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ENABLING KNOWLEDGE STRUCTURES TO SUSTAIN ICT INTERVENTIONS

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Enabling knowledge structures to sustain ICT interventions

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Abstract:

Information systems research has primarily analyzed how structures influence human agency and practices. This focus has limited our understanding of how practices influence structures. This relation is especially important to understand how ICT initiatives may sustain or not over time, an enduring concern in ICT for development research. Drawing upon a structural analysis, this paper analyzes this relationship between practices and structure through an empirical analysis of community health workers called Health Surveillance Assistants (HSAs) in Malawi and their existing and emerging knowledge practices around the use of a mobile health system (MHealth) in maternal and infant healthcare. The analysis identified three sets of knowledge practices related to curative care, preventive care and communication, and how HSAs creatively innovated new practices to fit their context as they used the MHealth system. We argue that these new knowledge practices need new supporting structures to help enable the sustainability of the Mhealth system. These structures in turn need practices to mold and evolve them as they support this new MHealth system and emergent knowledge practices. We identified four such required structures related to infrastructure, training, reporting and knowledge learning. Further, supporting practices identified to strengthen sustainability included feedback, data quality assurance, new models of training and support.

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1. Introduction

The Social Sciences have historically been engaged with the analysis of the interaction between structure and agency. While macro theorists (e.g. Marx) have focused on the influence of structure on agency, micro-theorists such as the ethnomethodologists (e.g. Garfinkel) have focused on micro-level interactions and agency in relation to structure. Macro theorists have been critiqued for treating the agent as a “cultural dope” who is overpowered by structure with little agency to resist or act otherwise. Micro-theorists are critiqued for studying “agency in vacuum” by ignoring the influence of context in the expression of agency.

Giddens in his Structuration Theory (1984) has tried to resolve this dualism between agency and structure by analyzing them through the lens of a structurational process where the two are seen not as external to each other and recursively related. For Giddens, structures are not something external but shaped as rules and resources existing as memory traces in the heads of individual agents. For example, a child’s interaction with parents is shaped by the child’s interpretation of the rules and resources guiding parent-child interaction. Further, Giddens conceptualizes agents as being knowledgeable and reflexive, who always have the possibility to act otherwise and create “unintended” consequences. Giddens’ Structuration theory has found extensive application in the information systems research domain (see for example, Orlikowski and Robey 1992, Walsham 2002; Staehr, 2010), which has helped to develop insights about the agency-structure relation in the context of ICTs.¹

However, a general bias seen in structurational analysis in information systems (IS) research is a dominant attention given to the influence of structure on agency, while the reverse link, though acknowledged, is not adequately empirically established. For example, X and Y (1997) in their analysis of social structure and managerial agency in India examined how various rules and resources through structures of education and family influenced the shaping of agency in relation to public sector management in India. Very little is said, however, on how the changing agency of managers including relating to the introduction and use of new ICTs may help to create new rules and resources or the potential for change which underlies the redefining of structures. This one-way focus could probably be because changes in structures are harder to discern and take a long time to happen, which typically are beyond the framework of a research project.

We believe that we should revisit the structure-agency debate in the IS field because there has generally been a bias in the understanding of this interrelationship, often disregarding the potential of agency on broader social structures. Understanding the influence of agency on structure in the context of ICT for Development (ICT4D) projects, the focus of this paper, is generally lacking (Ramadani, Kurnia and Breidbach, 2017) but is important, as it can help provide insights on their sustainability, an important concern around such efforts. After all, new technology initiatives by design are social interventions, and require new rules and resources to function and sustain, such as related to budgets and policies, which in structurational terms can be conceptualized as structures. For example, a common inference at the end of an analysis of an ICT project is often that “more

¹ **Abbreviations:** MoH: Ministry of Health, DHO: District Health Office, HSA: Health Surveillance Assistant

training is required”. However, for this to happen there needs to be renewed structures in place related to budgets and institutional acceptance. Merely, providing “more training” without the enabling structures is not a recipe for sustainability, and will end up as a “one-shot” event with the same conclusion of “more training is required.”

Enabling structures do not emerge on their own, and require agents to create a demand for them, by exercising their agency for example by foregrounding the importance of training. This demand, especially coming from a multiplicity of sources, will set in motion the creation of these enabling structures, and their continuity over time. The analysis of how agency can work towards the building of these new required structures or not thus becomes important in understanding whether the initiatives sustain or not and in what form.

This agency-structure analysis is especially relevant in the context of ICT4D projects, which is the focus of this paper. Often, many of the required structures in the context of new ICT initiatives such as related to knowledge, regulation, governance, infrastructure and capacity are not mature in most developing countries, especially in the public-sector context. A failure to actively identify and address these missing structures, leads to pilot projects which do not scale over time and space (Heeks, 2006). Another motivation for strengthening this agency-structure analysis comes from the need to develop more human-centred approaches to ICT design, development and implementation (Mukherjee, 2017). Often, ICT4D projects tend to be sub-optimal as they focus primarily on the supply side (provision of more hardware, internet connections, and mobile phones (Sarker and Wells, 2003; Madon, 2008), while ignoring the demand side relating to the aspirations, capacities and values of the humans who are the ultimate users of the systems and whose agency will define the nature of demand. The increasing acknowledgement in ICT4D research of the need for more human centred approaches is reflected in the heightened use of theories like the Capability Approach (Mukherjee, 2017).

Given this background, the aim of this paper is to understand the following:

- What are the missing or inadequate structures in the context of ICT4D projects that may impede their sustainability?
- How can agency be developed and expressed to help cultivate these missing structures to strengthen sustainability?

We analyze these questions in the context of a Mobile Health (MHealth) project being implemented in Malawi amongst community health workers (CHWs) locally referred to as Health Surveillance Assistants (HSAs). Mhealth projects are especially interesting to study as they are novel in the public health context, and require both new forms of work and supporting knowledge structures. We thus study the implementation processes around these projects, and seek to understand the existing and changing work practices, and why they sustain or not in relation to the existing and required structures.

The rest of the paper is organized as follows: In the section 2, we discuss our theoretical framing. We draw on Giddens descriptions of structures that regulate practice and agency to depict the knowledge and reflexivity of actors. This practice based lens is taken to analyze the agency-structure relationship. Knowledge is conceptualized as practice to understand how work is done and revised over time in the work of HSAs. Section 3

details our methodology followed by a description of our research context highlighting the main work of HSAs in primary healthcare. The case study on the MHealth system is then described. Section 4 follows with the findings depicting the knowledgeability of HSAs in their everyday work. This is followed by our case analysis in section 5 and section 6 highlights our discussion, contributions drawing on the theoretical perspective presented earlier and concluding remarks.

2. Theoretical Reflections

2.1 Structures and practice

Giddens' (1984) structuration framework develops the concepts of structure, agency and structuration which are important to practice research for their emphasis on understanding people's activities in a social setting and ongoing outcomes. To remove the dualism between structure and agency, Giddens conceptualizes structures as memory traces in the heads of agents, and does not allocate material properties to them. Structures play out as rules and resources drawn upon by human agents in the production and reproduction of social action and practice (Giddens, 1984). The rules of social activity are, "techniques or generalizable procedures applied in the enactment/reproduction of social practices." (p. 21). These rules are not simply legislated but also include less formal routines, procedures, morals and habits. Resources are the mediums through which power is manifested and exercised, building transformative capacity/capability of agents. There are two types of resources, allocative and authoritative. Allocative resources refer to power creating command over objects and material phenomena. Authoritative resources are related to status and power involving power generating command over people. It is these rules (codes, norms, principles) and resources (material and symbolic) that actors apply routinely in the conduct and justification of their everyday work and are held accountable.

Giddens (1976) refers to practice as "ongoing series of practical activities ". Practice is therefore related to regularized acts that have continuity. They are shared by knowledgeable actors that draw on rules and resources to produce and reproduce them over time through continued interaction. This is what Giddens refers to as the 'duality of structure' where structure and agency mutually depend on each other generatively. The structures regulate contingent activity or practice, construction of meaning, continuous interaction, joint sense making and knowledge integration. They are both the medium and the outcome of the reproduction of practice. Giddens (1984) observes that although structures organize practice and enable or constrain it, he is quick to emphasize the potential of humans and their agency. Agency is the capacity to act and all agents have knowledge which they apply in the production and reproduction of practice (Giddens 1984) but they can choose to do otherwise, reproducing structure or negating it, and with it creating unintended consequences. As much as actors are knowledgeable, they are also reflexive in the sense that they actively monitor their interactions in which their activities are constituted. Agents actions can therefore have unintended consequences in practice that eventually implicate modification of structures.

There are various ways of analyzing ICTs in work and organizations, and the practice lens has in recent years been given significant attention in information systems research (see Orlikowski; 2000, 2002; Walsham, 2002), including to understand how structures both enable and constrain practice. However, often, accounts of how work practices around a technology influence the creation of new structures are overlooked (X and Y,

Working paper). To understand this relationship better, we draw upon Giddens' (1984) account of structure. This practice lens enables us to account for human agency, its knowledgeability, creativity and highlight the reflexivity of actors in their everyday practices as they engage with technology.

Studies which seek to account for the agency of individuals around their use of ICTs in organizational work, view technology use as a product of shared interpretations, conduct of human action, design, appropriation, and dependent on the context and strategies of users (Zuboff, 1988). Such studies are heavily reliant on the capability of human actions to construct and reconstruct technology and examines how shared interpretations around a technology develop and influence future interactions. An extension of this view to the work place will focus on how meanings around a technology arise and are sustained through locally owned practices developed around the technology system.

2.2 Viewpoints on Knowledge practices and sustainability

We conceptualize knowledge as practice to understand how work is done and knowledge drawn upon and created, and their linkages with underlying practices and enabling and constraining structures. Giddens structuration framework (1984) claims that knowledge (including tacit) is instantiated in everyday practice and activities by knowledgeable actors. In this reading, actors are seen to have mastered the procedures of their practice, which knowledge is made actionable through the practical activities of their everyday life. There are different perspectives on knowledge in organizations. The classifications made by Polanyi (1966) 'tacit' and 'explicit' knowledge and Ryle's (1949) 'know how' and 'know that' have widely been a basis for analyzing knowledge in organization studies and work (Collins, 2007; Nonaka and von Krogh, 2009; Brown and Duguid, 2001). Some examples of research studies drawing upon these categorizations of knowledge to study how it circulates within and across organizations include; Schmidt (2012), Zimmermann and Ravishankar (2014), Williams (2010), and Davison, Ou and Martinsons (2012). A challenge experienced in these studies is that research is drawn away from investigating actual work practices and is deflected towards existing forms of symbolism around knowledge (Schmidt, 2012). The focus then is on the representations and classifications of knowledge rather than on understanding the logics of underlying work practices. A primary focus on knowledge often tends to treat it as a well-defined substance, commodity, that is static, stable, possessed by individuals and as having existence external from the heads and practices of individuals (Brown and Duguid, 2001; Orlikowski, 2002; Cook and Brown, 1999).

Accounts in IS literature utilize knowledge taxonomies (Hecker, 2012; Trusson, Doherty and Hislop, 2013) whilst recognizing the constitution of action or practice and knowledge (Nicolini, 2011). For example, Brown and Duguid (2001) argue that knowledge must be actionable for it to be shared or transferred. They treat knowledge as recursive with a discrete element of practice, where practice and knowledge reproduce each other in a duality, being envisioned as reciprocally constitutive of each other where actions depend on predefined knowledge. This resonates with Giddens (1984) ideas on the cyclical nature of structure and agency. Notably, this kind of knowing is characterized by human agency in knowledgeable action with the capacity to act in particular situations. It is generalizable in the sense that it can be applied in diverse contexts (Giddens, 1984) but it

can also be reinvented by reflexive agents depending on the contextual world they are engaged in.

We therefore agree that practices should be seen with a more dynamic, creative and a reflective notion (Sami and Kai, 2009; Orlikowski, 2002), where knowledgeable and reflexive agents adjust their knowing depending on the social and physical world they operate in (Cook and Brown 1999). Reflexivity is core to this analysis and involves a self-conscious reflection, monitoring and questioning of one's own behavior and the behavior of others (Giddens, 1984, 1991; Beck, 1992; Ewenstein and Whyte, 2007). Giddens (1984) has stressed that agents are not bound by structure but can chose to pursue other interests. The theoretical reflection indicates knowledge is instantiated in action and Giddens (1984) acknowledges diverse and dynamic contexts in which it can be applied. Orlikowski (2002), drawing inspiration from Giddens work coined the term 'knowing in practice' to capture knowledge practice changes. She argues that knowing is in our actions enacted in practice and it emerges and is modified through ongoing and situated actions across time and space. Since work environments are dynamic, generating non-routine events and raising unusual questions, reflexivity helps actors engage with 'knowing in practice' (Orlikowski, 2002) involving action, doing and practice. Knowing in practice is illustrated by Suchman's (1996) narration of air traffic controllers work. They improvised communication strategies outside their standard operating procedures to maneuver the orderly arrival and departure of airplanes that were blocked from their sight by buildings. Such knowing is therefore not stable or enduring, and is constructed and renovated as people engage with the organizational world in practice (Nicolini, 2011; Orlikowski, 2002).

Our focus here is on knowledge embedded in practices and their reflective changes (Argote and Miron-Spektor, 2011). In our approach, we go beyond formal structures of knowledge such as standard operating procedures and practice guidelines, and focus on the practices of actors that affect, transform, maintain knowledge structures and create innovations within social contexts (Lawrence and Suddaby, 2005; Timmemans and Berg, 1997; Orlikowski, 2002). This perspective helps to understand the workings of social systems and particularly how knowing in practice in turn influences knowledge structures. On their own, structures wither away, and need recurrent practices to endure. Our analysis seeks to understand how practices are intertwined with new knowledge structures and how these are maintained or sustained over time.

Sustainability has been an enduring issue with ICT4D projects generally and MHealth systems in particular. Majority of MHealth systems in low income contexts very often fail to succeed or endure over time and space (Heeks, 2002; Braa et al, 2007). Often sustainability of ICT interventions is tied up with external support which by design is limited over resources, time and space. Contributing to this situation is the absence or inadequacies of structures that enable continuity. Structures are related to sustainability because structural properties reinforce the existence of practices over varying spans of time and space, giving them systematic form (Giddens, 1984). The issue of maintaining new practices, and sustaining them has received little attention in information systems (Lawrence and Suddaby, 2005). Maruster, Faber and Peters (2008) have linked sustainability of information systems through their assumptions of adaptability to environmental changes, which tends to consider knowledge as stable.

Lawrence and Suddaby (2005) discuss how agents can maintain structures through enabling work, policing, mythologizing among others. It is inadequate to only understand how knowledge practices can be influenced to create new ones and it is important to analyze how these practices are sustained. In the study of MHealth systems in developing countries, the lack of sustainability has been a major concern (Sanner, 2017; X and Y, 2017) with projects dying as pilots after external funding stops. Supply driven efforts (X and Y, 2017) focus primarily on the provision of infrastructure and ignore local demands. Sanner (2017) suggests addressing the challenge of sustainability by making ICT4D projects more open to local improvisations, and building local capacity to enhance innovations. Focusing on the supply side, ignores users' agency, the role of institutions and other conditions relevant to enable deep rooted change (Authors, 2017). This demand side focus we develop through the focus on knowledge work practices and structures.

3. Empirical Approach

3.1 Research Context: The work of HSAs in Malawi

Malawi is a developing country in Southeast Africa faced with a heavy disease burden, a very poor health system and low levels of professional medical personnel (UNDP, 2015). HSAs comprise the biggest health work force in the country (Kok and Muula, 2013), providing care to 85% of the national population, residing primarily in rural areas (UNDP, 2015). HSAs are formally employed by the Ministry of Health (MoH) and attached to rural health facilities but provide care in about 10 villages each, comprising an average of about 2286 people. Typically, health facilities are at average 7.2kms away from their catchment areas.

Upon recruitment, HSAs get 6-8 weeks training by the District Health Office (DHO) on how to deliver both curative and preventive services, relating to disease surveillance, mother and child health care, sanitation monitoring, nutrition guidance, patient follow up, and enabling referral transfers through the sharing of information between communities and health facilities. In maternal and infant health services, which is the primary focus on this paper, HSAs conduct patient follow-up activities, counselling, treating simple illnesses, making referrals, educating communities, and conducting monthly outreach activities such as for child growth and immunization monitoring. They also perform significant administrative tasks relating to data, including the recording of data in diaries or registers, compiling of summary reports and their transmission to higher administrative levels. To support care giving and data related tasks, a Mobile Health system (MHealth) was introduced, which is the focus of analysis for this paper.

The case study focuses on the analysis of a mobile health system (MHealth) introduced into the world of work of HSAs to help provide care and support reporting functions. This application was designed by a third-party organization to assist HSAs in decision making when attending to expectant mothers and infants. The system was based on existing paper protocols that were incorporated into the mobile phone to help take HSAs through a step by step analysis of expectant mothers' and infants' health conditions. It guides them to make diagnosis and treatment choices. The MHealth application is flexible and expandable and new conditions have been incorporated such as for malaria, pneumonia, malnutrition among others. While the MHealth application provides decision support, the final decisions are made by the HSAs.

3.2 Data Collection methods

The study follows an interpretive research approach with an aim to get HSAs' interpretations of their work and knowledge practices and the role of ICTs in enabling (or not) this process. Walsham (1995) has described that interpretive case studies in IS research help to develop thick descriptions of the human-ICT interaction in contexts. The first author visited Malawi for a period of four months during data collection involving a combination of various qualitative methods such as open-ended semi-structured interviews, focus group discussions and observations of HSAs work practices in villages (during home visits and child monitoring exercises) and at the health facilities. In semi-structured interviews, the researcher invited HSAs to describe their work, the guidelines followed when conducting various activities and their experiences of using the MHealth system. These interviews helped to understand how knowledge practices were enacted and organized.

Thirty-three HSAs were interviewed between September to October each in 2015/2016. In both periods, HSAs were first interviewed individually and later in a group of 6 in 2015 and 12 in 2016. Group discussions helped to understand how collectively HSAs conducted and made sense of their activities. Two HSA coordinators were also interviewed to establish how knowledge guidelines to conduct work are established for HSAs and their shared experiences in using them through the paper and the MHealth system. Finally, three health personnel at the health facility to which HSAs are attached were interviewed to understand their interactions with HSAs and the knowledge structures at play. Data collection was also done through informal discussions and observations of HSAs' work in communities and at the health facilities. The researcher also joined in a planning meeting where the HSA coordinator oversaw assignment of duties to his colleagues, including relating to child growth monitoring exercises. Work practices were observed in the communities to develop insights into HSAs' work, especially what they did as compared to what they said they did.

3.3 Data analysis

During data analysis, field data was transcribed and organized from field notes and audio recordings. First, the two authors compiled raw data into themes of related findings through extensive readings of the primary data and discussions around it. The themes generated were further elaborated upon and made coherent by discussing them in context of examples and relevant field quotations. We went back and forth between the transcribed primary data and emergent themes to make increasing sense of the data, and discern relationship between the themes. Key themes identified were around the activities HSAs did, how they did them, including the everyday practices involved, the underlying knowledge that is drawn upon, and experiences with the MHealth system in influencing these practices. We then related these themes to the theoretical basis of the agency-structure relationship, through the lens of knowledge practices.

4. Findings

HSAs conduct a wide range of activities, for which they receive a single training at the beginning of their careers from the MoH, the DHO and a fellow HSA coordinator who provides field supervision. This training provides HSAs with the "initial stock of knowledge", which is further expanded and revised through their everyday work practices. However, formal training was rarely refreshed, implying that HSAs primarily

rely on their memory, experience, peer support and improvisations in the field. We now elaborate on three sets of HSA knowledge practices that were inductively generated from data relating to; curative care, preventive care, and communication. These three categories are not exhaustive of HSAs' work but are relevant to our analysis of the practices related to knowledge. We summarize the knowledge practices in HSAs' work, and the changes with the MHealth system.

4.1 Curative care knowledge practices

HSAs engage in curative care which concerns treating some simple illnesses like cough, fever, diarrhea etc., and administering basic drugs. They used as job aids, paper forms and registers with guidelines on how to address different health conditions. For instance, to treat expectant mothers, the maternal health registers guided HSAs in identifying danger signs and symptoms, and deciding on a course of action which could involve referring the patient to a health facility or providing her with simple treatment and counselling. Similarly, infants were mostly referred to the health facility and later followed up by HSAs in their respective villages. HSAs maintain a list of women of child bearing age (14+ years) to whom services on maternal and child health are targeted. This list is revised and updated every 3 months. Registers thus become an important "stock of knowledge" which shapes HSAs' work including the use of these guidelines and updating registers.

"...while visiting an expectant mother at a particular time in her pregnancy, we learned that we use particular counselling cards to educate a woman. At the first home visit to an expectant mother, we use four cards. On the second visit, we also use four cards to counsel the woman. After birth, we make 3 home visits between the first 24 hours, the first 3 days and 8 days and we use different cards respectively" (HSA coordinator).

However, specialist knowledge is needed to guide the HSAs in knowing which cards to use, which is shaped by their initial training and their everyday work experiences. See figure 1 for an example of a counselling card used to educate pregnant women, and figure 2, for an example of a mobile phone based protocol.



Figure 1: Example of a counselling card showing best pregnancy practices and danger signs

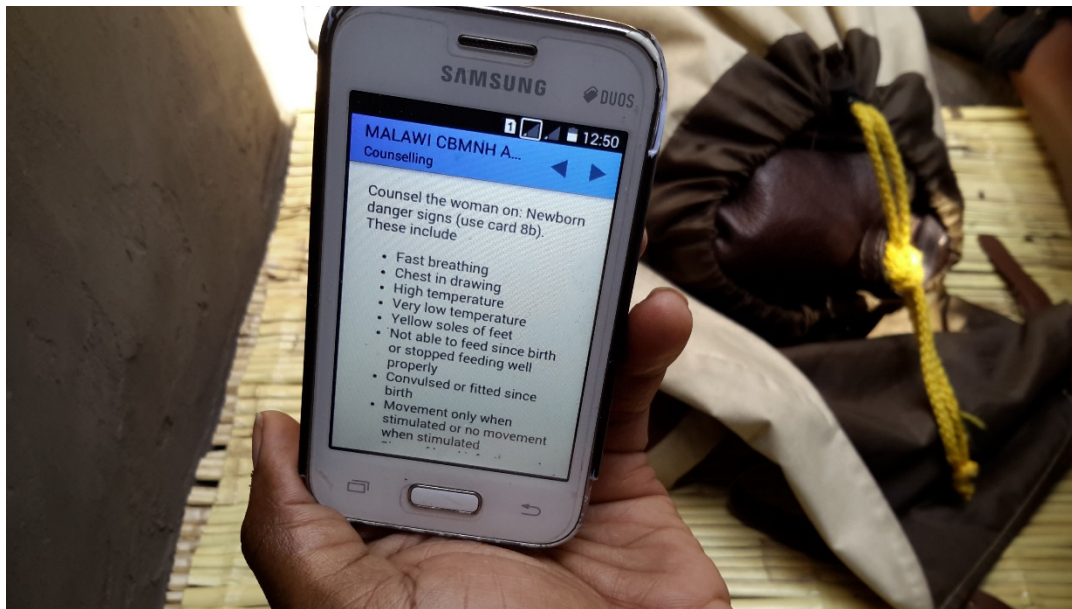


Figure 1: A section of the MHealth system showing instructions to a Health Surveillance Assistant

Curative care also involves educating patients and communities on how to take care of themselves and their infants to prevent the re-occurrence of diseases. This work was previously dependent on the guidelines given in the registers to HSAs which allowed them to ask patients various pre-defined questions and based on their responses regarding signs and symptoms, to make a diagnosis. Depending on how serious the HSA determined the condition to be, the patient would then either be treated locally or referred to a health facility for higher level care. Currently, all HSAs have almost entirely replaced paper register guidelines with the MHealth system in the field. HSAs attributed this smooth transition to the system's ability to facilitate their making of quick decisions through following a standardized process of assessing health conditions and offering them a precise course of action to take.

"It is so fast and easy to use. After I enter signs and symptoms of a patient into my smart phone, it then says to either refer the child or woman to the health facility or treat them with prescribed medicine. If it is a home visit to an expectant mother, after I have entered the information, the system says, counsel the woman using card number this...we use cards when educating expectant mothers. The cards have different information and are used differently according to the stage in a pregnancy and information we get from the mother." (HSA)

Although there is a primary dependence on the MHealth system for curative care giving, HSAs are still required to make paper reports for which they manually transfer data from their mobile phones into the paper register at the end of every day. Aggregated reports are made from these registers and physically delivered to the health facility where they are further aggregated into an overall health facility report which is then submitted to the DHO and later to the MOH. Notably, some registers had been eliminated by HSAs, for example, the sick child assessment form, a paper tool previously used to screen and assess danger signs in children was now fully included in the MHealth system.

Other than being fast and efficient, HSAs also felt that the application helped them to avoid forgetting important information crucial for making a diagnosis, as was the case with the paper forms. With the MHealth system, all sections needed to be completed before the HSA could proceed thus ensuring completeness of information. However, HSAs noted some limitations to access the electronic information when the mobile was down due to low battery or electricity being unavailable, forcing them to revert to the paper guidelines. In some cases, they relied on solar chargers to make their phones operational again. Some HSAs needed to trek to the health facility to access electricity to charge their phones. As a result, the HSAs relied on both the old and new forms of guidance inscribed as knowledge on paper or their phones to make decisions. Interestingly, they felt that they did not lose their potential or self-knowledge with the new system.

“We are not losing our potential to make credible decisions because we are going back and forth between the papers and the smart phones especially when the batteries are low” (HSA).

“The phone helps us very much in making decisions. For example, after assessing a child and you have entered all the signs and symptoms, the MHealth system says that treat this child with this medicine or refer them. And if the phone is not working, we go back to the old way of assessing with paper forms and coming up with decisions ourselves. We go back to using the knowledge we have and not having to depend entirely on the phone. It is not as quick as the phone, but we do it.” (HSA)

4.2 Preventive care knowledge practices: follow-up and education

For HSAs, preventive work involves activities to prevent disease outbreaks and health shortages in their communities. Often directives come from the MoH on what education topics to give to communities, for example in times of disease outbreaks. For topics on preparing for childbirth, these are conducted routinely during home visits and HSAs follow counseling cards to illustrate safe childbirth and infant care. Sanitation and nutrition inspections also involve educating community members how to care for infants and themselves based on paper guidelines from the MoH. Where the MHealth system included the required protocols, those were used. For example,

“Yes, we use them both [paper and MHealth system]. It is actually very good because before when we used the paper registers, we had to decide by ourselves which cards to choose as guidelines to educate expectant mothers. We use 11 cards and deciding on what counseling card to use, depends on several factors. One; the trimester of the pregnancy. We give expectant mothers different information at each stage. For example, in the first trimester we emphasize, nutrition and how to take care of oneself through pregnancy. We emphasize identifying danger signs. In the last trimester, we also emphasize identifying danger signs and preparing for child birth. However, we sometimes forgot to ask some questions when using paper registers and it therefore meant that we based our decisions on inadequate information. It was quite hard to choose among the 11 cards on our own. But now it is easier as the phone recommends which cards to use based on information entered. You can’t skip asking questions in the system as you cannot continue. This is unlike the paper forms.”

Preventive care involves combining new and old guidelines to provide maternal and infant care in villages. In addition, another important aspect of preventive work involved following up expectant mothers and infants after an initial point of care contact. This was important in catching any early danger signs to prevent maternal and infant mortality, and to immediately refer them to a higher facility. Post their referral visit, patients were followed up in the villages by the referring HSA. HSAs previously had to arrange and organize follow up activities using their paper registers. Based on the registered number of patients, they would have to go through multiple registers to establish which patients in the communities needed to be followed up and when. This was indeed a time taking and laborious task, and often led to missed patients. Often registers were destroyed due to rains leading to the loss of important patient information. The MoH often delayed in giving new registers, and HSAs would improvise by rubbing away old patients' information in the existing registers to make space for new entries. This improvisation sometimes made it impossible for HSAs to keep themselves updated on who to follow up or not, and could not organize their everyday activities effectively.

The MHealth system allowed HSAs to capture and store individual patients' data and marked the follow up cases with three red dots. HSAs learned to organize follow up activities on their phones as it was easily visible on who to follow up or not. If a child was treated or referred by the HSA, it became impossible for the HSA to forget doing the follow up. Sometimes following up patients was compromised because a parent did not return with their child to the village clinic. Overall, it became easier to follow up patients, as the system did not allow infant cases to stay redundant, and it was impossible to continue with a case without previously following it up. Also, since redundant cases were seen by supervisors, they would require HSAs to conduct follow-up activities. Considering that HSAs worked with health facilities, they often knew by name which of the referred women had shown up or not at the health facility. The clinicians at the health facility used a health profile card which HSAs checked to verify if mothers had received treatment. The HSAs would also call the health facility, often during emergencies, to find out if a referred case was handled or not.

4.3 Communication related knowledge practices

Communicating events, making and responding to inquiries are crucial activities in the everyday work of HSAs. HSAs act as the link between the community and the formal health system, making communication crucial. Since HSAs are attached to designated health facilities serving pre-defined catchment areas, they are required to communicate events and activities happening in their communities. Traditionally, such communication took place through monthly paper reports submitted to the HSA coordinator, who would then aggregate and transit for upward reporting. There was typically, no feedback received by HSAs on these reports. Using the MHealth system was however changing the ways of reporting to the DHO. Instead of aggregated reports, data was now simultaneously captured into the organization's database as HSAs attended to patients in their homes, enabling more real-time reporting and greater control. It also imparted greater visibility and appreciation for their work. Considering that the MoH and the district both expected reports, HSAs opted for the MHealth system that simultaneously captured and transmitted data in the field and later transferred it into the paper registers which they subsequently aggregated to deliver monthly reports as previously. HSAs

therefore transversed between the new and the old methods to conduct their everyday work.

Communication in the form of inquiries to the health personnel at the health facility occurred when HSAs were at the health facility, typically on a Monday when HSAs weekly planning was done in consultation with the other health staff. Visits were limited to once a week because of the distances involved and travel costs. This has however changed as now many inquiries took place through phone calls and messaging even when HSAs were in their villages. The HSA coordinator also passed on information to HSAs in villages using WhatsApp informing them of activities at the health facility. Previously messengers were utilized to transfer information, but now this was done electronically, as one HSA noted;

“We sometimes call the health personnel when we have urgent inquiries about what to do. If for example I need to give a child first aid before I send him on his way to the health facility and I am not sure about what to do, I have a choice to either call a colleague or a professional medical person. They usually tell us what to do and to send the child immediately to the health facility”.

Communication also is important in the communities. Often HSAs passed on information about health activities to communities during health exercises like immunization. Community inquiries were also answered during visits to the village clinic or a home visit. However, this communication practice was altered with community members making some inquires over phone. HSAs still emphasized in some cases physical meetings with mothers and infants in their homes or at the village clinic. Sometimes HSAs would call an expectant mother to follow up and ascertain if she went to the health facility for referral care. The HSA's phone number was also displayed at the village clinic and s/he could be reached any time in case of emergency in the community. Previously, the HSA only wrote important communication on the village clinic wall to pass on information about when and where activities were to be held.

In villages, the Village Health Committees (VHCs) traditionally formed a network of selected members from a village to pass on information to other members in their villages. This group helped HSAs to identify expecting mothers in their villages, and register them in their paper systems. After their identification, relevant data such as; age, health condition, and address of the mothers was also captured in the MHealth system for follow up throughout the pregnancy period. If any danger signs were registered, mothers were immediately referred to a health facility. Usually the VHCs meet once a month with the HSAs to communicate community events. There were also some impromptu meetings to share information, which now no longer required physical movement as VHCs and HSAs had learned to communicate some events on their phones, such as related to mobilizing activities for child growth monitoring and community education.

Communication amongst geographically distributed colleagues used to happen through the HSA coordinator as a mediator. Often HSAs requiring assistance in their catchment areas had to make their requests during the weekly meetings at the health facility. The HSA coordinator also passed on information to other HSAs detailing ways in which they could assist those needing support. HSAs have now reversed their way of working by bypassing these protocols to respond directly to requests for assistance. They created a

WhatsApp group in which communication was coordinated without relying on the weekly meetings and the HSA coordinator. One HSA said:

“We have a team working spirit enhanced even more with the mobiles because we share information about events in the field and solve situations among colleagues and our supervisors.”

The HSAs coordinator mobilized required logistic supplies and drugs for HSAs every month, involving a paper trail including the community, the health facility in-charge up to the DHO. With the MHealth system, HSAs learned to make drug requests through SMS directly to the DHO, and received drugs much earlier than before. This mode of communication was dramatically different from the earlier paper trail.

4.4 Summarizing: Knowledge practices in HSA work

With the advent of the MHealth system, there were significant changes emerging in the everyday work of the HSAs in the villages. The MHealth system integrated some of the existing paper protocols and extended traditional knowledge guidelines, and HSAs were trained on its use. Unlike in the case of traditional paper registers, the system developer sought HSAs' feedback to help improve the MHealth system. For example,

“Before the mobile system, every fever was treated as malaria. There was no provision for doing the malaria test in the paper guidelines. It was one of the things we deliberated about, and the organization added a section in the system requiring us to do a malaria test. A fever could be a symptom of something else. Now we are required by the system to do a rapid malaria diagnosis test (MRDT). Every fever is not always malaria. This year (2016), the requirement to do a malaria test was added to the system. This is not possible with paper forms such as the ‘sick child assessment form’ that we previously used to assess health conditions of children. We are each equipped with drug boxes in our village clinics that contain drugs and other medical kits like the rapid malaria diagnostic test.”
(HSA)

As they interacted with the MHealth system, HSAs generated new ways of doing things in the field and some previous mistakes could be avoided. For example, determining a woman's gestation period became easier by recording the woman's last menstrual period which helped them estimate the stage of the pregnancy. This was not possible with the paper forms and women often had to themselves estimate their pregnancy timeframe. Also, determining a woman's age became easier because the system required their date of birth and not just rounded off figures. Given many of the women could not count, the system enabled a more accurate capture of their ages.

Although HSAs got initial training in the beginning of their careers, there were no subsequent refresher trainings as earlier noted. In its absence, HSAs needed to reinforce their knowledge primarily through everyday practice, even though some mistakes could take place when treating expectant mothers and infants. The MHealth system to some extent contributed to filling this knowledge gap.

“We were trained on how to use the phone to treat children, expectant and lactating mothers. We must visit a woman at least two times during her pregnancy, and 3 times after a birth and we use our phones. The phone reminds you on which patients in the communities to follow up. We combine the phone with counselling cards and based on the

information you enter, it recommends what card to use to counsel a woman....it was difficult to use the phone in the beginning, but we are now used to it. It is faster than the paper where we had to think a lot about a decision” (HSA)

The system was easily accepted by HSAs as part of their everyday work and decision making. The paper system was now only used when the phone batteries were low. As the paper system was gradually replaced, community members became receptive of this system and started to conceive of HSAs as knowledgeable “village doctors” performing higher level work:

“More people are coming to me because they have more confidence in my ability to deliver with the phone. Community members trust our skills to treat them and address their health concerns, but this level of trust has even increased with the phone.” (HSA)

“I feel more qualified and confident to attend to expectant mothers and infants because of the decision support I get from the MHealth system. The system guides me through a step by step process. I ask mothers questions and they must recall for example if a child was vomiting, has been unconscious before. They must also recall knowledge from previous discussions. We share more knowledge with the community because of the extra things we now do with the MHealth system” (HSA).

In this section, we have summarized some key practices enacted by HSAs using the MHealth system, and the kind of knowledge related changes it reflected as compared to the previous practices. Across the practices of curative care, preventive care and communication, paper registers formed the basic guidelines embedded with rules and resources on how to accomplish tasks. For example, the sick child assessment form formerly facilitated care giving to infants. The maternal health registers guided care giving to expectant mothers. As care guidelines were inscribed in the MHealth system, HSAs innovated various knowings and utilized the MHealth system across their practices. For example, although the MHealth system was solely preferred in care giving, a hybrid of paper and MHealth system guidelines were used in preventive work. Where internet and electricity challenges constrained phone use, HSAs learned to go between the old (paper forms) and new (MHealth system) knowledge guidelines. The knowledge component earlier across the practices was mostly guided by paper forms but HSAs accommodated new ways of knowing as they used the MHealth system. For example, new ways to communicate and incite feedback. We now present an analysis of the case.

5. Case Analysis

This analysis is situated in the context of our two research questions; what are the missing or inadequate structures in the context of ICT4D projects that may impede their sustainability? And, how can agency be developed and expressed to help cultivate these missing structures to strengthen sustainability?

5.1 What are the Missing Structures and Their Influence on Sustainability?

In this paper, we have focused on describing the knowledge practices undertaken by HSAs and their shared sense-making on how they got things done, the knowledge required to do so, and the new knowledge and related practices in play. We have argued that a neglect of users’ agency and emphasis on supply driven efforts in MHealth systems have impeded sustainability. Especially because they overlook locally enabled improvisations that can ground sustainability of ICT4D projects within local capacities

and contexts. We discussed the early knowledge that HSAs were equipped with at the time of recruitment and how this evolved over time with using the MHealth system. Paper forms always formed a basis for formalized operating rules that mediated most of HSAs' work practices and representations (Hecker 2012). They tried to make sense of the knowledge embedded in paper forms and how it guided their work. We have tried to understand how HSA practices with the MHealth system raised and influenced existing structures to create potentially new ones. These practices reflect their reflexivity and innovative knowing in practice (Orlikowski 2002; Argote and Miron-Spektor 2011) generating new practices. However, these practices need to be sustained, requiring supporting structures, which we next discuss.

5.1.1 Infrastructural related structures

In our case, relevant infrastructure consists of aspects of electricity supply, the battery of the phone, access to its charging, and travel distances between the villages where HSAs provide care, and the health facility to which they are attached. Infrastructure related structures refer to the material and symbolic properties of these infrastructural conditions which exist as rules and resources in memory traces of the HSA which they draw upon in shaping their everyday work practices. The HSAs understanding of the lack of electricity supply in certain regions, kept them aware that their phones cannot be in constant use, and so prepared them to rely on their paper protocols. Their emerging practices thus involved a hybrid of the electronic and paper based, leading to new knowledge practices on how and when to transition between the two. Similarly, the material condition of distance was seen "conquerable" in addressing routine matters, like answering queries, through the phone. However, for certain matters, like treating a high-risk pregnancy, physical follow up was seen required by the HSA.

Arguably, infrastructure related structures required to sustain reliance on completely new knowledge practices are more extensive than what is currently available. Curative care, relating to making a diagnosis, has taken on elements of both the new and old knowledge guidelines, and now no longer only dependent on paper forms. New practices are also emerging to try and deal with these limitations, such as the use of solar power supply when some rural areas are not connected to the national electricity grid. Collectively, the HSAs have shown a definite preference for the MHealth system, but need to often improvise on their practices in different conditions.

One may ask the question of how the practice of individual HSAs in certain isolated rural areas can have influence on strengthening or expanding national conditions of rural electrification or making improvements in road networks? Directly, and in the short run, the answer will be no, the HSAs cannot influence these macro structures. However, indirectly, and in the longer run, some alternative practices and supporting structures may emerge. For example, if the sporadic use of solar-based phone charging is seen as a feasible alternative, the authorities may introduce policies and budgets to provide for such supply on a more systematic basis. This can be an enabling structure in a country where strengthening the rural electrification program, requiring significant budget allocations is not easily forthcoming in a resource constrained setting of Malawi. Expanding self-reliance of the system through designing locally relevant frugal solutions will contribute positively towards sustainability. But first, existing practices must establish these solutions as feasible.

5.1.2 Training related structures

Training related structures consist of the availability of competent trainers, adequacy of budgets, and policies in place to impart training especially refresher ones to renew HSAs' knowledge skills, upgrade guidelines in both the paper and MHealth system, and possibly provide trainings closer to HSA centres. Currently, the MoH controls the training content limited to introductory training and passes it on to HSAs in paper forms. HSAs see formal training systems as inadequate, not reflecting their renewed work practices, and rely on their experiences and that shared with other HSAs. They locally learn how to transverse between the worlds of the MHealth system and paper, and under which conditions each work. Since paper guidelines are also limited, and the MHealth system at times inaccessible, HSAs make mistakes such as in mis-diagnosing malaria or forgetting to ask questions while attending to patients. Given that learning on the job is preferred and potentially less expensive (than going to the DHO), the authorities need to enable structures (such as online support) to guide HSAs in times of need. Or HSAs could use their WhatsApp group to try to strengthen and access peer-to-peer support.

In preventive work, HSAs combine paper forms such as counselling cards with the MHealth system to educate masses on health issues. Enabling structures of training need to be established especially in cases where guidelines are only paper based. Simultaneously, the MHealth system developer needs to be contracted to continually upgrade the application to gradually incorporate all existing paper guidelines and also to include new ones. Enabling training structures could also be created through online means, given the HSAs' high degree of comfort with using mobile phones. Such enabling structures may potentially lead to new knowledge practices where HSAs learn online, and support their peers through similar media. There is of course strength in the HSA being able to transverse between the paper and the phone, as all the use cases that HSAs must engage with in their everyday work of care are not covered by the MHealth system. Training content thus needs to be sensitively designed and administered which keeps at its core the existing work practices HSAs experience, and the gaps they see. Practical experiential knowledge of HSAs is key to providing effective care, and their work practices need to be nurtured, and not be totally dictated by the ministry guidelines, making them mere "robots". Training content and methods should support work practices that allow HSAs to transverse between the old and new worlds of work, and to take advantage of the media that works best for them in particular situations.

5.1.3 Reporting related structures

Reporting related structures concern the channels of information flows from the community to higher level authorities and back, and reflecting the content of what flows and by what media. The MHealth system with its material and symbolic properties represents a new media that has allowed for novel reporting procedures and practices to emerge, inscribing different forms of knowledge. Electronic daily data reporting emerged parallel to HSAs' care and preventive work. HSAs learned to work and report more data using the phone. Although traditional reporting structures still hold strong (following the bureaucratic paper trail described), these need to be revised by creating formal online reporting structures. Several similar technology initiatives in healthcare exist in Malawi without much clarity as to where health data is stored (Chikumba and Kaunda, 2013). Often this leads to data security issues, parallel reporting and fragmentation of the national health information system. This requires structures of new policies of reporting

that build upon the online reporting practices, while providing stronger regulation of data privacy, security and access. These include policies to ensure that data collected by third-party players and various technology supported health systems is well protected, transparent and interoperable with the national health information system. Furthermore, infrastructure related structures concerning server hosting and supporting guidelines need to be created to continue and encourage the practice of online reporting.

New reporting structures related to feedback need to be created to enhance learning and to match the speed by which HSAs can now send data over the phone. Currently, in the traditional reporting structures, no feedback is given to HSAs who consider their reports to only serve a bureaucratic formality. These structures need to shift where reporting is seen by HSAs as a mode of learning and for enhancing the visibility and status of their everyday work. Such feedback structures can also strengthen those relating to training and providing more on-the-job support. An active mode of exchange of information from the HSAs and higher authorities like the DHO can provide incentives to both sides to strengthen reporting, make improvements in data quality and use, and provide for more active support and various others. Such enabling structures thus help to encourage work practices and with it the emergence of new knowledge practices to develop through the interactions. For example, in the initial phases of using the MHealth system, HSAs were encouraged to give feedback on their experiences with the system which helped to further evolve the system and encourage HSAs to use it. With such feedback loops, the system can then evolve depending on users' context creating new knowledge structures that help HSAs to respond to emerging needs and dynamic situations. Such loops help sustainability by allowing the system to adapt better to its local contexts (Maruster et al, 2008) and by providing the space for improvisations to thrive (Sanner, 2017).

5.1.4 Knowledge learning structures.

There are currently no knowledge sharing structures to ensure that emerging practices in the field are made visible to the rest of the health system organization. From the empirics, most of the new knowledge practices are emerging in villages where HSAs conduct their work far away from the formal health system. They have learned to remain invisible from the wider health system organization especially since there is limited feedback regarding their work. For example, some communication practices went by unnoticed as HSAs learned to communicate without their coordinator's mediation. For consultations among colleagues, coordination of collaborations, the HSA coordinator previously played a pivotal role in arranging these activities while ensuring that work activities were supervised. However, HSAs bypass the HSA coordinator by rearranging these activities themselves via communication platforms like WhatsApp making them invisible to the health system. Current monitoring and coordinating mechanisms are lacking in integrating technology based activities into the organization of the health system. Supervision for example should be extended to ensure that communication and work activities among HSAs and health personnel do not go unnoticed. We have already noticed that paper forms such as the 'sick-child assessment form' have been cut from HSAs' work as their own initiative without their supervisors' knowledge. Therefore, there should be guidelines describing expectations with technology mediated work. We suggest that knowledge sharing structures (Argote and Miron Spektor, 2011; Jasimuddin, Connell and Klein, 2011) are put in place so that HSAs emergent knowledge practices are captured and shared by others. The WhatsApp platform forms an informal social network

for sharing new knowledge practices, but this is only among HSAs. Knowledge repositories can be used to capture experiences from the bottom to the top to strengthen knowledge sharing structures in the health system. Emergent practices should not remain closed to individual HSAs but circulated across various villages and shared with others. In addition, the knowledge repository also acts as a resource that can be used to monitor work not seen by the HSA coordinator for instance.

5.2 What kinds of practices need to be in place to enable or sustain those structures?

The above discussion presents an opportunity for understanding how ICT interventions may be sustained in an organization through enabling the development of supporting structures for enabling and sustaining new knowledge practices. HSAs are seen to reflexively reconstruct their knowledge practices by enabling new ones and also through combining the old and the new. However, for these practices to sustain over time, they need enabling structures which themselves have to be continuously renewed to remain relevant. Practices and structures need to evolve in a mutually constitutive manner (Giddens, 1984; Orlikowski, 2000). In Table 1 below, we summarize the discussion from the above analysis and identify practices to mold required structures for sustainability.

Knowledge practices	Existing knowledge Structures	Required structures for sustainability	Existing gaps	Intervention to fill the gaps
Curative care	Large dependence on phone procedures Use of paper based guidelines.	Infrastructure-electricity and internet coverage	Poor power supply Limited refresher training Protocols not easily updated	Providing policies and budgets for solar energy Offering on the job support Enabling frequent feedback
Preventive care	Hybrid between Paper based and Phone guidelines.	Training. Infrastructure-electricity supply.	Delayed paper form deliveries. Inconsistent training.	Availing online support. Backing Peer-to-peer support through platforms on the phones. Upgrading paper and MHealth system guidelines. Supporting feedback Offering consistent training with content to fit old and new work worlds. Providing policies and budgets for training.
Communication	More reliance on mobile based rules and resources for	Reporting. Knowledge sharing	No clarity about online reporting. Limited feedback	Creating formal online reporting and data checks. Providing server

	communicating, collaborating, mobilization and reporting. Paper guidelines largely endure for routine monthly paper reporting.	structures.	mechanisms.	hosting and supporting guidelines to support online reporting. Providing active feedback between the top and HSAs. Creating supporting monitoring and supervision Encouraging data use, data checks Developing standards for online and paper reporting
Using the MHealth system	Phone based.	Infrastructure-full electricity coverage.	Poor power supply. Knowledge sharing	Providing clear feedback mechanisms. Making timely system upgrades. Creating clear monitoring and supervision mechanisms. -Providing shared knowledge repositories.

Table 1: Summary of Analysis

From the analysis, HSAs practices have taken on a hybrid of paper and MHealth systems inscribing new rules and resources for conducting everyday work. HSAs have learned to go back and forth between their new and old guidelines depending on their contexts, leading to the emergence of new knowledge practices in care giving, preventive work, and communication. The MHealth system use and non-use significantly mediates these practices, both in enabling and constraining them. These new knowledge practices require enabling structures, proposed above, some of which are currently absent or inadequate. We next discuss the practices required to mold and redefine these structures.

Feedback practices, currently absent, provide a positive opportunity to evolve using the MHealth system. HSAs can potentially create and share new knowledge practices in care and preventive work with their peers and authorities by engaging in systematic and periodic feedback, and also reaching out for support in times of need. Feedback has the potential to aid the MHealth system's evolution with consideration of users' needs, and the inscription of new knowledge. Regular feedback from superiors in addition to enhancing their knowledge of the field, will signal to HSAs that their work is visible and appreciated, and further encourage the strengthening of work practices and reporting structures. This process will lead to the improvement of data quality and data use which encourages the development of new knowledge structures.

Although feedback in terms of data reporting especially from the field by HSAs is important, these need to be supported by additional structures responsible for monitoring data quality assurance and taking required interventions spanning both online and traditional reporting. These data checks by the MoH should emphasize a consistent and ongoing integration between online and paper reporting, and the generation of more uniform standards spanning the national health information system. Reporting structures should be revised by the MoH in accordance to the country's data needs and encouraging the development of new knowledge practices. In addition, data use needs to be encouraged as a practice at both the top and local levels for the standards to be shared and evolve in quality.

Furthermore, training practices are required to shape new training structures that accommodate both paper and technological mediums and sensitively mediate the work practices of HSAs. Training ensures that local capacities are cultivated to provide knowledgeable work in preventive care for instance and shape how systems evolve within contexts. In addition to training, vigilant supervision by superiors can strengthen HSAs' work in accordance to given training and monitoring of emerging knowledge practices. However, currently there is negligible training which constrains rather than enables evolving HSAs' skills and practices. Consistent and periodic training practices are required to accommodate these two mediums of HSAs' practice in the poor infrastructure context. Network and electricity infrastructures are a challenge often requiring the use of both paper and MHealth systems. The government should allocate policies and budgets to engage in more energy production to build energy infrastructures that sustain MHealth initiatives.

6. Discussion and Conclusion

This paper investigated the crucial ways in which knowledge practices shape structures. Although, it was beyond the scope of this study to see how structures were actualized in practice, typically a long-term process, we have emphasized how human agency and practices can be cultivated to mold certain kinds of structures especially those relevant to bolster sustainability. To place this discussion into context, we return to our main arguments and discuss their implications for research in information systems and organizational studies.

Firstly, our study complements research relating to mediums and mediums specificity of knowledge practices in organization studies (Lanzara, 2009; Hecker, 2012). Lanzara has argued that practices are shaped by the material mediating influences of the medium through which they are performed. This argument responds to Orlikowski's (2006) observation of the disregard of material matters in organizational knowledge which adversely influences our conceptualization of knowing. She puts forth the metaphor of scaffolding to understand the material and social intertwining in knowledgeable work, and how technologies both give support and are a means towards accomplishing knowledgeable work goals by human agents. Similarly, Lanzara (2009) has observed that knowledge practices are dependent on mediums in which they are formed and live. Although we have emphasized the role of human agency and its interpretations around MHealth system use, we are not oblivious of the materiality aspects and so is Giddens. He argues that material allocative resources such as land (even ICTs) with material properties can become resources when incorporated in the structuration process (Giddens

1984). That is, when they are implicated in human agents' actions. His later work (Giddens and Pierson, 1998), also observes that material aspects like technology can influence social practice, but this depends on how social agents engage with it in their actions and social practice (Jones and Karsten, 2008). Care protocols are inscribed in the technology which HSAs instantiate in their recurrent care practice making us account for people, technologies and their social practices. Our findings show HSAs' knowledge practices traditionally dependent on paper based registers, but new practices emerge when their work is mediated by the MHealth system. Interestingly, these emergent practices are dependent on existing work context, structural resources, the technology itself and the associated skills to use it (Lawrence and Suddaby, 2005; Timmemans and Berg, 1997). The going back and forth between different material forms, such as the old (paper forms) and the new (MHealth system), leads to creating improvisations by HSAs, and is also a means to cope with their poor and uneven infrastructural setting. HSAs' agency and knowing enacted in practice is entangled with the materiality of both paper forms and the design features inscribed in the MHealth system. Emergent practices and the resulting knowing are situated in the entanglement of human agency and the material performativity of the MHealth system. Seeing the interaction of HSAs with their work networks and contexts allows us to analyse the changes in work and the emerging practices afforded by the material performativity of the system. Some properties of the MHealth system for example the care protocols, are materialized with enacted practices (Orlikowski, 2002) creating shifts in care giving – preventive and curative work, and processes of communication.

We have argued for a shift from the dominant attention on the influence of structure on agency to contribute towards empirically establishing the reverse. This takes our research from a techno-centric approach that sees technology as stable and neutral, to an agency-structure analysis. We could be criticized for a preoccupation with the social and human constructs and interpretations of technology use, backgrounding the materiality of technology (Orlikowski, 2006). We respond by acknowledging and elaborating the intermingling of the social and material in emergent practices and resulting knowing in HSAs' work. We produce insights into how the materiality of these mobile systems structure human agency, their work practices and with this their knowledgeability over time. For example, enabling consultations and other communication over time and space on the WhatsApp platform provides HSAs autonomy and avoids the gaze of their coordinators. Simultaneously, the system compliments their work by offering support on taking decisions whilst engaging with care giving. While these were previously only dependent on HSAs knowledgeability, they were now deeply mediated through the MHealth system. But of course, the use of the technology also demands a new form of knowledgeability from the HSAs.

Secondly, we show the importance of examining reflexivity of social agents and its implications on broader social structures (Ellway and Walsham, 2015). Orlikowski (2002) has suggested using the sociological work of Giddens (1984) to understand practices of knowledgeable work which offers insights into the reflexivity of knowledgeable agents whose knowing is not stable but is enacted through everyday practice. We have adopted Giddens (1984) ideas on structure and agency to reflect the reflexivity in the work of HSAs, focusing on understanding emergent practices that develop from HSAs' interaction with the MHealth system in their work. Our contribution has been in

furthering an understanding of how these emergent practices can in turn mold structures that can better sustain the MHealth system in this work context. For instance, new care, consultation and communication practices required knowledge structures to be retained and spread into the broader health organization system. In addition, we provided rich accounts of reflexivity and detail how some material properties of the MHealth system shape human agency. For example, paper based care protocols previously directed care when attending to expectant mothers and infants, but HSAs were prompted to replace the paper forms with the MHealth system due to its efficiency. This empirical work provides a theoretical building block to elucidate important social and material properties of agency that facilitate and shape broader social structuring.

Thirdly, we also contribute to research on sustainability of ICT initiatives. We further previous accounts of how practices emerge and the role of actors (Orlikowski, 2006; Barrett and Walsham, 1999) by arguing how they need to be maintained and sustained (Lawrence and Suddaby, 2005), including incorporating the role of technology. This analysis is especially relevant for MHealth initiatives challenged with discontinuity in many developing contexts. We extend Giddens ideas on structures and agency by including a technology dimension, to not only understand technology and social change but also develop practical means to sustain them through locally born initiatives.

Our analysis has been crucial to revisiting the structure-agency debate in IS studies. It offers a distinctive perspective that accounts for the linkage of micro level actions and practices to wider social structures of health systems in which ICTs are increasingly implicated. We suggest that future research should critically utilize Giddens' work especially where it provides insightful perspectives on agency and the role of technology. And like Jones and Karsten (2008), we observe that Giddens' work has potential to inform IS research and in turn for IS research to develop it. This is not to put it over other social theories. We suggest for future research to also critically consider Giddens' later ideas that may be more relevant to IS research and phenomena.

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