layder (1998) version of adaptive theory development. Thus, we adopted the dialectical interplay where prior theoretical concepts of affordance actualization (Strong et al., 2014), Self-determination theory (SDT) (Deci & Ryan, 1985), Sustainability framework for e-Government success (Lessa et al., 2015) and context-mechanism-outcomes-configuration (Pawson et al., 2005) are integrated (Hoon & Baluch, 2019; Modell et al., 2017; Okhuysen & Bonardi, 2011; Ononiwu et al., 2018). Altogether, such integration of theories “shape and inform the analysis of data that emanate from the ongoing research at the same time the emergent data itself shapes and molds the existing theoretical materials” (Rambaree, 2018). Therefore, we adopted the abductive thematic analysis that involved four key steps of gathering the initial empirical evidence as explained earlier (Rambaree, 2018; Richter et al., 2018). Such steps which are recursive between collection and analyzing of data as well as being iterative until data saturation. Following Glaser and Strauss (1967) “saturation’ means that no additional data are being found whereby the sociologist can develop properties of the category. As he sees similar instances over and over again, the researcher becomes empirically confident that a category is saturated.” (p. 61).

Figure 1 Realist evaluation methodology as adapted from Mukumbang, Van Belle (2016)
4.1 Phase 2: Theory validation and refinement

We used both quantitative and qualitative methods to validate the IPT fusing the two investigative contexts as the multiple cases as shown in Figure 1. First, we conducted a quantitative survey using contingency evaluation method (CVM). This is to confirm if the citizens’ actualized value propositions of implemented e-Government project exist. CVM survey instrument indicating citizens willing to pay to actualize or continue actualizing the value propositions of quality service delivery, effective public organizations, social value and general wellbeing and Open government and democratic values. The CVM instrument was developed to generate categorical data of Yes or NO when completed by the citizens. We distributed 430 questionnaires, with 250 of the questionnaires translated into Kinyarwanda, the local language of Rwanda and mostly used medium in engaging the e-Government platforms. Subsequently, we re-translated the answered questionnaires in Kinyarwanda back to English language. The remaining 150 questionnaires were in English and 30 are specifically for e-Procurement users, particularly, businesses that uses the platform. Subsequently, we conducted face to face and semi structured realist interviews. This is where the IPT are discussed with interviewees, audio recorded and transcribed verbatim. That lasted for about 30-45 minutes each with program designers, implementers, and managers of Irembo, and e-Procurement.

Investigative Context

Such case studies hold two dominant entities: typical and deviant. The “typical” case which is Irembo in Rwanda because it is an ideal one-stop platform that provide government-to-citizen (G2C), government-to-business (G2B), and government-to-government (G2G) services. The “deviant” case is the e-procurement platform in Rwanda. This is because it is an e-procurement platform accessed predominantly by businesses that are into supplies and contract biddings that witnessed initial resistance before being accepted.

4.3 Irembo

Irembo (meaning “gateway” in local parlance) is a public-private partnership (PPP) initiative conceived by the Government of Rwanda and Rwanda Online Platform Ltd (ROL). It is aimed at providing a single platform window for all government services (Bakunzibake et al., 2019). ROL will implement a digital one-stop platform for all government services across G2C, G2B, G2G, and...
to a large extent government-to-society (G2S) (Mukamurenzi et al., 2019). Services targeted were: registration such as birth, death, marriages, driver’s license, and business registration. Other services include tax filing, land management, road traffic, and motor vehicle inspection (Twizeyimana, 2017). By September 28, 2017, 95 online services were fully deployed and accessible (Twizeyimana et al., 2018). Access to Irembo services is via mobile phones, USSD, computers or a visit to Irembo service centers, and Irembo agents.

### 4.4 e-Procurement

The government of Rwanda have changed its procurement processes from paper based to a digital e-Procurement platform called “Umucyo” meaning transparency (Harelimana, 2018). This is in line with global best practice in procurement used to adopt and retain the fundamental principles of transparency, accountability, competition, equity, and fairness (Omwono et al., 2020). The initiative was deployed in August 2016 with the inaugural system having eight public institutions. Such institutions include Rwanda public procurement authority (RPPA), Rwanda development board and ministry of finance and economic planning. Other institutions include ministry of justice, Rwanda revenue authority, Rwanda social security board, banks and insurance companies (Gihozo, 2020). Owing to its launching in 2016, e-Procurement (Umucyo) became the only avenue for all public procurement process in Rwanda by both public and private institutions (Isimbi U., 2016). Such as government purchases, goods, works, services, and non-consultancy to be integrated using Umucyo (Gihozo, 2020).

### 5. FINDINGS

We used logistic regression to analyze our data. It is a multivariate regression that permits the understanding of what independent variables could constitute and a dependent variable via their degree of importance, polarity of the effects and significant effects (Yilmaz & Belbag, 2016). Here the independent variables are quality service delivery, effective public organizations, social value and general wellbeing, and open government and democratic values. The dependent variable is the actualized value propositions seen as outcomes. Logistics regression is beneficial to the study for the interpretation of binary and categorical data (Suthar et al., 2010; Yilmaz & Belbag, 2016). Table 2 and 3 depict the result of the data analysis for Irembo and e-procurement in Rwandan e-Government implemented projects.

Based on the logistics regression, the Wald value should be ≥2 to show which variable have influence on the model. The value of $\beta$ informs decision maker about the influence direction of the variable/factor. A negative value represents negative effect, while a positive value represents positive effect. SIG represents the significance value that should be less than 0.05 to be important in the model, while $\text{EXP}(\beta)$ is the ranking order level of importance of the independent variables in the model. A variable with the highest $\text{EXP}(\beta)$ value is the first most important variable in the model (Suthar et al., 2010; Yilmaz & Belbag, 2016).

<table>
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<tr>
<th>Independent Variables</th>
<th>Service Item</th>
<th>$\beta$</th>
<th>S.E.</th>
<th>Wald</th>
<th>df</th>
<th>SIG.</th>
<th>$\text{Exp}(\beta)$</th>
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<td>1</td>
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<td>54.76</td>
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983
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<th>Wald</th>
<th>df</th>
<th>SIG.</th>
<th>Exp (β)</th>
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<td>Registration and certification</td>
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<td>1.071</td>
<td>1.608</td>
<td>1</td>
<td>0.35</td>
<td>13.887</td>
</tr>
<tr>
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<td>Filing Tax</td>
<td>-17.669</td>
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<td>14.000</td>
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<td>0.097</td>
<td>1.000</td>
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<td>Procurement</td>
<td>4.337</td>
<td>1.684</td>
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<td>44.89</td>
</tr>
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Table 2 Variables in equation Table for Irembo
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<th>Quality Service Delivery</th>
<th>IS</th>
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<th>4.235</th>
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<th>3.526</th>
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<tr>
<td>IA</td>
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</table>

**Table 3 Variables in equation Table for e-Procurement**

As both two Tables 2 and 3 could attest, Quality Service Delivery, Effective Public Organizations, Social Value and General Wellbeing, and Open Government and Democratic values constitute the actualized value propositions. The factors have the Wald value ≥2 to show that such factors have influence on the model. With SIG less than 0.05 with most of the items that represent the factors, suggest that such factors influence the actualized values. While the higher EXP(β) suggests that all the factors constitute the actualized value propositions with item improved service delivery under quality of service as the highest.

### 5.1 Goodness-of-Fit of the Model

Goodness of Fit for both Irembo and eProcurement models is the measure of Likelihood. Likelihood is the probability of observed results; given the parameter estimates and -2 times the log likelihood (-2LL). The -2log likelihood is in turn the measure of badness-of-fit, illustrating error remaining in the model after accounting for all independent variables. The -2LL of 44.817 in the Irembo model
indicated that there is no significant error remaining in the model. The Nagelkerke R square shows that about 80% of the variation in the actualized values is explained by Quality Service Delivery, Effective Public Organizations, Social Value and General Wellbeing, and Open Government and Democratic values as shown in Table 4.

<table>
<thead>
<tr>
<th>Step</th>
<th>-2 Log likelihood</th>
<th>Cox &amp; Snell R Square</th>
<th>Nagelkerke R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>44.817&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.043</td>
<td>.795</td>
</tr>
</tbody>
</table>

**Table 4 Model summary table for Irembo**

The same goes for eProcurement model, where the -2LL of 17.173 indicates that there is no significant error remaining in the model. The Nagelkerke R square shows that about 75% of the variation in the actualized values is explained by Quality Service Delivery, Effective Public Organizations, Social Value and General Wellbeing as well as Open Government and Democratic values as shown in Table 5.

<table>
<thead>
<tr>
<th>Step</th>
<th>-2 Log likelihood</th>
<th>Cox &amp; Snell R Square</th>
<th>Nagelkerke R Square</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>17.173&lt;sup&gt;a&lt;/sup&gt;</td>
<td>.388</td>
<td>.754</td>
</tr>
</tbody>
</table>

**Table 5 Model Summary for e-Procurement**

Having now empirically identified the factors that constituted the actualized values propositions in the investigative context, we move to how it was sustained as shown in the next section.

### 5.2 Sustaining the Actualized Value Propositions

Our empirical qualitative data analysis as shown in Table 6 confirmed that: (a) Endurance of the actualized values. (b) Persistence of routinization or institutionalization of the initial e-Government projects. (c) Continued adaptation within the context the innovation is embedded. (d) Evolutionary growth through configuration, and (e) Maintenance and appropriation with local capacities over time are factors that reflect sustaining the actualized values. Such factors identified empirically as what constitute sustainability of the actualized values.

<table>
<thead>
<tr>
<th>Factors</th>
<th>Direct Quotes from Participants</th>
</tr>
</thead>
</table>
| Endurance of actualized values | “We continue to use the platform components and activities after the initial funding period for achievement of our intended outcomes”  
  *Thematic Analysis from Realist interview with Irembo* |
| Persistence of routinization or institutionalization of the initial e-Government projects | “We put in place structures and processes of innovation as a culture of practices by staff, the organizations and our systems”  
  *Thematic Analysis from Realist interview with SORMAS* |
| Continued adaptation within the context the innovation | “Our platform adapts to distinct possible situation within context of the services we deliver”  
  *Thematic Analysis from Realist interview with SORMAS* |
| Evolutionary growth through configuration | “We have in place organizational strategies, structures, and processes to grow and sustain the platform”  
  *Thematic Analysis from Realist interview with e-Procurement* |
“We rebuilt and launched the platform to be fully managed by local staff” Extract from Interview in Irembo

Table 6. Sustaining the Actualized Value Propositions

Besides, since the actualized value propositions are the concrete outcome of acting on the affordance of the implemented e-Government projects. It then behooves us to identify such affordances that are useful for realizing the actualized value propositions that is under sustenance as detailed next.

5.3 Affordances of the implemented e-Government Projects

e-Government affordances as revealed by the data were value creation affordance (Manoury et al., 2019), visualizing affordance (Rietveld & Brouwers, 2017), as well as mobility affordance (Kohut, 2018) are empirically validated as shown in Table 5.

Table 7 e-Government Affordances

Now under what context and mechanisms in charge of sustaining the actualized value propositions as outcomes is detailed next.

5.4 Context-Mechanism-Outcomes

As Table 6 could attest, our empirical data confirm the mechanisms are of two types. Individual mechanisms and organizational mechanism. The individual mechanisms are: (1) Technological autonomy and cognizance, and (2) Competence. The organizational mechanisms are: (1) Continuous availability of funds, (2) Institutional administrative and coordinating capacity, (3) Sense of ownership, (4) Strong political support and leadership, (5) Institutionalized in local settings, and (6)
Ongoing monitoring and evaluation. The contextual conditions are socio-economic, institutional, political and external donor agencies.

<table>
<thead>
<tr>
<th>Context</th>
<th>Mechanism</th>
<th>Outcomes validated by the logistic regression analysis of CVM data</th>
<th>Outcome Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Societal</td>
<td>Continuous availability of funds</td>
<td>Improved service delivery</td>
<td>Quality Service Delivery</td>
</tr>
<tr>
<td>-Economic</td>
<td>“We have a business model that charges commission on every transaction”</td>
<td>Source: Thematic Analysis of Realist interview</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-Social</td>
<td>Institutional administrative and coordinating capacity</td>
<td>Improved service delivery</td>
<td>Quality Service Delivery</td>
</tr>
<tr>
<td></td>
<td>“We are headed by a DG, directors of product services, engineering,</td>
<td>Opendata</td>
<td>Open Government and Democratic</td>
</tr>
<tr>
<td></td>
<td>developers, and support team thereby institutionalizing our</td>
<td></td>
<td>Value</td>
</tr>
<tr>
<td></td>
<td>capacity to run the platform”</td>
<td></td>
<td>Social Value and General Wellbeing</td>
</tr>
<tr>
<td></td>
<td>Sense of ownership “We have multiple service channels (website, USSD,</td>
<td>Building trust between government and citizens</td>
<td>Social Value and General Wellbeing</td>
</tr>
<tr>
<td></td>
<td>agents) in English, Kinyarwanda, and French making the platform to</td>
<td>Status reports of contact tracing, isolation, and quarantine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>have a sense of local ownership”</td>
<td>Status reports of surveillance and response</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Source: Thematic Analysis of Realist interview</td>
<td>Status reports on diseases and pandemic</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Political</td>
<td>Strong political support and leadership “We have a</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>dedicated Minister of ICT who is responsible for the</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>success of the platform”</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Source: Thematic Analysis of Realist interview</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Thematic Analysis of Realist interview
<table>
<thead>
<tr>
<th><strong>Context</strong></th>
<th><strong>Mechanism</strong></th>
<th><strong>Outcome</strong></th>
<th><strong>Source</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Institutionalized in local settings</td>
<td>Improved transparency, accuracy, and facilitating information between government and citizens</td>
<td>Effective Public Organizations</td>
<td></td>
</tr>
<tr>
<td>“We rebuilt and launched the platform to be fully managed by local staff”</td>
<td>Accountability and transparency</td>
<td>Effective Public Organizations</td>
<td></td>
</tr>
<tr>
<td>Source: Thematic Analysis of Realist interview</td>
<td>Streamlining procedures Procurement</td>
<td>Effective Public Organizations</td>
<td></td>
</tr>
<tr>
<td>Ongoing monitoring and evaluation</td>
<td>Improved transparency, accuracy, and facilitating information between government and citizens</td>
<td>Effective Public Organizations</td>
<td></td>
</tr>
<tr>
<td>“We have a support team for feedback through social media platforms, email, and toll free call centers to ensure monitoring and evaluation”</td>
<td>Source: Data from Contingent Valuation Questionnaire</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source: Thematic Analysis of Realist interview</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technological autonomy and cognizance</td>
<td>Source: Data from Contingent Valuation Questionnaire on rationale for choice under actualize value and willingness to pay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Knowing that the platform is a secured automated procurement process gives me the confidence and convenience to select which tender to bid for anywhere, anytime”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data from Contingent Valuation Questionnaire on rationale for choice under actualize value and willingness to pay</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Competence</td>
<td>“My IT skills and ability enable easy use of the platform which in turn save time, resources, and to get update on news and information”</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source: Data from Contingent Valuation Questionnaire on rationale for choice under actualize value and willingness to pay</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 8 Context-Mechanism-Outcome configuration Table.** Source: Authors
5.5 Phase 3: Theory Consolidation

In our third phase, we synthesized the findings into one model as shown in Figure 3.

![Diagram](image)

Figure 3: Refined Model of Actualized Values Sustainability Framework of Implemented e-Government Projects. Source: Authors

The mechanisms seen in the IPT of Figure 2 such as independence from external assistance, continuously meeting the stakeholders’ needs and relatedness were eliminated due to insufficient empirical data to support them.

6. DISCUSSION

Based on our findings, the actualized value propositions of the implemented e-Government projects in the investigative context is constituted with the following factors: (a) Quality service delivery, which is also confirmed by other scholars (e.g., Bannister & Connolly, 2014; Castelnovo, 2013). (b) Effective public organization (Heeks & Bailur, 2007). (c) Open government and democratic values (Deng et al., 2018; Harrison et al., 2012), and lastly (d) Social value and general wellbeing (Grimsley & Meehan, 2008; Karunasena & Deng, 2012). Such factors as outcomes came to be by affordance actualization of the e-Government projects. The affordances that have been actualized include value creation affordance, visualizing affordance and mobility affordance. This is done by the citizens’ competences in the technology as one of the individual mechanisms that must be in operation. Such citizens are also endowed with technological autonomy and cognizance in the e-Government environment when engaging with the technology as another individual mechanism. Besides, the organization (i.e., the public sector that host the e-government projects) is endued with continuous availability of funds by the host government, institutional administrative and coordinating capacity with strong leadership and political support from the government in power as mechanisms. Other mechanisms were the technology being institutionalized in the local settings with its ongoing monitoring and evaluation for improvements. Such identified underlying mechanisms are in concerted interaction to actualize the e-Governments affordances to bring about the actualized value propositions as outcomes and its sustainability. Empirically, the sustainability of the actualized values takes the shape of endurance of the identified actualized values, persistence of institutionalization of the e-Government projects and continued adaptation within the context the
innovation is embedded. Other of such shapes of sustainability include evolutionary growth through configuration, as well as maintenance and appropriation with local capacities over time. All of these occurred when external donor agencies such as the World Bank continue to support the host county as the enabling condition. Other enabling conditions include enactment of institutional policies, political and socio-economic enablement. All these are encapsulated in the consolidated model shown in Figure 3 and classified as the actualized values sustainability framework of implemented e-Government projects.

7. CONTRIBUTIONS

By the use of realist evaluation in e-Government studies, our nascent refined program theory in the form actualized values sustainability framework of implemented e-Government projects could provide the following contributions. The framework could be generalized to other emerging economies of sub-Saharan Africa to be used for identification of actualized values propositions of implemented e-Government projects their citizens are willing to pay (WTP) in their contexts-of-use. By discovering a new research stream and unexplored opportunities through the development of a new research framework (i.e., actualized values sustainability framework), we open the door for future investigations in e-Government research. By the use of such a framework, researchers will identify e-Government affordances and both organization and citizens’ motivations and capabilities as mechanisms to actualize such affordances in order to obtain the values as outcomes and sustaining it. To practitioners it will: (1) build-up citizens’ satisfaction and public trust about government e-service delivery (Agbabiaka, 2018), (2) meet the demands for external/donor accountability and (3) establish a clear, strategic goal for the organization. Other benefits to practitioners are: (4) identify the relevant value propositions from the citizen’s perspective to foster a strong sense of operational accountability (Agbabiaka, 2018; Panagiotopoulos et al., 2019), and lastly (5) to increase organizational performance (Panagiotopoulos et al., 2019).

8. CONCLUSION AND FUTURE RESEARCH

Based on this study, we come to know that actualization of the value proposition of implemented e-Government projects and sustaining it is critical in Sub-Saharan Africa. This is because citizens have to engage and use such projects to achieve their needs in their respective contexts with satisfaction if they are to trust the government. Besides, other stakeholders such as businesses must continuously use the e-Government projects to achieve the cardinal objectives of their implementations. Consequently, by developing the actualized values sustainability framework of implemented e-Government projects we have unraveled what is really the actualized values and citizens’ motivation to use the platforms (Deci & Ryan, 1985; Ryan & Deci, 2002). Besides, we revealed the generative mechanisms to sustain the value propositions to shape innovation continuation. As we deployed the realist evaluation methodology Mukumbang et al. (2016) that resonated with multiple theories; we come to understand the enabling contexts, the concerted mechanisms in interaction both at individual and organizational levels to sustain the actualized value propositions as outcomes. The future research stream is to adopt the actualized values sustainability framework in other countries of sub-Saharan Africa that have implemented e-Government projects.

REFERENCES


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SUSTAINABLE DEVELOPMENT THROUGH A MOBILE APPLICATION FOR A COMMUNITY CLINIC

Martina A. Clarke, University of Nebraska-Omaha, USA, martinaclarke@unomaha.edu
Sajda Qureshi, University of Nebraska-Omaha, USA, squreshi@unomaha.edu
Timi Barone, University of Nebraska-Omaha, USA, tbarone@unomaha.edu
John R. Windle, University of Nebraska, USA, jrwindle@unmc.edu

Abstract: Implementing Information and Communication Technology (ICT) solutions can alleviate pressing problems in society and are a central component of sustainable development. Often, healthcare addresses the symptoms without approaching the socioeconomic limiters that can lead to reduced individual economic freedoms from receiving healthcare. This paper investigates the question: How can technology and training interventions enable clinicians to offer care that addresses the socioeconomic limitations of their patients? This paper observes the implementation of a mobile app designed to offer people who cannot access health resources in Omaha, Nebraska, a city in the Midwestern United States. This study follows the design science and action research approach, with clinicians participating in developing the mobile app. As a result of COVID, patients no longer have access to the free clinic because it was shut down. The app is available to the broader community needing basic resources to stay healthy. Through sets of application revisions and observations of usage, this paper arrives at insights into how such applications can support multi-ethnic and underserved communities. The contribution of this paper is to provide contextually specific and rich descriptions of how to implement sustainable ICT solutions to meet the information needs of patients in underserved communities.

Keywords: Sustainable Development, Information and Communication Technology for Development (ICT4D), Information Technology Therapy, Information Technology Interventions.

1. INTRODUCTION
The concept of development can be understood from three different scopes 1) generic development, which is progressive change as a society, 2) geography-specific development, which is progressive change in a developing country, and 3) agenda-specific development, which is continuous changes in a developing country where societies are divided into government, community, and the private sector (Heeks, 2017). Information and Communications Technologies for Development (ICT4D) is about social and technical research on the effects of Information Technology (IT) on economic, social, and human development. The eradication of poverty is the primary pillar of sustainable development and there is conclusive evidence that health directly correlates with the rates of poverty in an observed community. Attending to these aspects together are the precursor to development in a community. In Omaha, Nebraska, a city in the Midwestern United States, it is estimated that 68,334 people or 15.1 percent of the entire population live below the poverty line (Office of Assistant Secretary for Planning and Evaluation, 2020); this means that poverty rates in Omaha are 2.8 percent higher than the national average of 12.3 percent. Based on the Nebraska Health Disparities Report, American Indians report the highest number of socio-economic indicators of disparity, followed by African Americans (Anthone, Medinger, Rodriguez 2020).
The goal of poverty eradication is to reinvigorate the human element of society and to further the creation of opportunity. The most direct method for enticing human and social development is for community members to participate in nonprofits that support the health and wellbeing of the struggling and underprivileged, where economic development is mostly non-existent. The pandemic has increased the need for community resources that can help people stay healthy. These factors heighten the necessity to provide accessible healthcare, especially in a non-profit form.

Sustainable Development is “meeting the needs of the people without affecting the future.” Sustainable Development falls under the chronology of development paradigms. Development paradigms started from Modernization in the 1950s, where development, growth, technology, and the transfer of ideas took place. In the 1960s, development focused on dependency which are core-periphery positions within the world system and countries breaking away from an exploitative world system. In the 1970s basic needs of an individual focused on food, clothes, shelter. In the 1980s, Neoliberalism began to take hold, which focused mainly on markets. In the 1990s the human development concept started which focuses on gender, education, poverty and where humans have freedom to live and do what they want to do. In the 2000s, the sustainable development phase started, which focuses on “meeting current needs without compromising future needs, especially the environment (Heeks, 2017).”

Socio-economic status is seen to be linked to health. Adler et al. (1994) contend that individuals living in better socio-economic conditions enjoy better health than those living in lower socio-economic conditions. They reported on a model that illustrates a directly inverse correlation between morbidity rates and socio-economic status. They found that the lower the socio-economic status of individuals the higher the percentage of people were diagnosed with osteoarthritis, chronic diseases, hypertension, and cervical cancer. Additionally, education, income, and life expectancies are key factors that lead to different socio-economic conditions (Adler et al., 1994). Roztocki and Weistroffer (2016) define socio-economic development to be “a process of change or improvements in social and economic conditions as they relate to an individual, an organization, or a whole country (p.542).”

In this paper the concept of socio-economic development is seen as a combination of social factors such as healthcare, wellbeing, and economic factors, such as, income, and assets. To be healthy and lead the lives they choose to live, people need access to social and economic resources (Siahpush, 2019; Ramos, 2020; Clarke, 2020). This paper aims to investigate the question: How can technology and training interventions enable clinicians to offer care while addressing the socio-economic limitations of their patients? This paper observes the implementation and use of a mobile app for a student led free clinic that serves patients who are uninsured and unable to pay for their healthcare. It follows an “Information Technology Therapy” process in which clinicians are supported with the mobile app and training to help them better manage the care of their patients. Through sets of app revisions and observations of usage, this paper arrives at insights into how such applications can support multi-ethnic and underserved communities. The contribution of this paper is to provide contextually specific and rich descriptions of how to implement sustainable Information and Communications Technologies (ICT) solutions to meet the information needs of patients in underserved communities.

1.1. Sustainable Development and Health Inequities
ICT support health and wellbeing by standardizing and disseminating the information essential to the maintenance of a community’s people and their health, creating efficiencies, and improving the interoperability of collected data. By increasing accessibility to healthcare and its degree of quality through ICTs, the time spent between inhibiting health issues and being a more productive member of the community is minimized (Jones, 2018). Qureshi & Xiong (2021) found a relationship between mobile phone and internet usage on the health and wellbeing of a population. They found that inequalities in education and income moderate the positive relationship between the mobility effect for health and human development. In some cases, higher health standards can be seen to be
attributed to better education. This means that people with higher education can access the resources, including information, they need to stay healthy. They are also seen to have higher economic outcomes within a local community and strengthens the community from within.

Equitable healthcare provision entails socio-economic development (Roztocki and Weistroffer 2016, Qureshi & Xiong 2021). Accessibility to healthcare and ICT-based solutions that are involved with, and help facilitate healthcare accessibility are needed in these communities. ICTs are efficient and cost-effective solutions to the management of health needs and for assisting the duties of healthcare professionals. In these underserved communities, it is often women and children that are the recipients of non-profit healthcare. Impoverished communities are among the highest benefactors of ICT systems such as mobile applications that offer information and advice on how to treat symptoms without having to travel long distances. Such healthcare accessibility is an important component of sustainable development in such communities (Heeks 2017, Qureshi 2009, Qureshi & Xiong 2021).

Two communities in Omaha exhibit the social inequities that affect health disparities. Hispanic communities in South Omaha are close-knit and widely supportive of each other. The community is limited by healthcare expenses, of which are beyond the economic means of the majority in the area. This environment is a prime scenario for the insertion of ICTs. The African American communities in North Omaha, though similar in low economic development, is dissimilar in the community-supporting factors that South Omaha exhibited. The neighborhoods in this region were lacking evident forms of financial support; this was noted by directly observing the conditions of the infrastructure and conditions of the community in general (Qureshi 2020).

2. METHODOLOGY

This study follows the design science approach (Table 1). Hevner et al. (2004) assert that information systems (IS) exist as a discipline designated to improve effectiveness and efficiency of organizations. To do so, a theoretical framework of an existing problem must be determined (behavior science) and the process of effectively addressing that problem must be established (design science). Hevner et al. focus on the role of design science while paying tribute to the necessity of behavioral science, and lays out a framework to guide researchers and practitioners of IS on “how to conduct, evaluate, and present design science research (Hevner et al., 2004).”

<table>
<thead>
<tr>
<th>Guideline</th>
<th>Hevner’s Description</th>
<th>Our Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guideline 1: Design as an Artifact</td>
<td>Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an installation</td>
<td>IOS Application/ Website</td>
</tr>
<tr>
<td>Guideline 2: Problem Relevance</td>
<td>The objective of design-science research is to develop technology-based solutions to important and relevant business problems</td>
<td>The problem: The barrier between knowledge of community resources and members of the community who would benefit from these resources. The app/website addresses this problem.</td>
</tr>
<tr>
<td>Guideline 3: Design Evaluation</td>
<td>The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods</td>
<td>Interviews will be conducted to address the utility, quality, and efficacy of the design artifact (app/website)</td>
</tr>
<tr>
<td>Guideline 4: Research Contributions</td>
<td>Effective design-science research must provide clear and verifiable contributions in the area of the design artifact, design foundations, and/or design methodologies</td>
<td>Our design is a “one stop shop” for resources because most people who need one resources would benefit from multiple resources. The website is condensed to address existing community health needs and available resources that offer low cost and no cost services (as money is a barrier for many).</td>
</tr>
<tr>
<td>Guideline 5: Research Rigor</td>
<td>Design-science research relies upon the application of rigorous methods</td>
<td>Data analysis from website visits, feedback survey, interviews</td>
</tr>
</tbody>
</table>
The relationship between behavioral science and design science creates what the authors call a “build-and-evaluate loop,” in which a problem is determined, a solution is designed, the solution is evaluated, and the solution is tweaked until its solution is effective. This will be addressed through interviews and analysis of website data.

The action research approach was taken in this study because of its demonstrated ability to research the “conditions and effects of various forms of social action,” and with that research, lead to social action (Lewin, 1946). The process followed what we term “IT therapy” as it involves a set of steps:

1. **Diagnosis of problems and needs assessment**: This involves understanding the development context in which the clinic operates. When people cannot afford to pay for the healthcare they need, they may not be able to follow through with the treatments that are recommended to them, although assistance can be granted upon appeal. That is why it is important to identify the socio-economic factors affecting the people who seek care at this clinic.

2. **Identification and trial of alternative solutions**: This involves finding context-appropriate solutions to problems that were diagnosed. The criteria for selection of alternatives involves solutions that are free or cost effective, take little time to diagnose, and are easy to use.

3. **Development and implementation of IT solution**: The most appropriate IT solution is one that fits the criteria identified above and is quickly implementable. A prototyping method is used here to ensure that the users can offer feedback on improvements to the mobile app while using it to address the socio-economic needs of their patients.

4. **Adoption and use of IT solution**: Observations are made of the use and changes in usage patterns of the mobile app. They are recorded and analyzed for appropriateness to the development context.

5. **Sustainable Development Outcomes and Community Impact**: Outcomes to sustainable development are identified in terms of human development outcomes: what learning, and skill development has taken place because of the interventions?

The researchers ventured into the regions of North and South Omaha to investigate the development factors that were exhibited in each community. These important observations were necessary to evaluate and initiate a student-led implementation of an ICT that would contribute to the community. The implementation would benefit a microenterprise or non-profit on the micro-level and help facilitate the sustainable development cycle at the root. The following sections report on the interventions and offer observations of the interventions.
3. INTERVENTION

Addressing the needs of marginalized communities requires interventions that are culturally sensitive while understanding the socio-economic causes of the patient’s illness. The free Student Health Alliance Reaching Indigent Needy Groups (SHARING) clinic opened on September 9, 1997 in order to provide primary health care to underprivileged populations in South Omaha (University of Nebraska Medical Center). The SHARING clinic now operates at the junction between the North and South Omaha communities. The clinic lacked financial resources; therefore, a free solution was implemented that fulfilled their need to offer a growing body of services. A mobile application with information on community resources was developed so that the clinicians could find relevant socio-economic information for their patients. To offer clinicians with the ability to address the socio-economic needs of their patients, a series of interventions comprising of technology and training solutions were carried out at the free student clinic. The Free Student Led Clinic was started in 1997 to provide primary health care to multi-ethnic underserved populations in North and South Omaha. Patients who qualify for care at this clinic do not have health insurance and are living in poverty. The clinic is located in the middle of North and South Omaha serving the African American and Hispanic populations.

3.1. Diagnosis of problems and needs assessments.

While clinicians can address the symptoms that patients present with, longer term health of their patients need to be addressed based on the social and economic causes of their illness. The purpose of the mobile app is to: 1) allow clinicians to look up appropriate community resources based on patient needs, 2) allow patients to leave the clinic with a plan for further support, and 3) allow clinics to help our patients navigate bio-psycho-social barriers more meaningfully. Ten clinicians working in the clinics were interviewed about the requirements for the application to determine their information needs and to get some insight into the organization’s culture. A list was created of the information the clinicians would like in the application: 1) List of community resources 2) Nutrition guidelines documentation 3) Food, Dental, and Transportation related information 4) Scheduling system integration 5) Materials which can help to deal with a difficult conversation and sensitive cultural topics. Their top priority was an application to provide their patients with community resources. Some challenges mentioned during the interviews were being pressed for time, money, and resource constraints.

3.2. Identification and trial of alternative solutions

After gathering the requirements from the clinicians, the knowledgebase was created. The knowledge base provides a Cloud Solution for Community Resources. The Google Cloud Platform was used, which is a suite of cloud computing services that runs on the same infrastructure that Google uses internally for its end-user products, such as Google Search and YouTube. Google’s cloud platform provides a reliable and highly scalable infrastructure for developers to build, test, and deploy apps. It covers application, storage, and computing services for backend, mobile, and web solutions. More than four million apps trust and use the platform (Rohit Dogra, 2014).

3.3. Development and implementation of IT solution

To implement the free service, researchers put together a Google Sites application that fulfilled the community resources requirements. This is available as a website (Figure 1) for clinicians who are at their desks as well as a mobile application (Figure 2) that can be accessed through their phones. Researchers and clinicians walked through a prototype of the app to determine if the app met their needs.
4. RESULTS

4.1. Adoption and use of IT solution

To ensure the sustainability of the mHealth intervention, the researchers observed how the app was being used by clinicians within the cultural context of the clinic (Krauss 2013). The clinic provides the opportunity to have all their patients’ health care needs met, such as, access to primary care, dental care, and vision care, and they often must rely on low-cost community resources to fulfil these needs. The observations below illustrate this need:

When resources recommended how is it shared? Verbally? Written? How do patients remember? Is there a follow up with patients? i.e., “did you visit ______?”
Concern: if requirements not available on app, may lead to medical clinicians/staff recommending irrelevant information/resources

If patients given “homework” and left overwhelmed- (resources relevant to their specific needs are difficult to locate even after referral) they may give up or lose hope- may be difficult to research without speaking with patients

Transcript 1 Initial Description of Requirements

The application allows clinicians to provide immediate referral during consultation, which allows them to provide better and more informed care for their patients. Furthermore, clinicians who use the app can reduce the amount of time spent searching for community resources, and resource eligibility requirements. The following observation relates to how this app is used by clinicians during consultation:

App recommendations after speaking with Dr. M (Social Services) Accessibility- keep it as disability services.

Clinician B: “Do you want to flip to it?”
M: “How do I do that? I don’t have an iPad.” Make app user friendly for users of all levels of technological use knowledge. Don’t need physical health in app- that is what they do at Clinic

Transcript 2: Use during Consultation

The use of the mobile app offered a unique learning opportunity for the student clinicians in several ways. First, the app introduced the student clinicians to various community resources, which they will be able to refer to in their future practice. Second, it allowed the students to reflect on the implications of health for underserved communities and socio-economically vulnerable populations. The following transcripts illustrates how the app was used by clinicians to address the socioeconomic needs of patients:

Dr. M: when looking through resources “Mental health is good.” In Douglas County- Keep Chemical dependency- move it up to mental health. (list related services within close proximity to one another on app) i.e., mental health, and chemical dependency

Transcript 3: Addressing socio-economic needs of patients

Offering resources to their patients may improve the clinician-patient relationship in that the patient will be assured that their clinician is listening to their needs and attempting to remedy them; even in areas that are outside of the clinician’s immediate realm of practice. The following observations illustrate how the app is used to address these unique needs:

Add community support to disability services

Neb. Med Financial Assistance

[Patient comes in with “strange” characteristics] as noted by front desk workers. Dr. M notes they are symptoms of a mental illness. States that it is good for medical professionals to spend time working in an in-patient psych ward to be able to identify these characteristics.] How could they have the ability to identify these characteristics improve patient health? Patients might be confused or unsure of what they need.

Transcript 4: Sensitivity to patient needs

These results suggest that to remain healthy, people from low socio-economic backgrounds will need access to the socio-economic resources available through the mobile application to stay healthy.
5. ANALYSIS

1.1. Sustainable Development Outcomes and Community Impact

To achieve sustainability of the technology and training intervention, clinicians need to be able to use the app to support the socioeconomic needs of their patients. Following the initial implementation of the app, the researchers visited the student-led free clinic on four separate occasions to observe how the app was being used by the clinicians. Specifically, the researchers sought to analyze how the app was being used to address patient needs, how the app affected patient access to resources, how the app could be improved to ensure the relevancy of its resource list, and ensure that the app was considered user friendly among clinicians. This analysis is offered in this section.

Use of App to address patient needs. One clinician, a medical student, informed the researchers that he had a particular interest in understanding and addressing the socioeconomic circumstances that may influence one’s health outcomes, and he expressed enthusiasm in the app’s resources as the services listed confront the most pressing of needs met by his patients, such as financial assistance, mental health services, and dental care. Other clinicians noted that the app is relatively user friendly, even among clinicians who expressed lower confidence in their abilities to operate mobile technologies. The following transcript illustrates how the app is used to address patients’ socio-economic needs:

When looking at app updates. Dr. M. “Wow that is so cool. This is nice.”

Is there a way to print or copy information to give it to patients? - Asked by Clinician A, a student.
Clinician A also expressed pleasure that the phone numbers for the services was included. “Phone numbers. Nice.”

On the app- “Pretty smart. Pretty good looking.” Clinician A

When told that the app can be opened on multiple devices (i.e., cell phone, iPad, desktop) “nice. That’s convenient. Cool.” -Clinician A

Clinicians using the app noted that it was convenient and easy to use.

Dr. M expressed pleasure in that you can print off information from the app. “Wow. Look at that.”

Clinician D, to himself while looking through the app. “Oh man.” -tone appears excited. “Right on. I like this. “[The app is] very straightforward,” Clinician D, to Researcher P and Researcher M. “I like how easy this looks right at the beginning. Clinician D states that he would rate it a 5 when prompted to rate the app.

Transcript 5: Addressing patient needs using the app

Access to resources. Providing access to socioeconomic resources in the community are important for the patients. Yet, if clinicians can access these, the chances of the patients being able to avail these are higher. The mobile app offers this information to clinicians. Their use is described in the following transcript:

Dr. H. appears to have learned more about housing services through the app, “Oh, there’s a lot of places for housing [in Omaha].”

While looking through the app. Dr. H. “That’s great. Wow. That’s a lot of stuff.”

“Do you have that central building [with all the] services? A one stop shop?”- Dr. H

After speaking with Dr. M about Dr. H comment, she informed us that such a service does not exist. Dr. M suggested that Dr. H may be thinking of a multi-service organization. Perhaps “Multi Service Organizations” could/should be a section on the app.

Dr. M. Expressed interest in using the app for the Respect Clinic as well.

Clinician B, a student, is using the app to pull information for a patient.
Clinician B, while looking through the app. “Oh. That’s really cool.”

Clinician D feels that the app could save the users time and that it is relevant to the services their patients are looking for.

Clinician D mentioned that he is learning more about underserved communities in the medical field and that this app covers a lot of the resources underserved communities will need.

Transcript 6: Accessing resources for patient needs

**Improvements to ensure the relevancy.** The lead faculty member for social work at the student-led free clinic served as a key informant for the app’s content and regularly offered feedback regarding the resource list and its relevance to the population seen at the clinic. While the initial version of the app included resources that were deemed necessary, many of the resources were deemed obsolete because of their location, their health insurance requirements, or their wealth requirements. It was suggested that all resources outside of the immediate vicinity of the clinic be removed as most of their patients are locals and will not travel, or do not have the necessary means, to travel for resources. Additionally, any resource that required proof of insurance, or did not offer low-income services was removed from the app and replaced with more appropriate resources because the patients of the clinic are low income and many do not have health insurance coverage. These are indicated in the following transcript:

“Is that [Moby] the only transportation?”- Dr. H. Perhaps add more transportation if there is any

Description for ¾ way house was confusing for Dr. H. Perhaps simply keep it under housing services After speaking with Dr. M about Dr. H comment, she informed us that such a service does not exist. Dr. M suggested that Dr. H may be thinking of a multi-service organization. Perhaps “Multi Service Organizations” could/should be a section on the app.

Dr. M suggests under-lining titles and using single space for ease of use. Double space between services. “We want it to be super easy on the eyes” Remove any services that are not in Omaha Our people are local.” “We need to add vision on here.”

Dr. M. “The layout throws me off.” – Dr. M. Then repeats her suggestion of using single space, underlining titles, and only using double space between listed services. She stated that the clinic does not collect socio-economic data. However, they do have guidelines that clients must meet before being allowed services. Requirements included on the last page of this document

Clinician D, a student, stated that the URL is long and suggested shortening it if possible. (If not possible perhaps providing a link for all clinicians would be easier)

Transcript 7: Improvements to ensure the relevancy

Various clinicians also offered feedback regarding ease of use and impressions of the app’s implementation process. They noted that the layout of the app was initially confusing. After further discussion and clarification, a redesign of the app layout was implemented. For example, titles for individual resources were underlined and double spacing was used to signify when a new resource was listed. Clinicians agreed that the update improved the overall readability of the app.

COVID-19 is a global health crisis increasing human suffering, destabilizing the global economy and unsettling the lives of people around the world. As COVID-19 struck shortly after the app was implemented, the free clinics were shut down. This meant that the community resources made available through the app were updated to include COVID-19 related resources. Since COVID-19 struck, the mobile application was made available to the public and is being used to support the individuals suffering from the adverse effects of the shutdowns. Recent data suggests that among the effects of the COVID-19 shutdown, there have been increases in domestic violence, homelessness, and food insecurity. There has also been a sudden rise in the cost of prescription drugs. We expect that with the resources made available through this app, such hardship can at least, to a certain extent, be alleviated for those who are able to access the resources (Qureshi, 2020).
ICTs can address sustainable development, especially in urban settings by ensuring that underserved groups have access to information on resources needed to survive during the pandemic. Providing access to socioeconomic resources in the community are important for the patients. Understanding and addressing the socioeconomic circumstances that may influence a patient’s health outcomes is a step toward meeting patients’ needs, such as, financial assistance, mental health services, and dental care. Ensuring relevancy by providing resources based on patients’ location, health insurance requirements, or their wealth requirements is necessary to increase usefulness of the app.

6. SUMMARY AND CONCLUSIONS
Ensuring healthy lives and promoting well-being is necessary for sustainable development. This paper reports on a study of how technology and training interventions can enable clinicians in a student led free clinic to offer socio-economic based care to their marginalized patients. The interventions allowed clinicians to search for appropriate community resources based on patient needs and allowed patients to leave the clinic with a plan for further support, which helped the patients navigate the socio-economic barriers. Clinicians were able to use the app to better manage the care of their marginalized patients by providing them with information on community resources. Through sets of app revisions and observations of usage, this paper arrives at insights into how such applications can support multi-ethnic underserved communities.

Our research was influenced by the pandemic in diverse ways. Conducting fieldwork in the form of ethnography became impracticable because of the hospital shutdown of all human subjects research and individuals that were not a part of the healthcare team were unable to access the facilities. Also, the SHARING clinic was shut down completely, no longer accepting patients, which compelled us to resort to alternative ways to provide patients with access to the information they needed. Resilience became crucial in the conduct of our research. Resilience is “the ability of systems to cope with external shocks and trends (Heeks and Ospina 2019).” As a result of COVID-19, the SHARING clinics were shut down and a mobile application was developed to provide information on community resources to patients of this clinic who are unable to access health resources. Although the clinic was shut down, we were able to change the scope of our research by making the app available for public use instead of just a clinicians resource so patients are able to access our app to find the resources they need to lead healthy lives.

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READINESS OF THE SOUTH AFRICAN AGRICULTURAL SECTOR TO IMPLEMENT IOT

In’aam Soeker, University of Cape Town, inaamsoeker@gmail.com
Shallen Lusinga, University of Cape Town, shallen.lusinga@uct.ac.za
Wallace Chigona, University of Cape Town, wallace.chigona@uct.ac.za

Abstract: As the world’s population increases, so does the demand for food. This demand for food in turn puts pressure on agriculture in many countries. The impact of climate change on the environment has made it difficult to produce food that may be necessary to accommodate the growing population. Due to these concerns, the agriculture sector is forced to move towards more efficient and sustainable methods of farming to increase productivity. There is evidence that the use of technology in agriculture has the potential to improve food production and food sustainability; thereby addressing the concerns of food security. The Internet of Things (IoT) has been suggested as a potential tool for farmers to overcome the impact of climate change on food security. However, there is a dearth of research on the readiness of implementing IoT in South Africa’s agricultural sector. Therefore, this research aims to explore the readiness of the agricultural sector of South Africa for a wide implementation of IoT. This research conducts a desktop study through the lens of the PEST framework on the special case of South Africa. A thematic literature and documents review was deployed to examine the political, economic, societal and technological factors that may facilitate or impede the implementation of IoT in the agricultural sectors of South Africa. The findings suggest that the wide ranging political, economic, societal and technological constructs enable the implementation of IoT within South Africa’s agricultural sector. The most important include current policies, technological infrastructure, access to internet, and mobile technology which places South Africa in a good position to implement IoT in agriculture.

Keywords: Internet of Things, IoT, agriculture, Southern Africa, PEST

1. INTRODUCTION

Southern Africa has been bedeviled by diminished and late rainfall and, long-term increases in temperatures. In 2015, South Africa has experienced the worst drought the region has had in decades. As a result, the food security of millions of people in the region has been jeopardized (NASA, 2019). Currently, the United Nations (UN) estimates that 690 million people suffer from hunger, with 250 million of them living in Africa, where malnutrition is growing fastest in the world (UN, 2020).

The accessibility and utilization of technology is known to enhance and facilitate the political, economic, social, and cultural growth of developing countries. The UN and World Bank have suggested that economic development is enhanced through investments in Information and Communication Technologies (ICT) (Ungerer, Bowmaker-Falconer, Oosthuizen, Phehane, & Strever, 2018; World Bank, 2018b). The role of technology has intensified in the lives of people as well as the countries ever since the COVID-19 pandemic hit (Ungerer et al., 2018; WSIS, 2020). COVID-19 has accelerated the capability of information sharing and in turn enhanced the efficiency of society (Rogers, Apeh, & Richardson, 2016; WSIS, 2020). Due to COVID-19 restrictions on...
movements, farmers who traditionally relied on face to face interactions with experts for their critical farming decision making were forced to retrieve information through digital channels such as phone calls, SMS, or voice messages (WSIS, 2020). Technology has shown its potential by enabling the availability and reliability of low-cost solutions that caters to all people, especially the vulnerable (Ungerer et al., 2018).

The Internet of Things (IoT) is an ecosystem that comprises of intelligent devices and machines, objects, people, or animals that are interconnected without human-to-computer or human-to-human interaction (Ayaz, Ammad-Uddin, Sharif, Mansour, & Aggoune, 2019). Previous studies have shown that IoT has emerged as an effective way for agriculture to improve operations, enable effective and efficient production and reduce the effect on the environment (Ungerer et al., 2018). Therefore, this raises the question what factors of readiness influences the agricultural sector to benefit from the implementation of IoT. Implementing IoT will, in the long-run, assist developing countries in Southern Africa to increase agricultural efficiency and encourages the sector to achieve sustainable developmental goals (Ungerer et al., 2018). However, there is paucity of research on the benefit of implementing IoT in South Africa’s agricultural sector. As such, the research question for this paper is:

“What factors of readiness influence the agricultural sector of South Africa to implement of IoT?”

In answering this question, this study uses the Political, Economic, Social and Technology (PEST) analysis as a tool to evaluate the extent to which the agricultural sector is ready to implement IoT. The PEST analysis assesses IoT as a potential to increase the production and efficiency of the agricultural sector of South Africa and enable it to address its current climatic changes and food insecurity. The research conducts a desktop study utilizing a thematic literature and document review approach through the lens of the PEST framework.

South Africa is one of the leading countries in Africa in terms of technology use and adoption (AccessPartnership, 2018). The case of South Africa is representative of Southern Africa in terms of environmental conditions related to food production, while being an example of an aspiration to make use of IoT in improving the productivity of the agricultural sector in the Southern African region. IoT implementation within South African agriculture benefits the South African agricultural ecosystem, economy and society through improved agricultural production and efficiency, agricultural exports, and sustainability (Ayaz et al., 2019; Makate, Makate, Mango, & Siziba, 2019; Ungerer et al., 2018).

2. THE INTERNET OF THINGS

Kevin Ashton first coined the term Internet of Things in 1999, and defined it as a uniform way for the internet to connect and understand the physical world (Schoenberger, 2002). IoT is a network composed of physical integrated machines fitted with sensors, processors and networking systems that run either via the Internet or the on a local data network. Therefore, IoT can be described as the connection between the real world and the digital world. IoT enabled devices, with the assistance of sensors, collects data and appends it to the data of other smart devices connected to the network. The collected data can be analyzed and used to make decisions or archived for long-term purposes (De Cremer, Nguyen, & Simkin, 2017; Sullivan, 2018).

IoT generally refers to a mixture of technological functionality that intends to generate benefit based on functionality. For this reason, IoT devices range in complexity and are custom-made to achieve specific purposes. The flexibility of IoT ranges from a minimum requirement of possible communication and cooperation with other devices in the system to vastly complex. At a minimum communication and cooperation can occur via Bluetooth, Wi-Fi, or UMTS. To remotely control the smart devices, the devices are required to be addressable. The sensor technology enables the collection and transmission of information. While the processors and repository capacity allow the processing of collected data via the smart devices. The local usability of IoT extends to user interfaces such as smartphones (Makate et al., 2019). However, IoT is in its nascent stage and
requires further improvement to become more accessible and less expensive to all. The benefits of IoT focuses on the ability of the network to gather and analyze data and, as a result, support organizations', communities, and individuals (Ayaz et al., 2019).

2.1. The Use of IoT in Agriculture

IoT provides an opportunity to transform various industries, including agriculture (Brewster, Roussaki, Kalatzis, Doolin, & Ellis, 2017). IoT technologies enables the agricultural sector to overcome food scarcity and climate concerns. This can be achieved through IoT devices that enable automated drip irrigation, weather forecasting, water level detectors, and soil level detection that use software intelligence, sensors and ubiquitous connectivity (Madushanki, Halgamuge, Wirasagoda, & Syed, 2019). These IoT devices link to sensors which produces and collects data that can be analysed using open software and, therefore, assisting farmers in managing and protecting crops by providing valuable information wirelessly or through low-powered networks (Brewster et al., 2017; World Food Programme, 2020). In addition, a benefit of IoT in agriculture is that it enables farmers to receive this information on their smart phones, which allows for efficient and effective agricultural farm management and increased productivity (Dlodlo, & Kalezhi, 2015).

2.2. The Use of IoT in South Africa

IoT was introduced into the South African economy more than a decade ago and continues to shape the country and influence most industries. Although it is a relatively new technology, South Africa has been using IoT for many years. Currently, there has been a nationwide production of network sensors used to connect everything including traffic controls and electricity grids as well as developing cloud infrastructure across the various sectors. In 2012, the South African National Roads Agency Limited introduced an e-tolling system, which charged vehicles for using the road; the system operated uses an IoT enabled systems. The IoT device senses e-tags or vehicle number plates as they pass. Compared to most of the African countries, South Africa has responded fast to IoT technologies. ESKOM, a South African public electricity utility company, has implemented smart meters that measure electricity usage and an IoT application that allows customers to identify the times, dates and areas that power-outages will affect (Onyalo, Kandie, & Njuki, 2015).

In South African agriculture, a grain producer in North West province, Jozeph du Plessis has been practicing precision farming on his dryland crops since 2001. du Plessis started precision farming using satellite imagery and yield monitors to rotate between soya beans and sunflowers. The precision software mapped and monitored the physical properties and chemical conditions of the soil. The spatial features was digitized, and computerized models measured the predicted yield of maize based on the soil-water holding capacity. Low potential areas were replaced with pastures and soil nutrient levels were analyzed and designed to reach optimal levels; therefore, the soil could be utilized to its full potential. In addition, du Plessis used a soil moisture meter to manage low water content, which determined the need for the implementation of a fallow system to allow cultivated areas of land to conserve water. The result of the technological innovation was that du Plessis was able to increase average maize yield and water usage (Ungerer et al., 2018).

The increased number of connected devices (IoT) and use of cloud-based services by the public, academia, business, and other sectors in South Africa has resulted in an increased demand for higher broadband and reliable connectivity (Department of Telecommunications and Postal Services, 2016). Sufficient internet bandwidth and economic infrastructure is essential for the implementation of IoT, therefore for Africa to implement IoT, governments are required to provide infrastructure that supports IoT solutions (365FarmNet, 2017; World Bank, 2018b; Zander, Trang, Mandrella, Marrone, & Kolbe, 2015). Furthermore, South African farmers continue to experience the effects of centuries of institutionalized racial discrimination as a result of Apartheid. The effect is mirrored in the distribution of agricultural land to racial minorities in commercial farming (Venter, Shackleton, Van Staden, Selomane, & Masterson, 2020; Cousins, 2016). Although, the benefits of IoT in
agriculture are undeniable, it is not clear whether the agricultural sector in South Africa is ready to adopt and leverage the technology (Atayero, Oluwatobi, Alege, 2016).

3. ANALYTICAL FRAMEWORK

The PEST (Political, Economic, Sociological and Technological) framework is an analytical tool for examining how macro-environmental factors affect a phenomenon of interest. The framework is used to examine the success of a management initiative through understanding the relevant factors specific to its organizational environment. The organizational environment consists of the external social and physical factors that influence its decision-making process (Duncan, 1972). PEST assumes that these external factors, as well as indirect conditions, shape the organizational environment by influencing its value-adding capabilities. Therefore, an aerial perspective of the external environment is produced through a PEST analysis. This becomes increasingly important when trying to refine larger environments to understand its organizational systems (Law, 2006).

The PEST framework was used in this study to produce an understanding of the context through analyzing the PEST constructs of the agricultural industry within its natural environment. In addition, the framework helped us to narrow the focus of the study to specific factors of the PEST framework that influence readiness. This, in turn, developed meaningful insights and in-depth understandings of the sectors readiness for IoT implementation. However, each dimension of the PEST framework creates a multitude of variables. Therefore, the framework is viewed through an information systems lens to determine which variables have the greatest impact on the agricultural sector.

PEST seeks to assess the political, economic, social, and technological conditions of the agricultural sector to understand the factors of readiness of the industry to implement IoT. PEST addresses the most common issues of IoT in the agricultural sector, to determine whether there is benefit in implementing IoT in the South African agricultural sector.

By assessing the sector through the four constructs of the framework, the current and prospective state of readiness in the agricultural sector is understood. PEST analysis is used to analyze the macro-factors (political, economic, sociological, and technological) of the external environment to enable strategic management through leveraging its opportunities and mitigating threats (Law, 2006; Duncan, 1972). The results of the PEST analysis will illustrate the environment within the agricultural sector as well as identify the aspects that may strengthen, impede or create opportunities for technological growth.

4. RESEARCH METHODOLOGY

The study employs a desktop study using a thematic literature and documents review based on the PEST framework. The exploratory nature of this study enabled a holistic understanding of the research question. The study used a number of bibliographic references, which the researcher checked and compared. These sources were critiqued and combined to develop standpoints and arguments for the PEST framework. In addition, statistical data and grey literature were used to determine the background of the country.

The research was conducted through an analysis of the contributions made of the political, economic, socio-economic, and technological purposes of IoT within the agricultural sector of South Africa over the period of 2015 – 2020. The period is representative of the most recent uses of IoT within South Africa. The documents were retrieved between January and September 2020. We searched for the document using the following key words: Internet of Things, IoT, agriculture, IoT agriculture, IoT agriculture South Africa, South Africa, PEST analysis, South Africa PEST analysis. The key words were chosen due to its representativeness of the main objective of the research. The contributions were searched in two search engines, Google and Google Scholar, and multiple digital libraries to collect information. The chosen digital libraries were Elsevier, Xplore Springer, IEEE, and IGI which were chosen based on their contributions.
Initially, the search yielded 150 peer-reviewed papers. The papers were screened on the basis of titles, keywords, exclusions, and full articles which reduced it to 75. In the end, 26 papers out of the 150 were used. In addition, South African policy documents and international statistical documents were used. All research contributions found on the theme of the PEST factors of IoT in South African agriculture were gathered, assessed, and analyzed to understand the research topic.

5. FINDINGS AND DISCUSSION

5.1. Case Context

South Africa is a rich and diverse country with an agricultural sector that is characterized by its dual agricultural economy (AgriSETA, 2019; Mordor Intelligence, 2017; Goldblatt, 2016). The diversity of the South African agricultural sector is depicted by various types of farming, such as, crop and animal production, horticulture, and dairy, fish and, game farming (Mordor Intelligence, 2017). The agricultural economy of South Africa is categorized into well-developed commercial farming, which makes up approximately 87% of agricultural land, and subsistence, or small-scale farming, which occupies only 13% of total agricultural land (Tibesigwa, Visser, & Turpie, 2017). However, there is a lot of complexity and fluidity between commercial and subsistence farming (AgriSETA, 2019; Goldblatt, 2016). South African commercial farming is highly developed, and export driven and is still a significant exporter of agricultural products. Whereas small-scale subsistence farming is less developed and subject to various resource and production constraints (Kushke, I., & Jordaan, 2017).

As with many sectors in South Africa, the agriculture sector is affected by race. Where most agricultural employees in the agricultural sector are predominantly black (65%), followed by colored (19%), white (12%) and very few Asians (1%) (AgriSETA, 2019; Statistics South Africa, 2020).

Only 13.7% of South Africa’s total surface area is arable and used for crop production, while only 3% of the arable land is considered as truly fertile land (Goldblatt, 2016; Jacobs, Van Tol, & Du Preez, 2018). Since the early 1990’s, South Africa was left with less than two-thirds of the number of farms it had due to climate change, water scarcity and declining farming profitability (Goldblatt, 2016; Jacobs et al., 2018). The lost farms have been used for other uses, while the remaining farms have increased its productivity to achieve sustainability through technology adoption within their farming practices (Kane-Berman, 2016).

5.2. Political Factors

South Africa has experienced immense economic and social reform since the transition into a democratic state in 1994. Following the end of the Apartheid-era, economic reform and policy changes proposed to eliminate the previous Nationalist Governments’ socialist control of agriculture by improving the agricultural environment and redressing land inequalities (Goldblatt, 2016; Ungerer et al., 2018). The government’s approach to achieving social, political and economic reform and integration has undoubtedly shifted, and ICT policy needs to adapt and respond accordingly. Since 1990, focus was placed on redressing the injustices of apartheid and decades of racial discrimination through the Reconstruction and Development Programme (1994) (Goldblatt, 2016).

New approaches to ensure equality, quality of life and poverty eradication are targeted through ICT policy (National Treasury, 2019). The aim for equality within the agricultural sector arises from South Africa’s political history. Most commercial farmers were found to be white with access to resources, which enables the implementation of IoT. While most subsistence farmers were found to be black with a lack of access to resources which makes them less likely to implement IoT (AgriSETA, 2019; Statistics South Africa, 2020). This leads to an uneven distribution of IoT readiness in the agricultural sector which hinders the aim of ICT policy to ensure equality as readiness is not uniform across the sector and remains divided on race. Therefore, IoT can be implemented; however, its implementation will not align and redress currently inequalities in the country (KMPG, 2012; UN, 2020).
Current policies show the need for IoT in the South African agricultural sector. The National Development Plan 2030 policy highlights the importance of initiatives that links the agricultural sector to the green economy. The Department of Agriculture, Forestry and Fisheries Integrated Growth and Development Plan 2012 emphasizes sustainable agriculture with an aim to benefit all South Africans. These policies create the demand for IoT in terms of enabling a greener and more sustainable agricultural sector, with less water, fertilizers, and pesticides usage. The political aim for South African agriculture is conducive to the implementation of IoT because IoT enables sustainability, productivity and, information sharing within the sector (Ungerer et al., 2018). However, there is not much evidence on the effect and progress of these policies.

The lack of farmer support is causing the number of farms to decrease. The African Farmer’s Association of South Africa (AFASA) reported that of its total members, only one third of them farm for the income, of which only 2%, of those farming commercially, are successful (Nayak, Kavitha, & Rao, 2020). Therefore, regardless of the type of farming, many farms in South Africa are operating hand-to-mouth and require support to become sustainable. Over the years, the number of commercial farms has substantially decreased. However, this decrease in numbers has been accompanied by increases in farm sizes as well as the implementation of various technologies on the farms, including IoT (AgriSETA, 2019; Ungerer et al., 2018). Government policies that support farmers financially creates a demand for IoT by providing commercial and subsistence farmers equal opportunities for technological innovation. Therefore, subsidies given to farmers enables farmers readiness to implement IoT and provides an opportunity for actual IoT implementation on their farms (Ayaz et al., 2019; Ungerer et al., 2018).

5.3. Economic Factors
The South African forecasted gross domestic product (GDP) showed a reduction of 2% in GDP from 2019 – 2020 due to the COVID-19 outbreak, causing additional economic challenges to SA’s increasing debts, large fiscal deficits, depressed growth, and high social vulnerabilities (Statistics South Africa, 2020). While the agricultural sector has had a good quarter with a rise of 27.8% in production activity due to an increase in the production of field crops, animal and horticultural products (Statistics South Africa, 2020). This economic growth calls for the development of technological strategies that further improves the sector (Ungerer et al., 2018; World Food Programme, 2020). Therefore, the economic state of the agricultural sector can be seen to be in a good position to implement IoT strategies to further increase and improve productivity in the sector (Ayaz et al., 2019; AgriSETA, 2019; Ungerer et al., 2018; World Food Programme, 2020).

South African economic growth has been accelerated by the agricultural sector. To further improve such growth, the agricultural focus should shift to becoming more competitive through technological innovation. To become more competitive, farmers would need to implement technologies that improves productivity. IoT provides the platform for more competition within the sector, through improving productivity and, thereby, improving agriculture exports (Ayaz et al., 2019; Ungerer et al., 2018).

The overall slow growth rate and high inequality levels strengthen each other. The inequality promotes resource contestation (through corruption and crime), which impedes investment required to facilitate equality and technological innovation (Western Cape Government, 2017). Farmers who implement IoT are at risk of criminals stealing IoT devices in open fields (Ayaz et al., 2019). In addition, the corrupt South African government that might steal funding intended for agricultural technological development hinders farmers. This affects the implementation of IoT by farmers, as they are not provided with the financial support or security from government, especially those farmers who are in weaker positions, such as those doing subsistence farming (World Bank, 2018a; World Bank, 2018b).

South Africa has been known for its slow uptake and access to ICT compared to other countries (Onyalo et al., 2015), while most of its progress has been due to increased competition from
Soeker et al. Readiness of the South African Agricultural Sector to Implement IoT challenger firms (CCRED, 2016). Technology is being used to facilitate successful land reform as illustrated by modern crowdfunding platforms, while increasing agricultural economic development opportunities in rural areas (World Food Programme, 2020). The ICT policy enables equal opportunity for IoT implementation across both urban and rural areas, thereby, offering opportunity for growth within the sector (AgriSETA, 2019; Goldblatt, 2016)

5.4. Social Factors
Overall, the worldwide trend is unemployment is increasing with the implementation of technology leading to a reduction in the demand for semi-skilled and unskilled labor (World Food Programme, 2020). The lack of economic growth in South Africa negatively impacts the employment rate in the agricultural sector; as a result, there was a 0.6% decrease in employment due to the increased mechanization of farming processes (Statistics South Africa, 2020). The high unemployment rate may cause government resistance for IoT initiatives; however, there is no evidence to support this. The rapid technological changes in agriculture production is affecting skill-intensive employment demands through the creation of biases. The discrimination against the South African labor force is leading to increased unemployment. However, the agricultural industry is seen as a passage to growth in the labor and sociological sector. Technological innovation within the agricultural sector has promoted agrarian transformation and improved agricultural production and, therefore, should be supported (National Treasury, 2019).

A major improvement in South Africa's sociological capacity would entail breaking free from high unemployment that the region has been stuck for decades. IoT is considered to both increase and decrease employment rates in agriculture. The former is achieved through attracting the youth to the sector through the use of technology, in the fourth industrial revolution. The latter is a result of IoT devices replacing workers who do on-field manual labor tasks that can be performed through IoT implementation (Ayaz et al., 2019). Skilled laborers able to use new technologies will need to be accommodated with equitable wages to compensate for the need for a new skill set. While further accommodation is needed to upskill, retrain and socially develop current unskilled workers technological competence (World Food Programme, 2020). The reduction in labor costs associated with IoT acts an incentive for farmers to implement IoT in their current agricultural practices (KMPG, 2012). However, the costs associated with upskilling workers may act as a hinderance to IoT implementation.

Education levels of farmers play a key role in the implementation of IoT in the more educated farmers may be more ready to implement IoT. Whereas, those who are less educated may be more resistant to implement an unknown technology. In South Africa, commercial farmers are predominantly white and, therefore, more educated and likely to implement IoT. While subsistence farmers are mostly black, and more likely to be uneducated and less inclined to implement IoT. This leads to inequality across the sector, even though farmers are ready to implement IoT (Ayaz et al., 2019; Brewster et al., 2017; Jacobs et al., 2018).

The age of employees in the agricultural sector was reported to be between 15 and 65 year, while 40% were under the age of 35, 52% were between the ages of 35 to 55 and 8% were found to be older than 55 (AgriSETA, 2019). The large proportion of young farmer employees may act as an incentive for farmers to implement IoT in their practices. However, the education level of the young farmers may act as a hinderance to the use of IoT. With a larger distribution of the youth using mobile technologies, the transition to IoT will be easier if farming practices are managed via the mobile phone (ICASA, 2020).

Further consideration regarding the key sociological factors that affect the agricultural sector in South Africa are ethics and privacy issues associated with IoT. Farmers may be resistant to storing their agricultural information on IoT devices that may be vulnerable to security breaches by competitors. This may cause farmers to perceive IoT as unattractive (AgriSETA, 2019; Ungerer et al., 2018; World Food Programme, 2020). If these issues are left unresolved, they will contribute to
a decreased uptake of IoT on farms and an increased migration of farmers to urban areas as a result of unprofitable farming.

5.5. Technological Factors
Agriculture in South Africa is dependent on farming equipment, labor and infrastructure. The challenge would be optimizing the accessibility to resources such as fertilizers, seeds, and suitable cultivars, parallel to management techniques and expertise of agricultural processes and applications. This can be addressed through the use of IoT because it enables the optimal use of these farming inputs by farmers. In addition, it provides farmers with farming management capabilities that allows farmers to make informed decisions regarding crop production, thereby increasing production and profitability (Ayaz et al., 2019; Ungerer et al., 2018). The issues faced in South Africa are the accessibility to IoT, the organization of internet access, and the integration of IoT sensor technologies (Nayak et al., 2020). Access to new technologies remains unevenly distributed across commercial and subsistence agriculture in South Africa. Lack of access to technology is one of the major inhibitors for the implementation of IoT by subsistence farmer, thereby, increasing technological inequality in the sector (Ayaz et al., 2019; Jacobs et al., 2018).

Most farming equipment in operation are analogue and not compatible with new technologies and networks. However, modern agricultural equipment enables data collection and analysis by allowing farmers to meet requirements and improve their agricultural processes. Technological solutions already exist to solve these issues. For instance, GPS systems and Bluetooth together with software, interoperability and, standardization ensure that legacy machinery can be digitalized (World Bank, 2018b). The right IoT technology can be seamlessly integrated into existing farming equipment and linked to mobile technology. This may lead to greater implementation of IoT in agriculture. Commercial farmers are opting for more high-tech equipment, putting them in a better position to implement IoT technologies in their farming practices. While subsistence farmers lack access to advanced farming technologies, therefore, reducing their ability to use IoT (KMPG, 2012).

Technological infrastructure continues to be inadequate in rural areas. For certain technological solutions to operate, an internet connection is necessary. Like other sectors of the economy, modern agriculture relies heavily on effective telecommunication infrastructure. South Africa’s internet penetration stood at 62% in January 2020 (ICASA, 2020). In rural areas of developing countries, limited telecom infrastructure is common which causes challenges for the full utilization of IoT and realization of its cost-effectiveness (365FarmNet, 2017). However, in South Africa the lowest rural internet coverage was found in the Northern Cape with a coverage of 3G and LTE sitting at 99%, 97% and 72% in 2019, respectively. While the highest coverage was found in the Gauteng Province sitting at 100%, 100% and 99%. Urban internet coverage is marginally better than rural internet coverage. In 2019, all nine provinces had 100% 2G urban coverage, the Northern Cape Province had the lowest 3G urban population coverage at 99% in 2019, with the rest of the other Provinces had 100%. The Northern Cape had the lowest LTE urban coverage at 98% in 2019 (ICASA, 2020). This shows that South Africa’s technological infrastructure in the agricultural sector is ready for IoT implementation.

With an increase use of technology, so comes the rise in demand for data and reliable broadband technology. In January 2020, two undersea cables broke which resulted in slow internet connection across the country. This caused an inconvenience to many South Africans who were working from home as a result of the COVID-19 pandemic (Business Insider South Africa, 2020). Although these issues are uncontrollable, South Africa’s internet infrastructure has improved and, therefore, places them in a good position to support IoT implementation throughout the agricultural sector.

The Department of Telecommunications and Postal Services (DTPS) is in the process of deploying telecom infrastructure to enable more accessible fixed-line broadband access as it provides access to unlimited data transmission (National Treasury, 2019). Furthermore, it has been claimed that mobile broadband is not a sustainable technology for the future of broadband due to its limited data
transmission (National Treasury, 2019). However, in developing countries, where mobile technology and Wi-Fi are highest in demand in the agricultural sector, remains one of the main tools used to penetrate technological innovation (Gokul, & Tadepalli, 2017). In South Africa, smartphone penetration increased from 81.7% in 2018 to 91.2% in 2019 (ICASA, 2020). The widespread use of mobile technology created an opportunity for IoT use within the agricultural sector.

Mobile technologies are used as a tool in IoT to monitor water, crops, and land resources. Third generation (3G) connectivity is an accessible option for farmers because it is available across most of South Africa (Ayaz et al., 2019; World Food Programme, 2020). In South Africa, mobile network coverage is in a good state with national population coverage for 3G increasing from 99.5% in 2018 to 99.7% in 2019 and national population coverage for 4G/LTE increasing from 85.7% in 2018 to 92.8% in 2019 (ICASA, 2020). Data collected from monitoring crops through IoT devices can be transmitted via SMS’s, over the slowest networks, therefore, existing ICT infrastructure can be used. However, due to high mobile data costs and limited internet speed, low-powered, short-range networks or low-rate wireless PAN (LoRaWAN) can be used as an alternative to Wi-Fi and 3G, especially for the utilization of IoT (Madushanki et al., 2019). Therefore, the wide range of broadband options reduces the technological inequality within the sector because it enables the use of IoT across different network capabilities and provides efficient connectivity over a low-cost and reliable spectrum (Nayak et al., 2020).

6. CONCLUSION

Food security and sustainable food production has been long been recognized as a global issue. Evidence exists that the use of technology in agriculture has the potential to improve food production and sustainability. Therefore, the aim of this study was to explore the readiness of the agricultural sector of South Africa for a wide implementation of IoT. Through the PEST analysis, this study developed an in-depth understanding of South Africa’s agricultural context in terms of political, economic, social, and technological factors. The use of the PEST framework in this research enabled the assessment of South Africa’s readiness to implement IoT. The study found that the introduction of IoT within South African agriculture has many challenges for a wide implementation, however, there exists some degree of readiness. Overall, this study observed that some factors place South Africa in good position to implement IoT, such as, increased farmer support from South African government, the willingness of younger farmers to implement IoT, reduction in labor costs, easy integration of IoT technology to mobile phones, and wide ranging internet coverage. While, some challenges were found to be an unequal distribution of IoT technology between black and white farmers, lack of access to technology, risk of criminal activity, influence of age and education on the willingness to adopt IoT, slow uptake and access to ICT, and the potential to increase unemployment rates. However, current policies show that the South African government is actively planning to overcome these issues. There were some limitations to this study and so interpretation and generalization must be undertaken cautiously. The exploratory nature of this study requires that more cases are included in this investigation. In addition, this study would have benefited greatly from the inclusion of both qualitative and quantitative empirical data collected from the relevant parties in the agricultural sectors of Southern African countries. An extension to this work could consider assessing the perceptions of farmers to implement IoT in agricultural sector of South African agricultural.

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