

Towards Re-Calibrating the IS-Notion of Affordances

An Affordance Perspective on the
Implementation of a Platform-based
Education Management Information System
in The Gambia

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To Ingunn,

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Abbreviations

AIF	Affordance identification framework
AT	Affordance theory
DHIS2	Until 2022, an abbreviation for District Health Information Software 2. From 2023, DHIS2 is the official name of the software platform. ¹
DHIS2-EMIS	An EMIS implementation of DHIS2
DHIS2-HMIS	An HMIS implementation of DHIS2
EMIS	Education management information system
HCI	Human-computer interaction
HISP	Until 2022 an abbreviation for Health Information Systems Programme. From 2023, HISP is the official name of the organization. ^{1, 2}
HMIS	Health management information system
ICT4D	ICT for development
IRIS	Information Systems Research Seminar in Scandinavia
IS	Information systems
LMIC	Low- and middle-income country
MoBSE	Ministry of Basic and Secondary Education (in The Gambia)
NAP	Nested affordance process model
NSD	Norsk senter for forskningsdata (Norwegian center for research data)
SDG	Sustainable development goal
SRC	School report card
UiO	Universitetet i Oslo (University of Oslo)

¹ <https://dhis2.org/hisp-dhis2-official-names/>

² <https://www.mn.uio.no/hisp/english/>

Abstract

Affordance theory has gained increased traction in the information systems (IS) research field. However, the use of the theory is ambiguous among IS researchers, troubling a proper appropriation of the affordance theory in the IS field. While affordances are considered action possibilities, claimed affordances in extant IS research include technology artifacts, technology properties, technology features, technology use, and action possibilities emerging as a consequence of technology use. This thesis thus initiates a re-calibration process of the IS-notion of affordances.

In addition to a thorough literature review on the application of the affordance lens in IS research, this thesis presents a study of the affordances that emerged in the aftermath of the platformization of The Gambia's education management information system (EMIS). The Gambia implemented DHIS2 as the backbone for their nationwide EMIS, giving rise to new action possibilities not previously available.

The contribution of this thesis is twofold. First, the thesis contributes to the ongoing affordance theory discussion in the information systems (IS) field. The ambiguous use of the affordance lens is highlighted in an extensive literature review on IS research applying the affordance lens. Building on extant research, I suggest a common way forward and introduce the nested affordance process model (NAP) and the affordance identification framework (AIF) as tools to help IS researchers distinguish basic technology use affordances from mid- and higher-level affordances that emerge from basic technology use.

Second, the thesis applies the theoretical frameworks on empirical findings from The Gambia to illustrate how affordance theory can explain and guide stakeholders through the process from technology use towards societal-level outcomes, such as the attainment of the United Nation's sustainable development goals (SDGs). The thesis explores how the interdependency of affordances mutually affects the emergence, perception, and actualization of the interdependent affordances. There is a consensus among IS scholars that the actualization of affordances may give rise to the emergence of other affordances. In this thesis, I also show how the perception of future (higher-level) affordances may feed back as stimulating conditions for the actualization of preceding (lower-level) affordances.

This has practical implications for technology users. Translated to the empirical setting of the educational sector in The Gambia, it implies that capacity building should not only focus on training in how to use the features of DHIS2 (i.e., actualization of lower-level technology use affordances) but also on explaining what the technology use may afford in the longer term (e.g., better education). Understanding the future possibilities

and consequences thereof may serve as a stimulating condition (i.e., motivation) for the stakeholders to actually take the time to register the required data requested by the Ministry of Basic and Secondary Education (MoBSE). These lessons are also important contributions to EMIS at large.

Preface

This thesis is submitted as a partial fulfillment of the requirements for the doctoral degree (Ph.D.) at the Faculty of Mathematics and Natural Sciences at the University of Oslo, Norway. The research has been completed through my participation at the HISP center at the Department of Informatics.

The thesis consists of four peer-reviewed papers and an introductory part. The introductory part contextualizes the research and presents the research approach, as well as a synthesis of the contributions of the papers, documenting the coherence of the thesis.

The following papers constitute the thesis and are included as appendices.

1. **Meeting the Education Data Crisis: A Research Agenda on Digital Platforms for Education Management**

Terje Aksel Sanner, Monica Amuha, Seedy Ahmed Jallow, Silvia Masiero, and Bjørnar Valbø, in review with an international IS journal

2. **Information Systems Affordances: A Literature Review and a Derived Conceptual Model**

Bjørnar Valbø and Terje Aksel Sanner, in review with an international IS journal

3. **Investigating Mid-level IT Affordances as Drivers for Societal Change: Addressing the Education Data Challenge in The Gambia**

Bjørnar Valbø and Terje Aksel Sanner, IFIP 9.4 (2022)

4. **Informing Sustainable Development in Education: Identification and Actualization of Layered IS Affordances**

Bjørnar Valbø and Terje Aksel Sanner, The Electronic Journal of Information Systems in Developing Countries (2023)

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1 Introduction

This Ph.D. thesis analyses the extant use of the affordance theory in information systems (IS) research and suggests means for further appropriation of the affordance theory to the IS community. The thesis develops two theoretical frameworks, which are tested and corroborated using empirical data from the implementation process of DHIS2 in the educational sector in The Gambia.

DHIS2 is a digital software platform, and the uptake of DHIS2 as the backbone for The Gambia's national education management information system (EMIS) can be understood as a platformization process, affording several new possibilities compared to the situation before. The affordance theory thus serves as an appropriate lens since affordances describe action possibilities. The affordance theory has become increasingly popular in the IS research discipline, although the application of the theory is quite ambiguous. Through a thorough literature review as well as reflection on and abstraction from the DHIS2 for education (DHIS2-EMIS) implementation process in The Gambia, this thesis contributes to the collective appropriation process of the affordance theory in the IS field.

The main contributions of this thesis are two theoretical frameworks that can be used by IS scholars to help understand, identify, and talk about affordances in a unified manner. The thesis is thus a combination of theory development and a case study. Case empirics have been used to test and inform the theoretical contributions provided.

1.2 Motivation

1.2.1 Theoretical motivation

Coming from the field of ecological psychology, the affordance theory has undergone several rounds of adaptations to suit the IS field. However, IS scholars apply this theory in very distinct ways. A re-calibration of the "IS-notion" of affordances is thus warranted. As such, in this thesis, I contribute with a thorough analysis of the application of the affordance lens in extant IS research and provide suggestions on how to establish a common ground for further use of the affordance concept in IS research. Based on extant IS research findings and empirical data analysis, I developed two theoretical frameworks to guide future research. These frameworks are tested and further developed using empirical data from the DHIS2-EMIS implementation in The Gambia.

1.2.2 Practical motivation

A decade ago, I did my master's thesis on the implementation of DHIS2 as the backbone for The Gambia's health management information system (HMIS). Now, The Gambia and five other countries are also piloting DHIS2 in the educational sector. The "practical motivation" for embarking on this Ph.D. journey was thus rooted in the desire to participate again in the exciting work that HISP is part of in the Global South.

The worldwide Covid-19 pandemic did, however, impose some unforeseen restrictions. It caused delays in the rollout of DHIS2-EMIS in The Gambia and hampered international travel, thus affecting the balance between theory and case empirics in this thesis. The overarching research design thus changed significantly during the research project, and the project took a more deductive path than was initially planned.

Since embarking on the initial plans was not feasible, I focused on theory development and returned to the empirics to test and corroborate the theoretical contributions.

1.2.3 ICT in the Global South

There seems to be an expectation among non-governmental organizations and other good-willing actors when it comes to disseminating ICT resources. To bridge the digital divide, we are deploying ICT solutions in the Global South, expecting a societal-level outcome in return. In recent years, the ICT for development (ICT4D) debate around the digital divide has shifted from the "dualism of 'haves' vs. 'have nots' that related to technology access" towards considering divides in technology use (related to user skills and knowledge) and social inequalities (Heeks, 2021, p. 767; Ragnedda & Muschert, 2013; Van Dijk, 2020). But, as pointed out by Von Braun (2010), ICT is not a panacea, and we know from extant research that ICT projects in LMIC settings are prone to failure (Ali & Bailur, 2007; Best & Kumar, 2008; Kleine & Unwin, 2009). Using the theoretical frameworks that I developed in the work with this thesis, I show how technology use can lead to societal-level outcomes if capacity building in terms of user skills and knowledge is prioritized. Platform-based IT systems afford several new possibilities for stakeholders, but to benefit from these possibilities, extensive focus and resources must be put into proper capacity-building.

1.2.4 EMIS

EMIS is gaining increased focus from important actors, such as UNICEF (e.g., UNICEF East Asia & Pacific, 2020), and the demands and requirements for well-functioning EMISs are high. In paper 1, we argue that a platform-turn of EMISs is a good way to go in order to cater to the increasing demands, as software platforms provide several new possibilities compared to traditional IT silo systems. However, deploying a nationwide software solution is not enough in itself. In this thesis, I demonstrate how a multilevel affordance perspective can provide insight into the various action

possibilities available at different levels of granularity and how the actualization of these, in turn, may lead to societal-level effects. A substantial amount of resources must be used to prepare for the actualization of lower-level affordances so that sufficient capacity can be built and the higher-level affordances that cause society-level effects may be actualized.

1.3 Research Aim

This thesis explores how the affordance concept can be theoretically clarified and contributes to the ongoing appropriation process of the affordance theory to the IS community. I do this by developing theoretical affordance frameworks that contribute to closing the gaps in understanding affordances among IS scholars. These frameworks are then applied on empirical data from the Gambian DHIS2-EMIS implementation process, illustrating how the affordance theory can contribute to understanding large-scale implementations of a platform-based EMIS in an LMIC setting.

Although the empirical data in this thesis is from an LMIC setting, the thesis does not intend to venture into the ongoing discussion on how ICT can contribute to societal changes in LMIC settings. The thesis uses and adds to the affordance theory – “a lens that is particularly well suited to help IS scholars build theory about ICT use” (Majchrzak et al., 2016, p. 272) – and demonstrates its applicability and generalizability by applying the theoretical frameworks (that are developed from a literature review) on empirical data from an LMIC setting. Thus, while contributing to IS at large, the thesis also aims to help ICT4D understand affordance.

1.4 Research Approach

Embarking on this Ph.D. journey amid a worldwide pandemic hampered the possibilities of frequent field visits. While waiting for travel restrictions to be lifted, the work became more and more theoretical as I delved into affordance literature published in IS outlets. Through several iterations, paper 2 – which contains the major contributions of this thesis – took form. When international travel became possible, I had three visits to The Gambia, where I interviewed people in the educational sector and sat on roundtable meetings. The empirical data collected on these trips were used to test my theoretical frameworks and further inform the development of the frameworks.

1.5 Contributions

In this thesis, I develop two theoretical frameworks. First, the nested affordance process model (NAP) builds on, unites, and extends affordance frameworks developed in extant IS research. It does not particularly challenge the ideas behind existing frameworks but rather illustrates how extant contributions can be united into a whole. Additionally, the NAP also introduces further ideas to the affordance terminology, such as three major granularity levels of affordances (low, mid, and high) and affordance loops. Second, the affordance identification framework (AIF) is a framework I developed when I was analyzing the empirical data from The Gambia. In this thesis, I argue that IS scholars should be more concerned about the consequences of technology use rather than the technology use itself. As such, I developed the AIF to help categorize the identified affordances in my interviews. The AIF is a useful tool to distinguish between lower-level, mid-level, and higher-level affordances (as well as elements that do not qualify as affordances).

1.6 Disposition of the Thesis

The remaining chapters of this thesis are structured as follows.

In **Chapter 2 – Related Research**, I present an introduction to related IS research literature on EMIS and affordance theory. The chapter explains how much extant IS research focuses on basic technology use affordances and thereby risks losing the important focus on organizational-level actions causing organizational-level changes. Along with the presentation of extant research, I outline how the frameworks developed in this thesis may help nudge IS scholars toward a more appropriate level of granularity for affordance analyses in IS research.

In **Chapter 3 – Case: Background and Context**, I describe the context and the research object. I present the context as a whole to give an understanding of the full context in which this research takes place.

In **Chapter 4 – Research Approach**, I give an overview of the research approach. I present how my initial plans changed through the Ph.D. journey as well as a summary of the methods I have used. I explain how the theorizing was an iterative process, departing from a descriptive literature review (paper 2) and further informed by empirical data from The Gambia. The literature review considers affordance theory papers published in the AIS Senior Scholars' basket of eight journals.³ Most of the empirical data is collected from semi-structured interviews with stakeholders from several levels of the Gambian educational sector. I justify the interpretive stance I have

³ <https://aisnet.org/page/SeniorScholarBasket>

taken in the work with this thesis and end the chapter with ethical reflections on my research.

In **Chapter 5 – Findings**, I present a summary of each of the papers comprising this thesis before I give a synthesis of the findings. Each paper contributes to the theoretical development of this thesis, and the synthesis shows how the papers build on each other and present the research findings as a whole. Paper 2 contains the key theoretical contribution of this thesis but has been informed by the other papers through several iterations.

In **Chapter 6 – Contributions and Implications**, I present my contributions and the implications of my research. I explain why and how I have developed the new theoretical frameworks and the implications of applying these in IS research. I offer the frameworks as tools for the IS community to help bring clarity to what an affordance is, which affordances IS scholars should focus on, and how we can identify and talk about affordances in a unified manner.

Finally, in **Chapter 7 – Concluding Remarks**, I draw the conclusions and outline the limitations of my work.

2 Related Research

In the following, I summarize relevant affordance and EMIS research that motivates this thesis. While addressing the limitations in existing literature in the following, I also highlight the contributions of my research that seek to address these limitations.

2.1 Affordance Theory in IS Research

Affordance theory (AT) was first introduced to the field of ecological psychology by Gibson (1977, 1979).

The affordances of the environment are what it offers the animal, what it provides or furnishes, either for good or ill. The verb to afford is found in the dictionary, but the noun affordance is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment. (Gibson, 1979, p. 127)

The theory later gained traction in other research fields, including IS. The application of the notion of affordances does, however, vary significantly among IS researchers – perhaps due to the multitude of affordance definitions that have been introduced to the IS community (Table 2-1). While most of the definitions support the idea that affordances are action possibilities, there are some confusing nuances. For instance, Markus and Silver (2008) describe functional affordances as a relationship between an actor and the technology that indicates what the actor may “do with the object” (p. 622). An often-cited definition of affordances is that of Volkoff and Strong (2013)⁴, defining an affordance as “the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors” (p. 823). While Markus and Silver talk about how an actor can perform an action *with* the technology – that is, how we can use the technology specifically to perform an action – Volkoff and Strong’s definition refers not only to what we can do *with* the technology, but it also justifies that affordances can be of a somewhat more abstract nature than basic and concrete use of a technology feature. Leidner et al. (2018) allude to this distinction with their train ride example as they urge IS researchers to distinguish between mere technology use (the train ride itself) and the affordances that emerge from technology use (“working, sleeping, meditating, or conversing”; p. 120). In both cases, the action possibilities arguably arise from the relation between the actor and the technology. While riding the train can be seen as mere technology use, working and meditating are more indirect or abstract ways of using the technology.

⁴ Also published in Strong et al. (2014)

Table 2-1. Affordance definitions used by IS researchers (an adapted version of Table 6 in paper 2).

Affordance definitions	What is it?	Source
Technology affordances are action possibilities and opportunities that emerge from actors engaging with a focal technology	Possibility for action	Faraj and Azad (2012)
Affordances are functional and relational aspects which frame, while not determining, the possibilities for agentic action in relation to an object	Functional and relational aspect framing possibility for action	Hutchby (2001, p. 444)
The possibilities for goal-oriented action recognized by a specified user group	Possibility for action	Luo Carlo et al. (2012, p. 1084)
The mutuality of actor intentions and technology capabilities that provide the potential for a particular action	Mutuality providing potential for action	Majchrzak, Faraj, et al. (2013, p. 39)
The concept of technology affordance refers to an action potential, that is, to what an individual or organization with a particular purpose can do with a technology or information system	Potential for action	Majchrzak and Markus (2013, p. 1)
Functional affordances are defined as the possibilities for goal-oriented action afforded to specified user groups by technical objects	Possibility for action	Markus and Silver (2008, p. 622)
Functional affordances are a type of relationship between a technical object and a specified user (or user group) that identifies what the user may be able to do with the object, given the user's capabilities and goals	Relationship identifying action possibility	Markus and Silver (2008, p. 622)
The term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used	Property of a thing	Norman (1988, p. 9)
A concept to describe the perceived properties of an artifact, primarily the fundamental properties that determine just how a technology could possibly be used	Property of an artifact	Norman (1990)
Action possibilities allowed by material properties existent in information systems	Possibility for action	Seidel et al. (2013, p. 1279)
Tension between the “relational (i.e., affordances are relationships between actors and technical objects) and dispositional (i.e., affordances are a property of the technical object) nature of affordances.”	Relationship Property	Seidel et al. (2018, p. 224)
The potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors	Potential for behavior	Strong et al. (2014, p. 69); Volkoff and Strong (2013, p. 823)

This ambiguity illustrates the challenges IS scholars have faced when we have tried to appropriate the affordance theory to IS research. As Zheng and Yu (2016) point out, referring to Robey et al. (2013), “one of the challenges of affordance research in information systems is to understand technological practices as situated in broader social contexts and their effect on organisational and societal transformation” (p. 307). Related to Robey et al.’s call to conceptualize affordances “at a higher level of analysis than the individual” (p. 391), Zheng and Yu illustrate how functional affordances (Markus & Silver, 2008) can be socialized through collective action processes, causing *affordances for practice* (Fayard & Weeks, 2014) to emerge. While functional affordances relate to what an actor can do with the technology – in many studies referred to as “‘capabilities’ of a technology or an object, often interchangeably using features and affordance” (Fayard & Weeks, 2014, p. 237) – affordances for practice intend to describe what the technology can be used *for* “(e.g., for communicating, for collaborating), moving to the forefront the activities in which human actors engage with technology” (p. 238).

Although Volkoff and Strong’s (2013) definition is broadly accepted and frequently used, it is also disputed (Du et al., 2019). Coherent with Du et al.’s (2019) claim that outcomes from affordances are not always immediate nor concrete, there are also psychology scholars who argue that “Gibson’s affordance theory still needs to be brought beyond ‘the axiom of immediacy’” (Pedersen & Bang, 2016, p. 731). While it makes sense in the human-computer interaction (HCI) field to talk about immediate and concrete outcomes of actions (e.g., clicking a button, scrolling with the mouse), limiting affordance outcomes to something “immediate [and] concrete” (Volkoff & Strong, 2013, p. 823) makes little sense when studying organizational change. As posited by Keen (1981), “organizations are complex and change is incremental and evolutionary” (p. 24). Hence, a study of how technology affects organizations and contributes to organizational change should be more concerned about longitudinal processes and their effects rather than mere technology use with immediate observable outcomes. Although Leidner et al. (2018) go a long way in distancing themselves from Gibson’s initial definition of an affordance as they suggest that technology use is not an affordance, they raise a valid concern around how IS scholars have applied the affordance lens – namely that we should not be too concerned about the technology use itself, but rather what the technology use affords to the organization. However, organization-level action possibilities may or may not relate to concrete technology use. As IS affordances may relate to longitudinal change processes, the outcomes of actualized IS affordances are not necessarily direct and concrete. A consequence of this understanding of IS affordances is that we need to distinguish between granularity levels when we identify affordances. It is in this debate I position my contributions, providing theoretical frameworks that nudge IS researchers toward studying affordances at an appropriate level of granularity suitable for the study of how technology use affects organizations.

2.1.1 Affordance granularity levels

Pozzi et al. (2014) note that “scholars seem to identify more frequently technology-specific affordances” and warn that such a focus in future research might “transform affordances into technology characteristics” (p. 11). Consequently, there are IS scholars who propose a distinction between functional affordances and affordances that are channeled *through* functional affordances (Zheng & Yu, 2016, p. 308). Similarly, while acknowledging that technology use are indeed affordances, Fayard and Weeks (2014) suggest that IS researchers “shift the focus of affordance from the technology’s features ... to the practice enacted through technology” (p. 247). Along the same vein, Volkoff and Strong (2017) urge users not to study the very basic affordances but to be conscious about the granularity level of study.

Echoing this view, Wang et al. (2018) conclude in their literature review that IS researchers should consider social affordances alongside technological affordances. Other IS scholars go further and suggest that technology use should not be considered affordances at all. For instance, Faraj and Azad (2012) suggest that we “need to abandon the view that affordances are about a technology or an object. They are about actions in the world that involve technology” (p. 255). Similarly, Leidner et al. (2018) suggest that technology use is not affordances but that “the use of technology features provide affordances” (p. 120).

While technology use arguably are affordances, IS scholars should indeed question whether the study of basic technology use serves our purpose. The literature review (paper 2) reveals that about half of the affordances identified in the review set are either lower-level or mis-labeled affordances. The review also uncovers an increasing trend in IS research of identification of individual-centric affordances whose actualization benefits the individuals themselves. Curious about this trend, we raise the question, “Does this indicate that IS scholars have lost momentum in their efforts to extend and appropriate AT to account for complex organizational phenomena?” (p. 23). As IS scholars, we should not be too concerned about – figuratively speaking – an actor’s possibilities of grasping the doorknob and opening the door but rather ask, “Why does she open the door? What does opening the door afford her?” To help IS researchers identify affordances at an appropriate level of granularity, this thesis develops the affordance identification framework (AIF). By applying the AIF, IS scholars will be challenged to reflect more on the affordances we are studying. If they are lower-level affordances, we should seek to identify the mid-level affordances that emerge from the actualization of the lower-level affordances since they are likely to be of higher interest to IS scholars studying organizational changes.

In paper 2, we identify three dimensions along which AT has been extended by IS scholars to cater for the needs in IS research. I turn to these dimensions in the following.

2.1.2 Key elements for affordance theory in IS research

Three dimensions in affordance theory application in IS research emerged through the work with my literature review (paper 2). However, there does not seem to be a common terminology to speak about these dimensions. Neither does any overarching framework exist considering all these dimensions, and most IS studies focus on one or two dimensions (see Table 2-2). I thus developed the nested affordance process model (NAP) to cater for this gap. The NAP considers all the identified dimensions and suggests a concrete set of terminology to discuss them. In the following, the four dimensions are presented.

First, IS scholars have shown that there is an **interdependency** between affordances. Strong et al. (2014) introduce the affordance dependency diagram to illustrate the observed temporal sequence in which affordances were actualized (p. 75); Burton-Jones and Volkoff (2017) developed the affordance network to explain how affordances are interrelated (e.g., how an affordance “may require the achievement of ... prior outcomes” [p. 470]); and Thapa and Sein (2018) use their trajectory of affordances to explain how the actualization of affordances can lead to the discovery of other affordances. These ideas are similar and related to Gaver’s (1991) idea of “groups of affordances that are sequential in time” (p. 79). While all these ideas have some peculiarities, the essence of them all is that the emergence, discovery, and actualization of affordances depend on the actualization of other affordances.

Second, affordances are **nested**. This idea is also introduced by Gaver (1991). Markus and Silver (2008) also mention the repeating decomposition problem – that there are affordances within affordances. This is a fundamental property of affordances; an affordance can be decomposed into sub-affordances and/or constitute a higher-order affordance together with other affordances. Bernardi (2016) refers to nested affordances as composite affordances, illustrating it with an example of how building a support network affordance is a composite of the self-presentation and narration affordances. Nested affordances are different from sequential affordances in that two or more affordances constitute another affordance. For example, Bernardi’s building a support network affordance is not a third affordance that can be actualized after the self-presentation and narration affordances but rather a composite of the two. It is actualized only by virtue of the actualization of the other two. Thapa and Sein (2018) subscribe to this notion as they describe how affordances cluster together to form an ensemble of affordances. An ensemble of affordances is not necessarily equivalent to a nested affordance. However, nested/composite affordances and cluster/ensemble of affordances are similar concepts that explain how two or more affordances constitute another affordance and/or an ensemble of affordances which – when actualized – may lead to the emergence of new affordances. This brings us over to the third dimension.

Table 2-2. Theoretical concepts introduced in the reviewed affordance papers and the papers' relation to the complexities identified (from Table 7 in paper 2).

Theoretical concepts	Description	Source	The papers' relation to the complexities identified
Affordance actualization lens	"A theory of affordances is incomplete without a corresponding theory of how those affordances are actualized. Based on our data, we developed the concepts comprising affordance actualization, which explain how individual actions connect to organizational outcomes."	Strong et al. (2014)	G*: The paper identifies affordances at various granularity levels and refers to them as basic and more-advanced affordances (e.g., archiving data; coordinating care). T*: Affordance dependency diagram. "Shows the observed temporal sequence in which affordances were actualized" (p. 75). C*: N/A
Affordance dependency diagrams	"Shows the observed temporal sequence in which affordances were actualized" and depicts the dependency between them		
Affordance network	"Allows us to describe how larger outcomes are achieved in organizations through a linked set of more immediate concrete outcomes. For instance, a decision-making affordance at time 3 may require the achievement of at least two prior outcomes (right data entered at time 1 and right data accessed at time 2)."	Burton-Jones and Volkoff (2017)	G: The paper identifies affordances at various granularity levels (e.g., inputting data [technology use]; managerial decision-making [emerged from the relation between administrators and categorized populations]). T: Affordance network. "Affordances and outcomes depend on each other across time and organizational levels" (p. 470). C: N/A
Conversion factors	"Enable or restrict individuals' ability to gain new capabilities and make choices"	Hatakka et al. (2020)	G: Most identified affordances are at a somewhat abstract level of granularity (e.g., using computers to find and apply for jobs). T: The actualization of an affordance may reveal new affordances. C: N/A
Ensemble of affordances	Affordances can cluster to form ensembles of affordances. The role of an ensemble of affordances is to actualize a concrete outcome.	Thapa and Sein (2018)	G: Affordances at somewhat abstract level (e.g., volunteerability). T: Trajectory of affordances. "The actualization of an affordance can be a pathway to the emergence of new affordances" (p. 808).
Facilitating conditions	Conditions that serve as a prerequisite for an affordance to be actualized.		

Trajectory of affordances	The trajectory along which affordances travel, “specifying the process and conditions through which affordances are perceived leading to actualisation of affordances.”	Thapa and Sein (2018)	C: Affordances may cluster together to form an ensemble of affordances (e.g., volunteerability and virtual co-localisability cluster together).
IT spirit	“The incorporeal essence of an IT artifact.” A new conceptualization of DeSanctis and Pool’s IT spirit.	Cheikh-Ammar (2018)	G: The paper acknowledges that “affordances are inherently hierarchical, they exist at different levels of abstraction” (p. 285). T: N/A C: An affordance may be decomposed into sub-affordances (e.g., sending/receiving messages and replying/forwarding messages constitute the collaborating with others affordance).
Needs-affordances-features (NAF) perspective	“The NAF perspective, based on motivation-needs theories ..., submits that people high on a psychological need (e.g., relatedness) will be motivated to use social media applications that have affordances (e.g., relationship formation) that can satisfy that need.”	Karahan et al. (2018)	G: The paper identifies affordances at various granularity levels (e.g., browsing other’s content; collaboration), although without the authors acknowledging it. T: N/A C: N/A
Niches	With reference to Gibson: “a set of affordances for a particular animal.” In their own case: “a group of end-users in which all members have similar perceptions of and similar uses for service robots.”	Mettler et al. (2017)	No identified affordances in the paper. G: Speak about affordances as if they are technology use-affordances. T: N/A C: N/A
Symbolic expressions	“The communicative possibilities of a technical object for a specified user group.”	Markus and Silver (2008)	No identified affordances in the paper. G: Functional affordances relate to the concrete use of technology. T: N/A C: A system may be considered as a whole to avoid the repeating decomposition problem.
*) G = granularity; T = trajectory; C = composability			

Third, and related to the preceding dimensions, affordances reside on different levels of **granularity**. These levels are often just treated as two levels, as IS scholars speak of

lower and higher levels (e.g., Burton-Jones & Volkoff, 2017), first- and second-order (Leidner et al., 2018), and individual- and organizational-level (Strong et al., 2014). Cheikh-Amman (2018) speaks about different levels of abstraction, while Volkoff and Strong (2017) urge IS researchers to focus on the appropriate level of granularity while doing affordance research. This distinction in granularity levels is also addressed by other scholars using different terminology as they allude to the need to move beyond studying mere technology use in IS research (Faraj & Azad, 2012; Fayard & Weeks, 2014; Zheng & Yu, 2016).

Additionally, affordances are actualized in a social **context** and not in a vacuum (Volkoff & Strong, 2017). The organizational context affects the goals and actions of the actors (Strong et al., 2014). Bygstad et al. (2016) call social mechanisms the context beyond affordances, serving as “enabling/constraining, stimulating or releasing conditions” (p. 92). Similarly, Thapa and Sein (2018) use the term facilitating conditions to refer to the conditions that serve as a prerequisite for an affordance to be actualized.

The aforementioned dimensions should be further developed to develop an AT suitable for the IS community. It is rather unnecessary that our research community does not yet seem to agree on how to address these important dimensions. Do we need all these different frameworks about decomposed, interrelated, interdependent, or networked affordances, or can they be united into a single framework addressing the affordance interdependency? Similarly, is there really any significant difference between nested, composite, and clustered affordances?

2.1.3 Towards re-calibrating the IS-notion of affordances

Without a common consensus on what affordances are (Table 2-1) and how to speak about affordances, the IS community is already struggling to generate an accumulative knowledge base on affordance theory in IS research. If we are to accumulate knowledge, we should at least have a joint understanding of the fundamental building blocks in a theory. There is thus a need for a re-calibration of the IS-notion of affordances. As an initial step towards such a re-calibration, this thesis investigates theoretical clarity and contributes to the ongoing appropriation process of AT to IS. In the work with this thesis, I developed two AT frameworks. First, instead of developing many similar frameworks with different vocabulary, I suggest a framework that combines the key elaborations and extensions of AT by IS researchers while sticking to a certain vocabulary. The nested affordance process model (NAP) combines the three aforementioned dimensions into one framework, combining the ideas from Gaver (1991), Strong et al. (2014), Burton-Jones and Volkoff (2017), and Thapa and Sein (2018). The NAP illustrates the **interdependency** of affordance while considering that affordances are also **nested**. The interdependency across **granularity levels** is also

reflected in the NAP, as well as the importance of **context**. Second, since there is an apparent inconsistency around what an affordance is and – perhaps more importantly – which affordances deserve the focus of IS scholars, I also developed the affordance identification framework (AIF). The AIF seeks to guide IS scholars through a reflection process, helping us distinguish between “non-essential” and “essential” affordances for our research. While an HCI scholar would focus on how a like button should be designed to convey the affordance of liking a social media post, an IS scholar should rather be concerned about *why* we click that like button and what that affords us. Both the NAP and the AIF acknowledge that basic functionality and feature use, such as clicking the like button, is indeed an affordance. However, the intention is that these tools should be applied to help us focus on affordances at a more appropriate level of granularity. The NAP and AIF are further presented in chapters 5 and 6.

2.1.4 Affordances and societal-level changes

Technology is not a panacea for development (Von Braun, 2010, p. 12). Nonetheless, ICT interventions aim to improve the lives of the marginalized and poor and can be seen “everywhere” across the development landscape (e.g., De’ et al., 2018). IS scholars have traditionally looked at ICT-related organizational change, yet most IS studies using the affordance lens focus on lower-level technology use affordances (paper 2). Faik et al. (2020) also recently pointed out that there is limited attention to “how [societal consequences] emerge from the development, deployment, or use of IT” (p. 1361) and provide an analysis on how to relate affordances to societal changes. Along the same lines, Essén and Värlander (2019) conclude that “the introduction and evolution of a technological artifact in an institutional setting” can contribute to field-level changes (p. 1173). Both these studies (Essén & Värlander, 2019; Faik et al., 2020) apply the institutional logic lens to explain how IT contributes to societal-level changes. In my research, on the other hand, I illustrate how AT alone can explain how IT use contributes to societal-level changes without drawing on other theories. Combining several existing frameworks into one overarching framework (NAP) allows us to take nested, interdependent affordances across several levels of granularity into consideration in our analysis. By applying the AIF and the NAP, this thesis thus explains how we can trace societal-level changes back to concrete lower-level technology-use affordances. For instance, in The Gambia, I found that capacity building in terms of user skills and knowledge are important factors in ensuring the necessary motivation for actors so that they enact the affordances in the sequence of affordances that eventually may lead to societal changes.

2.2 Education Management Information Systems (EMISs)

Although education is one of – if not *the* – most important factor for the development of a society, EMISs are surprisingly understudied in IS research. For comparison, a search on Web of Science⁵ returns 16 papers on “education* management information system\$”⁶ for 2020-2022, while a search for “health management information system\$” returns 168 papers for the same time span. There is, however, a practice-oriented body of knowledge concerning EMIS, though mostly in the form of grey literature from the education sector.

Although there have been several attempts to define EMIS, a commonly shared definition is lacking. With reference to the Latin American context, Cassidy (2006) notes: “There is no universally-accepted definition of EMIS in popular use throughout the region. The acronym, EMIS, means different things to different people” (p. 2). Cassidy then provides an extensive definition himself, which has been widely referred to by others (e.g., Abdul-Hamid, 2014; Bhatti & Adnan, 2010; UNESCO, 2007):

An Education Management Information System (EMIS) is a system for the collection, integration, processing, maintenance and dissemination of data and information to support decision making, policy-analysis and formulation, planning, monitoring and management at all levels of an education system. It is a system of people, technology, models, methods, processes, procedures, rules and regulations that function together to provide education leaders, decision makers and managers at all levels with a comprehensive, integrated set of relevant, reliable, unambiguous, and timely data and information to support them in completion of their responsibilities. (Cassidy, 2006, p. 27)

I find that Cassidy’s definition includes all important functions and properties that constitute a successful EMIS and presents these in a way that lends itself to operationalization in the context of IS research. Hence, I adopt this definition in my research on EMIS.

Ultimately, the goal of an EMIS is informed decision-making that leads to equitable quality education and improved learning outcomes (Abdul-Hamid, 2014). To achieve this, information needs to be relevant, accurate, and timely (Abdul-Hamid, 2014; Bhatti & Adnan, 2010; Cassidy, 2006; Chapman, 1991; Hua & Herstein, 2003; Powell, 2006). IS researchers can help identify digital tools and procedures that enhance the appetite for and governance of education data, facilitate access to and scrutiny of education systems through open data, and strengthen data-driven decision making at all levels of national education systems. In paper 1, we argue that a platform-based EMIS may

⁵ <https://www.webofscience.com>

⁶ The asterisk wildcard matches zero or more characters, while the dollar sign wildcard matches zero or one character. *Education** thus matches *education* and *educational*, and *system\$* matches both *system* and *systems*.

provide the flexibility needed to adapt the system to cater for specific data collection and reporting needs. Platformizing a nation-wide EMIS is not done overnight but is a long-lasting transformation process (Bygstad & Hanseth, 2018). According to Bygstad and Hanseth (2018), platformization can be considered “a process where IT silo solutions are gradually transformed to a platform-oriented digital infrastructure” (p. 3). A software platform with its boundary resources (Ghazawneh & Henfridsson, 2013) affords many new possibilities compared with traditional silo systems.

Through its implementation of DHIS2 as the backbone for its national EMIS, The Gambia has been going through a platformization process of its EMIS. This has facilitated a range of new action possibilities that were not available with the previous EMIS. This context thus served as a suitable empirical setting for my research, in which I could apply AT to understand how technology use may contribute to societal change. The experiences from data collection in The Gambia motivated the development of the AIF and elements in the NAP. In the following chapter, the context is presented in further detail.

3 Case: Background and Context

The empirical setting for this thesis is in the educational sector of The Gambia, where the HISP-developed DHIS2 software platform is being piloted as the backbone for their national EMIS. To give a basic understanding of the empirical setting, I briefly present HISP, DHIS2, The Gambia, and the Gambian education sector in the following, accompanied by a vignette on the reflections from the current EMIS head in MoBSE.

3.1 HISP

HISP is a global action research network born from the initial DHIS project that started in post-apartheid South Africa in 1994. The aim of the initial project was to facilitate the decentralization of data reporting and data use so that districts of South Africa could report and use health data without relying on centralized processes and decisions. Since then, HISP has grown to be a global movement. Through collaboration with the HISP group at the University of Oslo (UiO), collaboration partners have grown to be acknowledged HISP groups, serving as trusted implementation partners providing capacity building and development support in the Global South. Currently, there are twenty officially acknowledged HISP groups across the globe⁷ supporting DHIS2 deployments in more than 100 countries⁸. In HISP UiO alone, there are more than 100 HISP employees, consisting of both academic staff and operational employees. Throughout the years, more than 500 masters' students and more than 60 Ph.D. candidates have graduated.

3.2 DHIS2

DHIS2 is a free and open-source software platform developed and maintained by the HISP center at UiO. For the past 20 years, DHIS2 has allowed public health managers to collect, report, analyze, and act on timely data. During the last decade, DHIS2 has grown in several dimensions. First, the number of implementations of DHIS2 as a country's HMIS has grown from one national (+eight pilot) implementations in 2010 to 64 national (+eight pilot) implementations in 2022⁹, and it is estimated that 2.3 billion people benefit from the services managed by the numerous DHIS2 implementations (Nicholson et al., 2020, p. 10).

⁷ <https://dhis2.org/hisp-network>

⁸ <https://www.mn.uio.no/hisp/english/about/facts>

⁹ In addition, DHIS2 was used by 23 Indian states in 2010, and in 22 states in 2022.

Implementation statistics in this paragraph are retrieved from <https://www.dhis2.org/in-action>, visited 15 December 2022.

Second, additional features and platform extensions have been implemented in a similar exponential way. For instance, the implementation of the DHIS2 Tracker app, which manages individual records, has increased from 9 to 85 from 2016 to 2022.

Third, DHIS2 is being adapted and used in several new domains and has, for example, been implemented as logistics management information systems (Adu-Gyamfi et al., 2020; Nielsen & Sæbø, 2016). Currently, there are six countries that are using (piloting) DHIS2-EMIS, namely Eswatini, The Gambia, Mozambique, Sri Lanka, Togo, and Uganda.

Fourth, DHIS2 is gaining acknowledgment and attracting major funding bodies. Since 2011, several influential actors in the international development landscape (e.g., the Norwegian Agency for Development Cooperation [Norad]; the Global Fund; The U.S. President's Emergency Plan for AIDS Relief [PEPFAR]; Centers for Disease Control and Prevention [CDC]; UNICEF; Gavi, the Vaccine Alliance; and the Bill & Melinda Gates Foundation)¹⁰ have contributed with funding, and the total investment in the core platform has increased tenfold from \$2 million in 2011 to more than \$21 million in 2022¹¹.

Fifth, and perhaps the underlying condition for the growth along the four aforementioned dimensions, DHIS2 has evolved from a monolithic HMIS software to a malleable, flexible digital software platform, facilitating the development of extensions (apps) and the adaptation and transferability to new contexts. One example of how DHIS2 has been adapted and transferred to another context (geographically speaking) is the use of DHIS2 as the primary tool for Covid-19 infection tracing in Norway. From being fairly unknown in Norway, DHIS2 was used for Covid-19 infection tracing in more than two-thirds of the Norwegian municipalities¹². Another example of context adaptation (domain change) is the aforementioned recent piloting of DHIS2 as EMIS, which is coordinated by the HISP Centre at UiO. These examples show that DHIS2 provides a flexibility that facilitates the usage in new contexts, both in terms of geography and domain.

3.2.1 Charting new domains for DHIS2: From health to education

There is an increasing interest in EMIS, and important international actors, such as UNICEF, emphasize the importance of well-functioning EMISs (e.g., UNICEF East Asia & Pacific, 2020). The increasing interest in using DHIS2 as the backbone for

¹⁰ <https://www.norad.no/en/front/>; <https://www.theglobalfund.org/en/>; <https://www.state.gov/pepfar/>; <https://www.cdc.gov/>; <https://www.unicef.org/>; <https://www.gavi.org/>; <https://www.gatesfoundation.org/>

¹¹ <https://www.mn.uio.no/hisp/english/about/strategy>, visited 23 January 2023

¹² KS reported (on 1 Sep 2020) that 94 municipalities used DHIS2 through Fiks (<https://www.ks.no/fagomrader/digitalisering/felleslosninger/fiks-smittesporing/hvilke-kommuner-med/>, visited 22 Oct 2020), while ReMin claimed that 220 municipalities used their DHIS2-based software in November 2020 (<https://remin.no/vre-kunder>, visited 15 December 2022).

countries' implementation of computer-based EMISs has also challenged HISP to modify the DHIS2 core to make it even more generalizable and adaptable in order to meet new demands caused by the use in a new domain. Although DHIS2 is very flexible and malleable, HISP's main focus has always been facilitating an easy uptake in the health domain. With the increasing interest from the educational sector, HISP established an EMIS team at the HISP center, whose focus is to reveal and promote important educational factors that need to be accounted for when adapting the DHIS2 core.

3.3 The Gambia

Surrounded by Senegal, except from the 80 km long coastline, The Gambia is the smallest country on the African continent, with a land area of 10,120 km². The official language is English, although 13 tribal languages are spoken (e.g., Mandinka, Wolof, and Fulani). Around 96% of the population are Muslims, while the remaining 4% are Christians. The rainy season lasts from June to October and provides around 1300 mm of rain in the coastal areas and around 750 mm in the eastern part of the country (Thuesen, n.d.). The Gambia is among the 15 poorest countries in Africa¹³, and post-Covid-19, the poverty rate has climbed to 53.4% in 2022 (from 45.8% in 2019)¹⁴, giving challenges to the distribution of resources, such as teaching material to schools and salaries to teachers. During my first field visit to The Gambia in February 2022, teachers were on strike due to the low salary and high workload.

The Gambia is one of six countries currently piloting DHIS2 as the backbone for their national EMIS. In 2010, I spent three months in The Gambia in relation to my master's thesis, assisting the Ministry of Health in their implementation of DHIS2 as the backbone for their HMIS (DHIS2-HMIS; Valbø, 2010). Thus, it was natural to choose The Gambia as the empirical setting for this thesis over the other countries piloting DHIS2-EMIS. Furthermore, the EMIS platformization process (Hanseth & Bygstad, 2018) that MoBSE had embarked on already showed promising results in terms of new action possibilities and could thus serve as a suitable empirical setting in which I could test my affordance-related theoretical frameworks. For further elaboration on the "research journey," refer to section 4.1.

3.3.1 The educational sector in The Gambia

In the past, the international education agenda has focused on providing universal access to education. This was reflected in the *World Declaration on Education for All* in

¹³ <https://worldpopulationreview.com/country-rankings/poorest-countries-in-africa>

¹⁴ <https://www.worldbank.org/en/news/press-release/2022/11/09/covid-19-elevated-poverty-in-the-gambia>

Jomtien 1990 (United Nations, 1990) and the Millennium Development Goals¹⁵. Priority indicators were often related to access, such as enrolment rates, completion rates, and the proportion of qualified teachers. However, the rapid growth in student enrollment over the past few decades has outpaced many governments' efforts to build classrooms, train and recruit teachers, and provide essential resources to schools. With the United Nations' sustainable development goals (SDGs), the focus has shifted towards ensuring inclusive and equitable quality education and promoting lifelong learning opportunities for all. Target 4.5 of the SDGs emphasizes the need for “vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations” (United Nations, n.d.). However, most African countries, including The Gambia, lack an institutionalized SDG 4 reporting framework and a flexible information system tool that can be used to collect, process, and report data on progress related to SDG 4 implementation (ADEA, 2019).

MoBSE has made “equitable, inclusive and quality education” a top priority in the Education policy for 2016-2030 (Ministries of Basic and Secondary Education and Higher Education, 2017). The national EMIS is considered an important infrastructure for monitoring and evaluation and is tasked with meeting education policy data needs, including developing a national teacher register and a learner identification system. The new policy goals require data to be disaggregated by gender, location, wealth quintile, and other factors, such as disability and financial situation (UNICEF East Asia & Pacific, 2020). EMISs must increasingly be capable of handling individual learner data to disaggregate by a wide range of socio-economic factors.



Figure 3-1. Empty schools in February 2022 due to teacher strike.

¹⁵ <https://www.un.org/millenniumgoals/>

3.3.2 DHIS2-EMIS in The Gambia

In early 2019, The Gambia launched the DHIS2-EMIS initiative. MoBSE used DHIS2, a platform previously used by the Ministry of Health since 2010 (Valbø, 2010), to design personalized modules for learners. These modules capture data on socio-economic background, attendance history, continuous assessment, and disciplinary record. In 2020, MoBSE successfully piloted the individual student admission and registration component in 200 schools using Chromebooks. Building on the resources from the pilot, MoBSE was able to register students across the entire country. The national EMIS team, trained in DHIS2 configuration and maintenance by the HISP West and Central Africa¹⁶ group, has configured thematic dashboards and analysis tools on the digital platform. Schools can visualize their data, and school cluster monitors, who oversee a group of schools, can review reporting rates from schools and attendance data for both teachers and learners.

As part of the DHIS2-EMIS initiative, MoBSE has digitized its school report card (SRC), which is intended to promote community participation and increase transparency. The Gambian SRC was first developed in 2008 using Microsoft Excel macros and Microsoft Access. Despite its complexity, it has gained widespread recognition and is well-integrated into EMIS practice. However, with the original Excel-based version, only printouts from the central level were available to sub-national levels. The tool has a broad audience, including the Minister of Education, planners, regional officers, head teachers, parents, and community leaders. It highlights priority areas for the coming year and informs the preparation of school improvement plans. With DHIS2-EMIS, the SRC was developed as an add-on to the DHIS2 platform, allowing for decentralized digital access with improved availability and use. The DHIS2-EMIS SRC is highly configurable, with no technical dependencies apart from the open DHIS2 API. This allows for local flexibility in presenting school performance to community members with varying levels of literacy and numeracy skills. Currently, EMIS stakeholders in Uganda are considering cross-border adoption and adaptation of the DHIS2-EMIS SRC.

To further contextualize this thesis, the following sub-section presents reflections from Idowu¹⁷, the EMIS head, about how DHIS2-EMIS came about in The Gambia.

¹⁶ <https://www.hispwca.org/>

¹⁷ This and other persons' names are fictional.

3.3.3 Case vignette: The EMIS journey towards DHIS2

Reflections from the EMIS head

There was no EMIS in The Gambia until 2001. Back then, an EMIS project funded by the UK department of foreign development was implemented. After a couple of years, the project was phased out and handed over to the Gambian government. The last system used, was CSPro, but one of the major drawbacks with that system, was that “you have to do all the learning yourself. If you want to customize anything, you don't have any partner to ... work with. We just have to go to their American website” (Idowu). The plan was to stick with CSPro combined with other systems, but the EMIS team sat with a feeling that:

“We had a tool that we only, Gambia, was using. And as people are changing roles, people are moving from point A to point B in their life, ... this tool was becoming very expensive to maintain. So, because of those challenges and failures, moving to a system like DHIS2, ... there is a wider consortium of people. ... That's why we better go there, so we don't work alone. In Africa they say, “If you want to go very far, you have to go with a lot of people. If you want to go very fast, you go alone.” And this is a long journey, so we cannot do it on our own.” (Idowu)

Since 1998, it has been said that EMIS should collect individual student IDs, but so far, the Gambian EMIS has not done so. When the agenda for the SDGs was put forth in 2015, the need for collection of individual student IDs was again emphasized by MoBSE. Idowu was working with EMIS at that time, but *he was reluctant to rush the EMIS into a shift towards individual data collection:

“They were pushing me to do something about it. But because we had stumbled, we had learned from our failures. I was not very happy to just shift to individual ID. ... I can shift. I can write the code or get the code. But it will not be sustainable. It will be like this investment on the EMIS in 2000, where you have people from the UK, came here and lived with us for two years – it works. When they leave, everything stumble. You don't want to do that.” (Idowu)

Idowu looked to other countries, like South Africa, Ghana and Namibia, and noted that the cost of a well-functioning EMIS is so high that it is unsustainable – even for the higher education. Idowu and the EMIS team then spent a weekend reading up on EMIS literature to find out, “What is the best tool?” They were very close to go back to Stateduc, and in 2017 *he explained to a Stateduc consultant his challenges of shifting to individual data collection:

“I don't want to do it to a point where ... [the system] will be there because I am the one doing it, and when I retire or when I move, it fails like all other system has failed. We want to make sure it ... comes slowly, is adopted slowly, and eventually, it lasts longer.” (Idowu)

The year after, in 2018, Idowu attended an EMIS conference by UNESCO in Paris and challenged the attendees, pointing out that “investment that development partners were putting in ... health data was more than what education development partners were putting on data.” The challenge was picked up, and so the new Gambian EMIS process started.

With the work of the new government’s national development plan in April 2018, Idowu was invited to a presentation, in which *he met Mosi, who had been working with the DHIS2-HMIS implementation in the Ministry of Health since its introduction in 2009. “After the presentation, I said, ‘Mosi, come to my office!’ Then *he came. That was the day we heard about DHIS.” The EMIS team were already working on Stateduc and CSPro but decided to learn more about DHIS2. They requested more information from Mosi, but as *he was very busy, they did not hear from Mosi again. However, in November 2018, Idowu was invited to New York for a follow-up meeting from the EMIS conference earlier that year. There *he met a UiO HISP employee working on DHIS2, who could explain further about DHIS2 and the HISP network. Idowu was invited to a meeting with a Norad representative, in which *he explained the situation in The Gambia. In February 2019, Idowu received a notification, that “Norad is considering including what you are telling me.” To use Idowu’s own words: “This is how it started.”

MoBSE is currently in the initial phase of the DHIS2-EMIS implementation, trying to get more buy-in and develop “a full-fledged DHIS database that is like the EMIS we had, where everybody was having access to it” (Idowu). EMIS is used by everybody along the chain, from education officers to the minister. As for the DHIS2-EMIS, it is currently used by some teachers at some schools, as well as by the EMIS team at the planning unit.

To avoid having only a few key persons that know the system, Idowu explains enthusiastically, “The goal is to get something ... like Facebook. *Everybody* uses it, whenever they want. Nobody controls it. So, data is just used.” And now, as they are implementing DHIS2 as the backbone for their EMIS and recently hosted the world’s very first DHIS2-EMIS academy, *he exclaims, “Come on! This is it!”

Idowu's reflections give a good overview of how the Gambian implementation process started and the challenges they have had. Idowu's reference to Facebook indicates that *he wanted to implement something widely known by others at the same time as all the local EMIS stakeholders know how to use the system. While DHIS2 is a system used in more than 100 countries, and even as the foundation for the Gambian HMIS, it still requires extensive capacity building in the educational sector to make sure DHIS2-EMIS becomes something "everybody uses" (Idowu). The HISP network and the established north-south-south collaboration practices have already contributed to significant strides towards the nation-wide rollout of and training in DHIS2-EMIS. As Idowu indicated, being part of and relying on the HISP network helps on the long journey they have just embarked on. Like s/he said: "If you want to go very far, you have to go with a lot of people." And indeed, a platformization process of a nation-wide EMIS is a long journey.



Figure 3-2. A head teacher's office showing quite some paperwork.

4 Research Approach

Embarking on a Ph.D. project initially intended to follow an action research approach during a worldwide pandemic proved to be a bit too optimistic. In section 4.1, I describe my research journey and how the Ph.D. project was reshaped. In 4.2, I explain the motivation behind the literature reviews, while 4.3 places the research in the interpretivist research paradigm. Section 4.4 gives an overview of the empirical data collection that forms the basis on which the theory development in this thesis was tested. In section 4.5, I explain how the theorizing has been an iterative process. I conclude this chapter by highlighting some ethical reflections on my research project.

4.1 Research Journey

Initially, this project set out to investigate the data use innovations afforded by the platformization of the EMISs in The Gambia, Uganda, and Togo, using the affordance lens to interpret the findings and contribute to understanding the differences between the DHIS2-EMIS implementations in the three countries. However, the Ph.D. project has undergone significant adjustments through the period it has been undertaken. The reason for the change of plans is threefold.

First, due to the Covid-19 pandemic and lockdowns, Norwegian authorities did not recommend international travel. Employees at UiO were also, for longer periods, obliged to work from home. I embarked on my three-year-long Ph.D. journey in August 2020. The government-imposed travel restrictions were not lifted until January 2022, so I had my first field trip to The Gambia in February 2022.

Second, The Gambia, Uganda, and Togo are at very different stages in their DHIS2-EMIS implementations. Comparing the DHIS2-EMIS use across these three countries would be counterproductive.

Third – and related to the two preceding reasons – a scope of three countries is quite wide. Due to the differences in the DHIS2-EMIS implementations in the three countries and the limited time left of the Ph.D. period after the travel restrictions were lifted, it was unrealistic to do in-depth studies in all three countries. I thus decided to narrow the scope down to one country and test the theoretical frameworks on empirical data from this country rather than participate in any action research project. During the work with my master's thesis (Valbø, 2010), I spent three months supporting the DHIS2-HMIS implementation in The Gambia and learned a lot about the country, the culture, and the working environment. When narrowing the scope down to one country, it was thus natural to choose The Gambia as the empirical setting rather than Uganda or Togo. The

empirical data collection activities are outlined in section 4.4. Figure 4-1 shows the research activities performed during the work with this thesis.

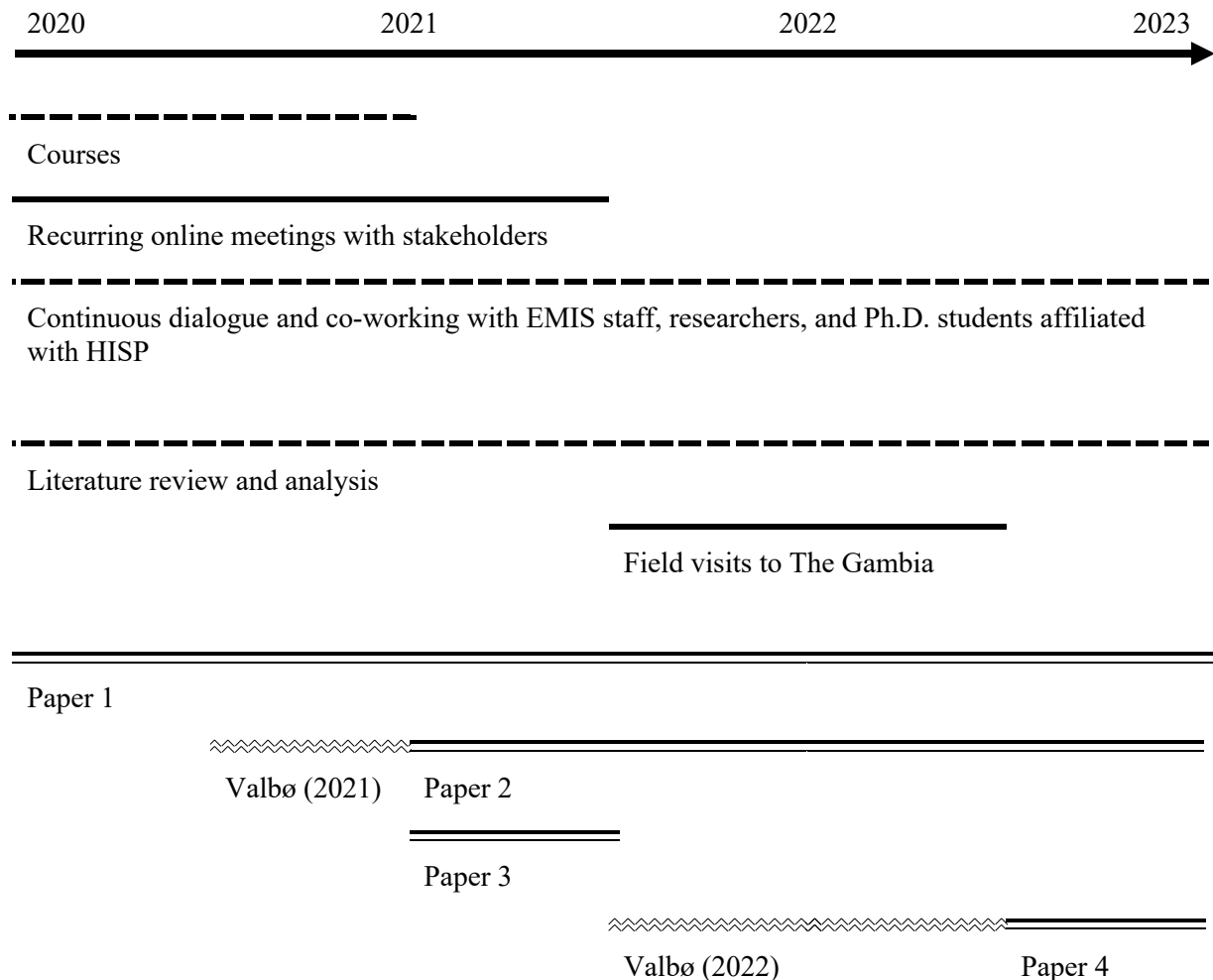


Figure 4-1. Research timeline. Solid lines = primary data sources. Dotted lines = secondary data sources. Double lines = paper writing. Paper 2 is a further developed version of Valbø (2021), while paper 4 is a further developed version of Valbø (2022).

4.2 Literature Reviews

Affordance theory was first introduced by Gibson (1977, 1979) to the field of ecological psychology. The theory explains how actors perceive objects in terms of what action possibilities they can afford rather than their physical appearance. The theory quickly gained traction in several research fields, including IS. While studying organizational change, it makes sense to investigate perceived and actualized action possibilities afforded by a technology. In my research, I wanted to study how the introduction of DHIS2-EMIS could affect work routines. I wanted to explore which possibilities the

local stakeholders perceived and how they wanted to approach these. The affordance lens thus seemed like an appealing lens to investigate my case. While waiting for the travel restrictions to be lifted, I decided to read up on affordance literature in IS research.

Since the affordance theory was developed to describe relations between animals and objects, it needed to undergo substantial adaptations to be of any proper use in IS research. Several IS scholars have contributed to this adaptation. However, as I delved into the IS affordance literature, it became apparent that there were differences when it came to the very basic understanding of an affordance, as well as how the concept was used in IS research. The IS community was further missing a thorough literature review on the application of affordance theory in IS research. I thus decided to perform a literature review on IS research using the affordance lens. Valbø (2021) was presented at the Information Systems Research Seminar in Scandinavia (commonly referred to as IRIS) in August 2021, and the workshop feedback was used to develop the paper further into a journal version (paper 2). Paper 2 is a descriptive literature review (Paré et al., 2015), following a three-phased sequential approach of (1) input (searching), (2) processing (analyzing and synthesizing), and (3) output (writing; Levy & Ellis, 2006; Vom Brocke et al., 2015).

4.2.1 Literature review method

The literature review aims to uncover the various ways the affordance concept has been applied in IS research. More specifically, I wanted to investigate how IS scholars have defined affordances, how they have identified affordances, and what they have identified as affordances. As such, I adopted a descriptive literature approach, as the aim was to “determine the extent to which a body of empirical studies [the review set] in a specific research area [IS research] supports or reveals any interpretable patterns or trends with respect to pre-existing propositions, theories [affordance theory], methodologies or findings” (p. 186). The approach for the literature review followed the three stages of 1) input (searching), 2) processing (analyzing and synthesizing), and 3) output (writing), as proposed by Levy and Ellis (2006). The steps are explained in the following.

Step1 – searching and scope. Paré et al. (2015) note that the aim of a descriptive review is not to be comprehensive but rather to present “a representative sample of a larger group of published works” (p. 189). Assuming that the most ambitious contributions to the appropriation of AT to the IS field can be found in prestigious IS journals, I thus considered the top ranked IS journals comprising the AIS Senior Scholars’ basket of eight journals, namely, the *European Journal of Information Systems (EJIS)*, *Information Systems Journal (ISJ)*, *Information Systems Research (ISR)*, *Journal of AIS (JAIS)*, *Journal of Information Technology (JIT)*, *Journal of MIS (JMIS)*, *Journal of Strategic Information Systems (JSIS)*, and *MIS Quarterly (MISQ)*.

Given the uniqueness of the term “affordance,” I opted for a focused approach using the keywords “affordance” and “affordances” for the literature search. Utilizing Web of Science, I used their “advanced search” possibility to search for papers with these keywords in their titles and/or abstracts. The search was confined to the specified IS journals. Executed on April 8th, 2021, the search yielded 71 results. In terms of the timeframe, the search spanned all papers published in the selected journals, resulting in publications ranging from 1999 to March 2021. This comprehensive and focused approach laid the groundwork for the subsequent literature review on the application of AT in IS research.

Step 2 – Processing. I implemented exclusion criteria to refine the dataset for in-depth analysis. Specifically, two editorials were excluded, leaving 69 articles for examination. To facilitate distinct analyses, two subsets were created: one for publication trends analysis and another for affordance analysis. The latter subset, comprising 54 articles, resulted from the removal of 15 articles lacking affordance findings.

Drawing inspiration from Glass et al. (2004), a paper classification scheme was established, aligning with key dimensions: (1) research type, (2) research method, (3) level of analysis, and (4) the nature of the study (prescriptive or descriptive). This classification aimed to discern prevalent research types and methodologies employing the affordance lens. Considering that AT initially targeted individual organisms, its adaptation to organizational contexts in IS research necessitated a classification by the level of analysis (individual or organizational). Additionally, the scheme distinguished between descriptive and prescriptive articles, shedding light on researchers’ usage of the affordance lens and their contributions to the appropriation process of AT to IS. This classification scheme served as a foundation for developing an emergent concept matrix and informed the subsequent coding process (Vom Brocke et al., 2015), explained in the following.

In the affordance categorization process, I conducted an iterative classification and coding of the identified affordances. Following the initial article classification, a subsequent iteration identified the 327 affordances explicitly mentioned by the authors. Each affordance underwent coding based on a concept matrix encompassing four dimensions: (1) enactor, (2) beneficiary, (3) granularity level, and (4) naming convention. Dimensions 1 and 2, focusing on enactors and beneficiaries, were integral for understanding who enacted and benefited from the affordances, aligning with the context of IS research. Dimension 3 addressed granularity levels, emphasizing the appropriate level for studying affordances in IS research. Dimension 4, naming conventions, aimed to comprehend the consistency of affordance labeling in IS research. Naming conventions, such as gerund, infinitive, possibility, present, and noun, reflected diverse approaches by IS researchers in articulating affordances.

To ensure uniqueness, I removed duplicate affordances, resulting in 306 distinct affordances. The literature review process is summed up in Table 4-1.

Step 3 – Output. Levy and Ellis’ (2006) last step of the literature review process regards the writing of the literature review. The findings of the literature review are presented in section 5.1.2.

For further details on the methods applied in the literature review, refer to paper 2.

Table 4-1. The literature review process (from paper 2)

Step	Action	Outcome
1: Input	Keyword search in SSB journals w/Web of Science	71 articles
	Keyword search in the SSB journals’ databases	0 additional articles
	Excluded two editorials	69 articles
	Excluded five 2021-articles from trend analysis ^{*)}	64 articles
	Excluded 15 articles with no identified affordances from the affordance analysis ^{**)}	54 articles
2: Processing	Developed classification scheme	Four categories
	Classified articles	
	Performed trend analysis	
	Identified affordances	327 affordances
	Developed coding scheme	Four dimensions
	Coded affordances	
	Removed duplicate affordances	306 affordances
	Performed affordance analysis	
3: Output	Writing and publishing the findings	
^{*)} The five 2021-articles were included in the analysis of the affordances ^{**)} The five articles with no identified affordances were included in the trend analysis		

4.3 Philosophical Underpinnings

Of the three major commonly recognized research paradigms (positivism, interpretivism, and critical theory; Chua, 1986; Orlikowski & Baroudi, 1991), I subscribe to the interpretivist paradigm. I “[attempt] to explore the phenomena of interest [DHIS2-EMIS] in its natural setting” (Orlikowski & Baroudi, 1991, p. 6). When studying technology-driven organizational changes involving actors engaging in social practices, such as information processing, I find it challenging to assume that an objective reality can be studied using quantitative methods. To quote Orlikowski and Baroudi (1991), paraphrasing Morgan (1983), “the more we recognize that information processing is a social practice that impacts on a social world, the less appropriate the positivist approach becomes” (p. 25). Sure, empirical observations and measurements can be done, but as actions of human actors are involved, inspired by a reality that is interpreted by the actors, I find the interpretivism paradigm more suitable. In an organization in which individuals are embedded and interact with technology, the “empirical world is ... subjective and hence having existence only through the action of humans in creating and recreating it” (p. 8). It is impossible to make hard predictions when humans are involved (Taylor, 1971), and I found the application of interpretive methods to be a necessity for my research.

This thesis does not intend to expose “deep-seated structural problems,” “critique the status quo,” or “remove contradictions from organizations and society” (Orlikowski & Baroudi, 1991, p. 6). The critical approach is thus not optimal for this study.

4.3.1 An interpretive case study

Gadamer (2013) claims that our understanding of the world is shaped by language and interpretation (p. 407). Since the hard predictions in natural sciences are not replicable in studies involving humans (Taylor, 1971, p. 49), IS researchers use interpretive methods to uncover the complexities embedded in the context of an information system. In his seminal book *Interpreting Information Systems in Organizations*, Walsham (1993) proposes “interpretive methods of research, aimed at producing an understanding of the context of the information system, and the process whereby the information system influences and is influenced by its context” (p. 9). Parts of the goal of my research was to use the affordance lens to try to understand which factors shape the implementation, use, and outcome of DHIS2-EMIS in The Gambia. Through detailed examination and interpretation of qualitative data – both from the literature review and from the empirical setting – I attempt to uncover the interplay that is taking place between the technology and its context. To assert the generalizability of my theoretical framework that was developed from the literature review, it was tested on empirical data from The Gambia. It proved to be a useful tool that helped understand the processes that shaped the implementation, use, and outcomes of the DHIS2-EMIS

implementation in the country. In the following (section 4.4), I describe more about what I did and the means that were taken to mitigate the risks of misinterpretations.

4.3.2 An interpretive literature review

The literature review in the thesis also aligns with interpretivism since it attempts to understand subjective interpretations and meanings attributed to the affordance concept in the IS field. We analyze how IS scholars have adapted and extended affordance theory to suit the complex socio-technical contexts we are studying. Our work highlighting the various ways IS researchers have used the affordance concept echoes an interpretivist perspective of studying diverse subjective interpretations. Furthermore, the modeling approach used to develop the nested affordance process model (NAP) from existing models and contributions reflects the interpretivist stance of seeking to uncover the underlying meanings and relationships between concepts.

4.4 Empirical Data Collection and Analysis

4.4.1 Fieldwork

During 2022, I had three visits to The Gambia for a total of five weeks. The first and third visits were dedicated to data collection through school visits, roundtable meetings, and interviews with relevant educational stakeholders. On the second visit, I attended the DHIS2 for Education Academy, which was hosted in the country by MoBSE and included participants from 18 countries and eight ministries of education. The data collection processes are outlined briefly below. Refer to paper 4 for details.

Roundtable meetings. On the first visit to The Gambia, we were a team of seven people from the HISP center, consisting of operational staff and research staff. Together, we visited several schools to learn from their experiences from the initial phase with DHIS2-EMIS and discuss potential problems they had. Together with the HISP team, I participated in six roundtable meetings at Gambian schools. I decided to sit in on these roundtable meetings to better understand the possibilities and challenges the Gambian stakeholders faced during the DHIS2-EMIS implementation and initial phases of usage.

Semi-structured interviews with individuals. With my main supervisor, who has been following the DHIS2-EMIS planning and implementation in The Gambia since the beginning, and a fellow EMIS Ph.D. student working in MoBSE, we identified some key stakeholders to start interviewing. We then applied the snowballing approach to identify new informants. The informants represent different levels in the educational sector in The Gambia, ranging from teachers to MoBSE employees.

The interviews for the first visit focused on how DHIS2 had been set up and used. Although the informants were asked about future possibilities and implications of the

use of DHIS2-EMIS, the answers revealed limited aspirations for the future. The questionnaire was thus modified slightly for the second field visit, attempting to nudge the informants towards revealing more of their aspirations for the future with DHIS2-EMIS and how the introduction and continuous use of DHIS2-EMIS could affect the Gambian education sector in particular, and Gambian society at large.

Table 4-2 shows an overview of the interviews done in the work with this thesis. I had more than double the number of interviews on the second field trip. Three main reasons explain that. First, I tested positive for Covid-19 upon arrival in The Gambia and spent the first week isolated in the hotel room. Second, The Gambian teachers were on strike, effectively making it difficult to locate interviewees. Third, the team I was traveling with had planned roundtable meetings with various stakeholders, leaving less time for individual interviews.

Table 4-2. Interview overview (adapted from paper 2)

Interviewee	First field trip	Second field trip
EMIS [†] Head	1 interview	1 interview
Technical advisor, EMIS unit	1 interview	1 interview
2 ICT officers, EMIS unit	1 interview (both together)	1 interview (both together)
ICT officer, EMIS unit	-	1 interview
Regional director	-	1 interview
2 Planning focal points [‡]	-	2 interviews
Assistant cluster monitor [§] focal point [¶]	-	1 interview
3 Cluster monitors	1 interview	2 interviews
Ex-cluster monitor	-	1 interview
2 Head teachers	1 interview	1 interview
ICT teacher	1 interview	-
Teacher	-	1 interview
[†] Education management information system. [‡] The planning focal point is the regional contact person for the planning unit in the Ministry of Education. [§] A cluster monitor has an advisory role for a cluster of schools. [¶] A cluster monitor focal point is the person responsible for coordinating the region's cluster monitors' work.		

Table 4-3. Overview of document sources and routine meetings (adapted from paper 3)

Data source	Type
Education Sector Strategic Plan 2016-2030 (Ministries of Basic and Secondary Education and Higher Education, 2017)	Official Gambian government publication
The shift from aggregate to individual-level data system in the case of The Gambia EMIS (Internal project document)	Ph.D. Proposal to the University of Oslo by a MoBSE employee
Meeting the Education Data Crisis: A Research Agenda on Digital Platforms for Education Management (paper 1)	Research opinion article
Information system centralization and decentralization: The introduction of digital learner records in The Gambia (Jallow & Sanner, 2022)	Conference proceedings article
17 Bi-weekly EMIS status and update meetings. Participants: • The EMIS project manager (HISP center) • 3 scientific staff (HISP center, including my main supervisor) • 1 Ph.D. research fellow (me) • 10 representatives from national EMIS implementations in The Gambia (2), Uganda (4), Mozambique (1), Sri Lanka (1), and Togo (2)	Recurring meetings with local stakeholders for EMIS implementations in The Gambia, Uganda, Mozambique, Sri Lanka, and Togo
20 Bi-weekly EMIS project coordination meetings. Participants: • The EMIS project management team ○ The EMIS project manager ○ 1 professor ○ 1 associate professor (my main supervisor) ○ 1 senior engineer • 1 Ph.D. research fellow (me)	Recurring meeting for HISP's EMIS project management team at the HISP center (UiO)
18 Bi-weekly research meeting. Participants: • 3 scientific employees at the HISP center ○ 1 professor ○ 2 associate professors (including my main supervisor) • 3 Ph.D. research fellows ○ 1 MoBSE employee currently doing a Ph.D. at UiO studying the Gambian <i>EMIS shift</i> towards individual data collection and reporting. ○ 1 HISP Uganda employee involved in the expansion of DHIS2 from the health sector to the education sector. Doing a Ph.D. studying disaggregation of decision-making in the Ugandan education sector. ○ Me	Recurring meeting among Ph.D. research fellows studying EMIS implementations in The Gambia and Uganda and our supervisors

Longitudinal routine meeting participation. During the work with this thesis, I have participated in recurring online routine meetings that have informed my work. These can be divided into three categories. First, in the EMIS status and update meetings with local stakeholders in The Gambia and four other countries implementing DHIS2-EMIS, the participants shared updates from their DHIS2-EMIS implementations, and we discussed challenges and shared ideas. These meetings gave me valuable input regarding the progress and challenges of the DHIS2-EMIS implementations. Second, in the EMIS project coordination meetings with HISP staff, we further discussed the issues raised in the status and update meetings. Furthermore, we discussed how to modify the DHIS2 software to cater to the educational sector's needs and plan the DHIS2 for the education academy in The Gambia and field trips. Third, in the research meetings with fellow EMIS Ph.D. students and HISP EMIS research staff, we shared research ideas with each other, discussed our progress, and coordinated work efforts for paper 1, which we are co-authoring together. Table 4-3 shows an overview of the longitudinal meetings I have participated in, along with key documents further informing my understanding of the context in which I conducted my research.

4.4.2 Secondary data sources

Document analysis. In addition to the literature review on IS affordance research, documents on EMIS in general and EMIS in The Gambia, in particular, were analyzed. Together with fellow EMIS Ph.D. students and our supervisors, we wrote a research opinion (paper 1) where we presented extant literature on EMIS and positioned EMIS as an IS research object.

4.4.3 Data analysis

The theorizing in the first empirical paper (paper 3) is based on the findings from the literature review paper presented at IRIS 2021 (Valbø, 2021), accumulated knowledge from both the DHIS2-HMIS and DHIS2-EMIS implementations in The Gambia, longitudinal routine meeting participation, and document analysis. Since DHIS2 was implemented as the backbone for The Gambia's HMIS in 2010, my main supervisor has closely followed the use of DHIS2-HMIS in the country. When MoBSE planned for a DHIS2-EMIS implementation, he also played a key role in this process. I then re-joined the HISP community after a 10-year-long break after my master's thesis and started to follow the online routine meetings as a Ph.D. research fellow. When we worked on paper 3, we derived action possibilities from the accumulated knowledge we possessed about the use of DHIS2-HMIS, as well as the DHIS2-EMIS implementation process MoBSE had embarked on. We used the preliminary findings from Valbø (2021) to theorize the importance of mid-level affordances.

For the second empirical paper (paper 5), I used the interview transcriptions to derive affordances, while the information gathered in the roundtable meetings and the DHIS2

for education academy informed the understanding of the context. I manually transcribed the interviews. Once transcribed, I carefully went through the 138 pages of interview transcriptions, looking for performed actions and aspirations for the future. I also took note of the prerequisites for the emergence and actualization of the identified affordances. The identified affordances were color-coded in the documents to distinguish actualized and non-actualized (i.e., only perceived) action possibilities. This exercise resulted in 235 identified affordances. I then sorted the affordances and derived grouped affordances based on similarities (e.g., *enter data*, *enter daily attendance*, *enter attendance*, *enter annual census data*, *input*, and *input data* were all grouped together to *data entry*). The groups were then further categorized into second-order group affordances (e.g., *data entry*, *store data*, *student registration*, and *self-registration* were categorized under the second-order group affordance *register data*). Finally, I derived the four overarching affordances *configurability*, *capturability*, *processability*, and *actionability*. Table 4-4 shows a subset of the affordances identified and how they were grouped through three iterations to derive the four overarching affordances.

In the work with affordance identification and categorization, I reflected a lot on what an affordance is and how to categorize the affordances in terms of the granularity levels derived from the literature review (paper 2). Since a framework guiding such processes does not exist, I developed the affordance identification framework (AIF) to explain how I was thinking during the analysis of the affordance identified in the interviews with Gambian stakeholders. The theorizing in this thesis has thus been iterative, which I will explain more in the following.

4.5 Iterative Theorizing

The theoretical contributions of this thesis have emerged through an iterative process. As illustrated in Figure 4-1, the theorizing started out with the first literature review (Valbø, 2021), in which I point out the divergent use of the affordance concept in IS research. My work is inspired by Leidner et al. (2018), who urge IS researchers to look beyond mere technology use. This was the background for the introduction of the notion of mid-level affordances in paper 3, as we explored identified affordances in the educational sector in The Gambia. Valbø (2021) and paper 3 were written fairly early in my Ph.D. journey and, as such, might not contain the same qualities as a paper from a senior scholar. They served nevertheless as a good point of departure for paper 2, which is a further reworked version of Valbø (2021). Paper 2 has undergone several revisions to reach its current form.

Table 4-4. Examples from the coding process of the capturability and processability affordances (from paper 4)

Identified affordances	First-order grouping	Second-order grouping	Overarching affordances
Collect data on time [†]	Collect data		Capturability
Collect enrolment data			
Collecting teacher attendance			
Enter annual census data	Data entry	Register data	
Enter daily attendance			
Enter data			
Store individual information about disability, health, family	Store data		
Enrol students	Student registration		
Register students			
Fill the form on [credentials]	Self-registration		
Upload documents			
Upload their credentials			
See enrolment	See data/ information	Gather information	Processability
See information			
See the data			
See the input			
Easily request/get data	Retrieve data		
Extract data			
Get some facts			
Get some reports			
Send data	Send/sync data	Share data	
Send enrolment			
Sync daily attendance			
Facilitate information flow through the structure	Share data across levels		
Forward things			
Share data			
Analyse data on time	Analyse data	Analyse data	
Analyse thematic areas			
Transform/refine data into information			
Look at trends	Identify trends		
See what is critical of evolvement			
Compare indicators	Compare data		
Look at comparisons here and there			
† The identified affordances in column 1 are named according to the informants’ own words/terms used in the interviews.			

Another important factor for developing this thesis is the valuable reviewer comments. For instance, paper 2 has undergone several major revisions. Starting off from Valbø (2021), via a desk reject from one journal, a reject from another journal, and then finally through a major revision at the current journal, the paper has been continuously reshaped. An example of impactful reviewer feedback is that the NAP was actually proposed by a reviewer from the second journal to which the manuscript was submitted.

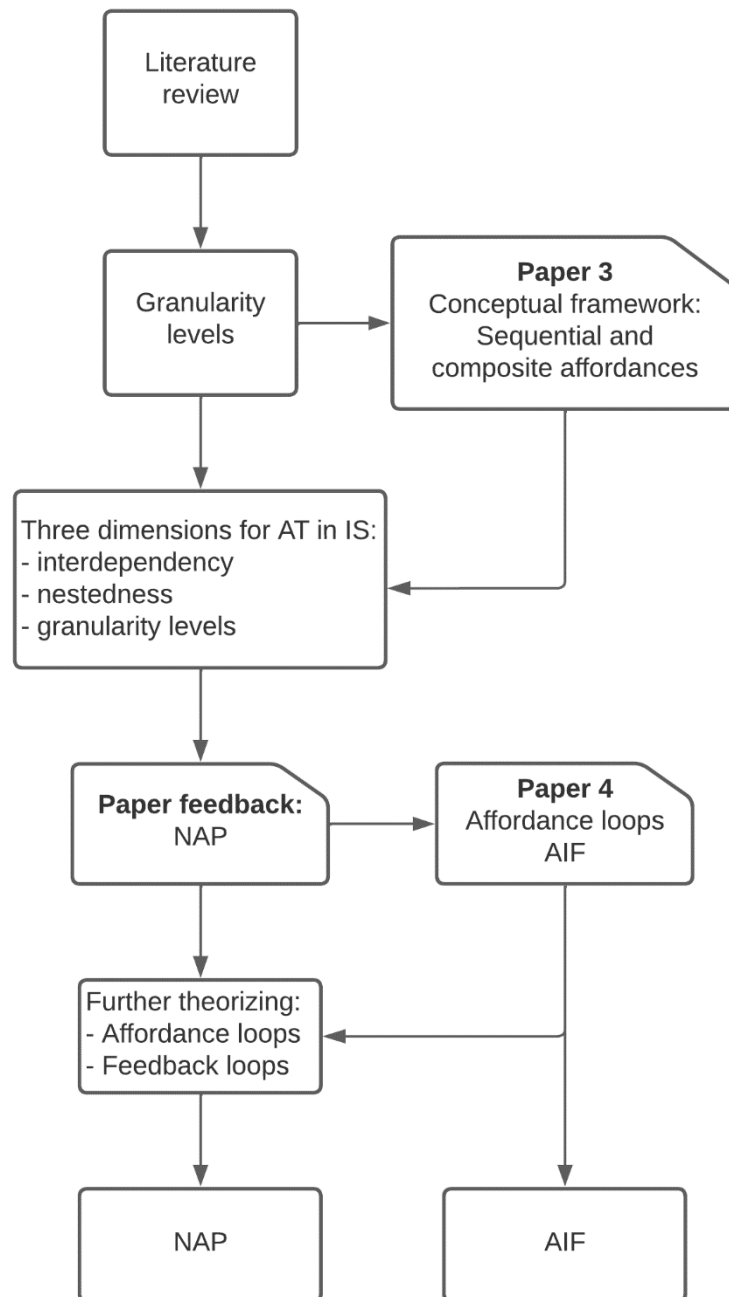


Figure 4-2. Iterative theorizing

Parallel to the work with paper 2, I submitted a paper to the pre-ICIS workshop for the special interest group of Global Development (Valbø, 2022), in which I introduce the affordance identification framework (AIF) but also present the nested affordance process model (NAP), which was being developed in parallel in paper 2. As I revisited the empirical data from Valbø (2022) and analyzed new data, I discovered that the outcome of affordances could serve as stimulating conditions, even if the affordance is not yet enacted. That was how the idea of *affordance loops* was born during the work with paper 4, which builds on Valbø (2022). Then, when revisiting the review set for paper 2, we discovered that we could indeed find support for the notion of affordance loops from extant research as well. In the latest version of paper 2, the NAP thus contains affordance loops.

All in all, the theorizing in this thesis has been an iterative process, going back and forth between literature and empirics. This iterative theorizing process is illustrated in Figure 4-2. A further and deeper synthesis of how the papers are connected and form a whole is presented in section 5.

4.6 Research Ethics

The empirical data used to build the theoretical arguments in this thesis is collected in an LMIC setting. My case study “brings together researchers and participants who come from very different contexts” (Dearden & Kleine, 2018) and positions itself as ICT4D research. Therefore, reflecting on issues that may arise in such a diverse and complex research setting is worthwhile. Dearden and Kleine (2018) have developed twenty guidelines for ICT4D research, and the most relevant for my research are presented in Table 4-5, along with a brief reflection. There are, however, some guidelines that are particularly prominent, such as guidelines 1, 2, and 11.

When a representative from the university that freely develops and provides the software that the entire educational sector in The Gambia is about to implement, one can but wonder whether a Gambian teacher feels obliged to participate in an interview with a researcher from this university. I am fully aware that I, as a researcher, have no moral or legal right to study other people, let alone use the time of the informants. For my first field trip, I formulated the supportive questionnaire for the interviews in a way that could help me learn about the DHIS2-EMIS implementation. After analyzing the initial results, a pattern emerged, and I created a new supportive questionnaire for the second visit in order to tease out even more answers that could further corroborate and strengthen my theoretical arguments. Relevant informants were identified in collaboration with a MoBSE employee, and we traveled together to these informants. I was, of course, eager to hear what they had to say, but I still did my best to maintain a

humble approach, emphasizing that participation in the interviews was completely voluntary. In the end, I truly believe that the informants participated wholly and fully voluntarily and that the information they provided in the interviews reflects the actual situation. Some answers were quite honest and bordered on criticism of approaches and processes. Before I published any paper using quotes from informants, I shared the papers with the informants, asking them to review the information provided and for their final approval of their quotes.

Further, my research's main unit of analysis is information system use. As such, there is no need for storing sensitive data, such as personal identification numbers. Neither did I process any beneficiary data (i.e., data of pupils and students), only data (names, phone numbers, and or email addresses) of the informants. Informed consent was sought in all interactions with the informants, and the purpose of my research was communicated to all informants.

Table 4-5. Reflections on ethical guidelines for ICT for development (ICT4D) research.

#	Guideline	Reflection
1	Researchers do not have moral or legal right to study other people	I do acknowledge that it is not my right to intervene in other people's lives and demand their time. On my field trips, I traveled with locals and politely asked people of interest whether they would like to participate in research, emphasizing that it was completely voluntary.
2	There might be power differentials causing the researchers to be perceived as important and influential actors	This is an important thing to keep in mind, and I strived to understand whether an interviewee's consent was genuine or whether it was due to whether s/he thought s/he <i>had</i> to comply
6	Unrealistic promises should never be used as a device to gain research access and cooperation	I have not given any unrealistic promises. I promised to reach out if I use a quotation from an interviewee in any form of publication.
8	Where it is culturally appropriate and expected, researchers may give and/or receive small gifts to partners or participants, as well as compensation for research participation	This was something that I was cautious of when analyzing my data. It is always tempting to mold the findings towards the result I expect. However, in this case, I was rather surprised to see how my findings emerged and revealed things that I did not anticipate in the beginning.
11	Research findings often require interpretation, and there is a high risk of misunderstanding and misinformation if the findings are being interpreted by people who are coming from outside the local cultural context	I have presented my findings and my publications to a fellow Gambian EMIS Ph.D. student to reduce the risk of misinterpretations. The papers have also been shared with the informants prior to publication.
17	Researchers should familiarize themselves with the legal rights of participants and partner institutions in relation to research data	The interview guides and details around the interview processes have been shared with and approved by the Norwegian center for research data (commonly referred to as NSD).
18	Personally identifiable data should be stored for the minimum length of time	Names and contact details will be stored separately from the interview transcriptions and will be deleted at the end of the Ph.D. period.
18	Collection of personal data should follow principles of data minimization so that no more data is collected than is necessary for the purposes or the methodology of the research, and personal data is anonymized and protected as soon as practically possible.	I collected only the necessary contact details from the interviewees so that I could contact them to approve quotations and facts in the papers. NSD has approved the collection and handling of personal data.

5 Findings

This thesis features four papers (Table 5-1). One paper is published in a peer-reviewed conference proceedings (paper 3 [Valbø & Sanner, 2022]), one is published in a peer-reviewed journal (paper 4 [Valbø & Sanner, 2023]), while two (papers 1 and 2) are in review processes. Papers 2 and 4 are further developed versions of already published papers (Valbø, 2021, 2022, respectively). Thus, four out of six papers have been published during my Ph.D. journey. Since papers 2 and 4 build on previously published papers, those are not included in the thesis, as most of the material in the published papers (Valbø, 2021, 2022) is also included in papers 2 and 4.

In the papers that constitute this thesis, theoretical approaches have been developed and contributed to developing the analytical frameworks adopted by this study. Although paper 2 – the paper that contains the major arguments for my theoretical contributions – has not yet been published, it has reached a second round of review in a top-tier IS journal, which indicates that the paper’s content meets a certain level of quality. In this chapter, I will summarize the findings and contributions in section 5.1, followed by a synthesis of the findings in section 5.2. The synthesis demonstrates how the papers build on each other and present the findings as a coherent whole.

5.1 Summaries of Research Papers

The papers that constitute this thesis are listed in Table 5-1 and are thematically sorted. Paper 1 is a research opinion, positioning EMIS in the IS literature and drafting an IS research agenda for EMIS. It is particularly concerned with the implication of well-functioning EMISs in LMIC settings and positions itself naturally within ICT4D research. Paper 2 is a literature review on affordance research in top-level IS journals. Paper 2 is a further developed version of Valbø (2021)¹⁸. Papers 3 and 4 are case studies from the educational sector in The Gambia. The findings in paper 3 are based on accumulated knowledge through more than a decade of research activities in The Gambia, and the theorizing is supported by the findings in an earlier version of paper 2 (Valbø, 2021). Paper 4 is a further developed version of Valbø (2022)¹⁹. The empirical data in paper 4 are from field visits to The Gambia. The theorizing in paper 4 applies the nested affordance process model (NAP) introduced in paper 2. Paper 4 extends this model by introducing the affordance identification framework (AIF). Thus, the papers build on each other and cumulate in paper 4. Although paper 4 uses empirical data from

¹⁸ Valbø (2021) was presented at the 44th Information Systems Research Seminar in Scandinavia (IRIS2021) and published in *Selected Papers of the IRIS, Issue Nr 12*.

¹⁹ Valbø (2022) was presented at the 14th Annual AIS SIG Global Development Pre-ICIS Workshop and published in the *GlobDev 2022* proceedings.

an LMIC setting, the theorizing also builds on the findings from the literature review in paper 2. The contribution of papers 2, 3, and 4 should thus be relevant to a broader IS audience.

In the following subsections, I present the findings and the contributions of each of the papers.

Table 5-1. The papers that constitute this thesis.

	Title, type	Authors	Year	Outlet
1	Meeting the Education Data Crisis: A Research Agenda on Digital Platforms for Education Management Research opinion	Sanner, Terje Aksel Amuha, Monica Jallow, Seedy Ahmed Masiero, Silvia Valbø, Bjørnar	2023	Second review round with an international IS journal
2	Information Systems Affordances: A Literature Review and a Derived Conceptual Model Literature review Theory building	Valbø, Bjørnar Sanner, Terje Aksel	2023	Second review round with an international IS journal
3	Investigating Mid-level IT Affordances as Drivers for Societal Change: Addressing the Education Data Challenge in The Gambia Case study Theory building	Valbø, Bjørnar Sanner, Terje Aksel	2022	Proceedings of the 17th IFIP WG 9.4, Freedom and Social Inclusion in a Connected World, Lima, Peru, 25-27 May 2022
4	Informing Sustainable Development in Education: Identification and Actualization of Layered IS Affordances Case study Theory building and testing	Valbø, Bjørnar Sanner, Terje Aksel	2023	The Electronic Journal of Information Systems in Developing Countries

5.1.1 Paper 1: Meeting the Education Data Crisis: A Research Agenda on Digital Platforms for Education Management

Purpose. Although education is one of – if not *the* – most important factor for the development of a society, education management information systems (EMISs) are surprisingly understudied in IS research. A search on Web of Science returns five papers on “education management information system” for 2020-2021, while a search for “health management information system” returns 96 papers for the same timespan – almost 20 times more. We thus set out to develop an EMIS research agenda, positioning EMIS as an important IS research object.

Research approach. The paper draws on knowledge from an ongoing research endeavor in The Gambia and Uganda, where they have implemented DHIS2 as the backbone for their national EMISs. The countries have been using DHIS2 in their HMIS for more than ten years, and in 2019, they embarked on an implementation process of DHIS2-based EMISs. The paper synthesizes extant EMIS literature and develops an EMIS research agenda for the IS community.

Findings. The paper highlights that there is a lack of research on EMIS. There is, however, a substantial amount of grey literature that talks about the importance of well-functioning EMISs.

Research implications. The paper suggests that the IS community – especially the ICT4D community – directs more focus towards the educational sector at large and EMIS in particular.

Practical implications. Although this research opinion may not have immediate practical implications for practitioners, more research may lead to increased knowledge around EMIS and best practices, which in turn will affect the day-to-day work of stakeholders and practitioners.

Contribution to overarching research aim. The paper contributes to the overarching research aim by explaining what an EMIS is and its importance. EMIS is the research object of this thesis, and a proper understanding of this artifact is an important base for my research.

5.1.2 Paper 2: Information Systems Affordances: A Literature Review and a Derived Conceptual Model

Purpose. Affordance theory has gained traction in the IS research community, but the application of the notion of affordances varies a lot among IS researchers. If IS scholars are to build on each other's work, there should be a common understanding of the concepts at the core of the theories we are using. A comprehensive literature review on the application of the affordance lens in IS research was missing, and the motivation for performing a literature review was thus to contribute to a common understanding of the concept of affordances in the IS community. The paper delves into the affordance analysis of the identified affordances in a review set of 54 papers. It looks at the overarching affordance themes of the reviewed papers, analyzes 306 identified affordances to produce a benchmark, and summarizes how the affordance concept has been used in influential IS literature.

Research approach. Using Web of Science as a search engine, I searched for affordance papers published in the AIS Senior Scholars' basket of eight journals. The journals' databases were also consulted to make sure all relevant papers were included in the search results. Paré et al. (2015) note that the purpose of a descriptive review is not to exhaustively cover all available literature but to feature "a representative sample of a larger group of published works" (p. 189). Guided by this principle, the paper focuses on the top ranked IS journals contained within the AIS Senior Scholars' basket of eight journals. This choice was premised on the assumption that these prestigious journals are likely to host the most significant contributions to the appropriation of AT to the IS field. The paper analyzes 54 affordance papers from the eight basket journals and highlights IS scholars' understandings and applications of the affordance concept in IS research. Specifically, we derive three complexities of interest for IS researchers from Volkoff and Strong (2017) and analyze IS researchers' extensions to the AT with respect to these. The three complexities are granularity, trajectory, and composability. The paper also codes the affordances in terms of enactor, beneficiary, granularity level, and naming convention to lay the foundation for categorizing the affordances.

Findings. The paper identifies the various ways in which IS scholars have employed the concept of affordances. Although there seems to be a consensus on the definition of an affordance as an action possibility, researchers have often referred to technology artifacts, properties, and features as affordances, even using nouns to describe these potential actions (see Table 5-2). We identify three key complexities along which IS scholars have extended AT.

First, IS researchers talk about two *granularity* levels when identifying affordances, although with different terms (e.g., lower and higher levels, first and second order, and individual and organizational levels). The analyses of the affordances suggest that the

IS community could benefit from a third granularity level. Thus, the paper introduces the notion of mid-level affordances²⁰ to describe affordances that emerge as a result of basic technology use (i.e., lower-level affordances). Mid-level affordances denote a more abstract way of using technology, that is, an action aided by technology. A good example of a mid-level affordance is Hatakka et al.'s (2020) job information reachability affordance, which “[relates] to the use of ICT to find available jobs” (p. 680). The utilization of technology to actualize the affordance is unequivocally conveyed. Yet, the affordance does not correlate to a particular technological feature or function in the same manner that lower-level affordances do. Higher-level affordances emerge from the actualization of mid-level affordances and are, as the name suggests, at a higher level of abstraction. Although higher-level affordances do not denote direct use of technology, technology affords these actions. As Gibson (1977, 1979) explains affordances as something that is afforded by an object, we argue that higher-level affordances indeed are affordances emerging through the relationship between technology and the actors.

Second, inspired by Thapa and Sein (2018), we remain with the term *trajectory* to convey the idea that an affordance is coming from somewhere (i.e., has a trajectory of preceding events before its emergence). Sequential affordance interdependencies are also addressed by other scholars, such as Gaver (1991), Strong et al. (2014), and Burton-Jones and Volkoff (2017).

Third, *composability* relates to the fact that an affordance can be broken down into sub-affordances and thus is a composite of other affordances. This idea is addressed by scholars such as Gaver (1991), Markus and Silver (2008), and Cheikh-Ammar (2018). Thapa and Sein (2018) also allude to a similar idea as they explain how affordances cluster together to form an ensemble of affordances.

IS researchers' contributions along these complexities differ in the conceptualizations and partly overlap without clear development from one another. For instance, the affordance dependency diagram (Strong et al., 2014), the affordance network (Burton-Jones & Volkoff, 2017), and the trajectory of affordances (Thapa & Sein, 2018) speaks about how the actualization of affordances can trigger the emergence of other affordances. These and other theoretical contributions that have been made to the affordance theory to make it more suitable for IS research are presented in Table 2-2.

We synthesize the extensions and propose that IS affordances are nested composites that form sequential trajectories over time, spanning three major levels of granularity (low, middle, and high), displaying interdependency within and across granularity levels. To consolidate these key complexities, the paper presents a nested affordance

²⁰ Mid-level affordances are introduced to the IS community both in paper 2 and in paper 3. The work with paper 2 started before paper 3, but paper 3 was published before paper 2.

process model (NAP) that illustrates the interdependency between lower-, mid-, and higher-level affordances, as well as their contextual dependencies. The NAP is presented in greater detail in section 6.1.

Furthermore, the paper reveals that many affordance studies primarily focus on individual-level analysis, emphasizing lower-level technology use affordances enacted by individuals, resulting in outcomes that benefit the enactors themselves. Until 2018, there was a clear organizational focus in affordance research, while from 2019 onwards, the focus shifted toward individuals. This raises the question of whether IS scholars have lost momentum in their endeavors to extend and apply AT to comprehend complex organizational phenomena. Quantitative trends (e.g., the development in the number of affordance articles and citation statistics) are also presented in the paper.

Table 5-2. The ambiguous nature of affordances presented in IS research (presented in paper 2).

Nature of claimed affordances	Examples
Technology artifact	Forums; listserv groups (Alam & Campbell, 2017)
Technology property	Dynamism (Lankton et al., 2015); Open access (Arazy & Gellatly, 2012)
Technology feature	Automation (Deng & Joshi, 2016); Membership (Mckenna, 2020)
Technology feature use	Animatability (Ciriello et al., 2019); Inputting data (Burton-Jones & Volkoff, 2017)
Technology use	Connecting members (Sæbø et al., 2020); Reaching out virtually (Waizenegger et al., 2020)
Abstract	Assess wildlife distribution (Pan et al., 2020); Social connection (Jiang & Cameron, 2020)
Higher-level category	Organizational memory affordance (Chatterjee et al., 2015); Reflective disclosure (Seidel et al., 2013)
Non-tech-affordance	Practice improvability (Hatakka et al., 2020); Wearing (Benbunan-Fich, 2019)
Workplace environmental affordance	Ad-hoc information exchange; Sharing and consuming food and drinks (Waizenegger et al., 2020)
Mislabeled	Patient-perceived media richness; Patient satisfaction with teleconsultation (Li et al., 2020)

Research implications. The paper contributes to IS research with the introduction of a nested affordance process model (NAP; Figure 5-1), which is a framework that can be used to guide IS researchers towards the identification of affordances at an appropriate level of investigation so that we study the *consequences* of technology use rather than the technology use itself. The NAP separates affordances into three levels of granularity: lower-level technology use affordances, mid-level affordances, and higher-level affordances. Mid-level affordances emerge due to technology use (i.e., actualization of lower-level affordances) and denote action possibilities aided by technology. Mid-level affordances are thus tightly coupled to technology use and are typically what would be of interest to IS researchers studying organizational change. The higher-level affordances are more abstract action possibilities that emerge because of the actualization of mid-level affordances. The NAP presents the three complexities in affordance research in the IS community in one model and suggests a common terminology to discuss these dimensions. The NAP emphasizes that there is not a one-to-one relation between affordances. That is, the actualization of one affordance might lead to the emergence of several new affordances. Similarly, one affordance may require the actualization of several preceding affordances.

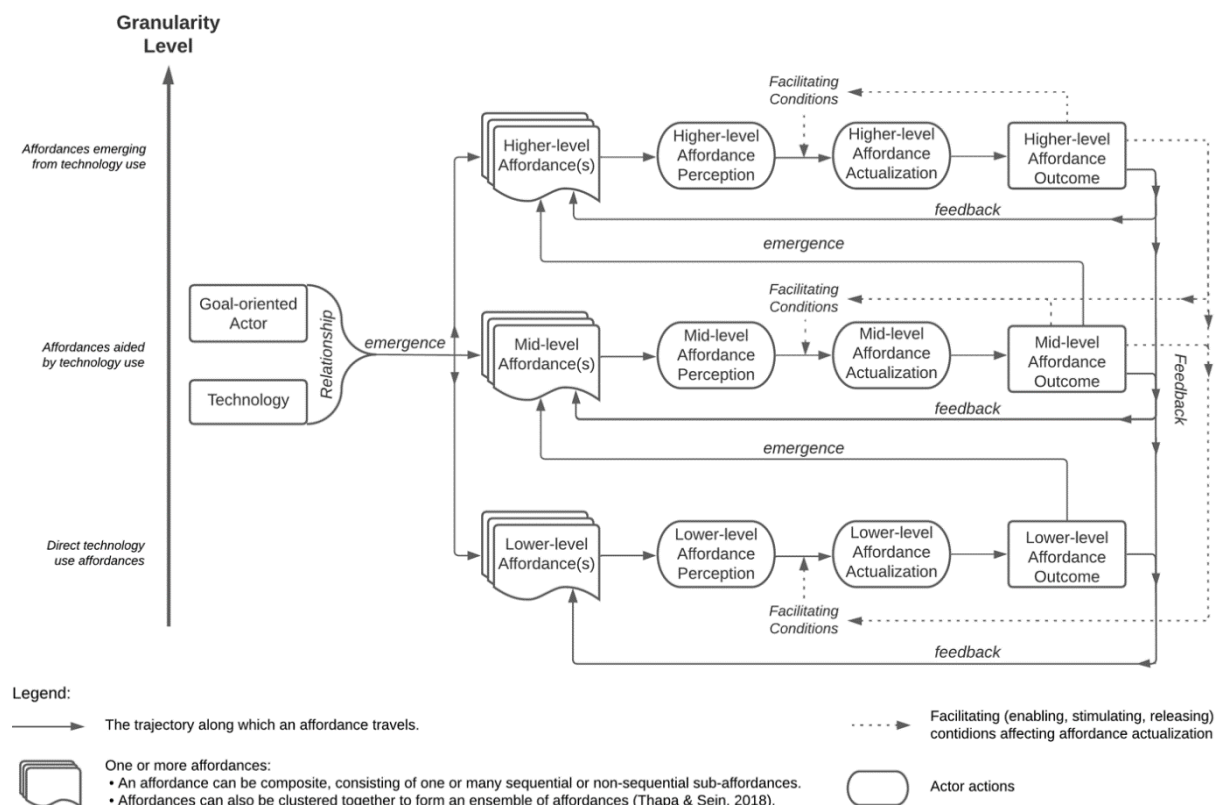


Figure 5-1. The nested affordance process model (NAP; presented in paper 2).

Practical implications. Although this literature review paper might nudge IS researchers towards doing research in a slightly different way, it does not have any immediate practical outcome for practitioners.

Contribution to overarching research aim. This paper motivates the introduction of the notion of mid-level affordances (paper 3). It lays the foundation for developing the affordance identification framework, which, together with the proposed NAP, guides the analysis of the empirical data and the theorizing in paper 4.

5.1.3 Paper 3: Investigating Mid-level IT Affordances as Drivers for Societal Change: Addressing the Education Data Challenge in The Gambia

Purpose. International development agendas encourage public sector actors to produce ever more granular data. However, the capacity to use the data is not correspondingly strengthened. This creates a gap between policy and practice, whereby investments in technology use affordances are not translated into IT affordances for monitoring progress on complex policy goals. A mid-level IT affordance perspective enables identifying and potentially mitigating such gaps. This paper introduces the notion of mid-level affordances to the IS community and demonstrates its practical implications for ICT4D research.

Research approach. The paper is based on experiences from an ongoing research project that has been following the DHIS2-HMIS implementation in The Gambia for more than a decade, as well as qualitative data from the recent DHIS2-EMIS implementation, gathered through semi-structured field interviews, roundtable meetings, online stakeholder meetings, and document analysis.

Findings. A set of affordances related to the ongoing DHIS2-EMIS implementation was identified and used as a basis to demonstrate the notion of mid-level affordances. The paper points out that the actualization of composite (i.e., nested in space and/or time) mid-level affordances may contribute to bridging a growing policy-practice divide in the educational sector in LMICs.

Research implications. The implication of the theorizing in this study suggests that when studying technology-caused organizational change, it is not the technology use itself (i.e., lower-level affordances) that should be the focus of the study but what technology use facilitates (i.e., mid-level affordances). When lifting the focus to mid-level affordances, IS researchers may find more interesting findings compared to if our research is centered around mere technology use.

Practical implications. To advance towards development outcomes at a societal level, such as the attainment of the SDG 4, more focus should be directed toward the actualization of mid-level affordances. That is, training in technology use is important, but data-centered processes and activities, such as data analysis, data use, and decision-making require even more attention to reach the goal of societal-level impact. In other words: “Mid-level IT affordances, such as the ones identified in our case study, must be actualized across heterogeneous socio-technical and political context to produce significant strides towards development outcomes at a societal level” (paper 3, p. 486).

Contribution to overarching research aim. The paper suggests that mid-level affordances may play a significant role in an organization’s strides toward societal-level impact. Using empirical data collected from field visits to The Gambia, paper 4 further develops this idea.

5.1.4 Paper 4: Informing Sustainable Development in Education: Identification and Actualization of Layered IS Affordances

Purpose. This paper aimed to use the NAP on empirical data from field visits to highlight the importance of meso-level (mid-level) affordances and corroborate the theoretical claims in paper 3. The paper strengthens the claims around the importance of meso-level affordances in general and in LMICs in particular by showing how the actualization of meso-level affordances may lead to an LMIC’s attainment of the SDG 4.

Research approach. The analysis in this paper is based on qualitative data from interviews with stakeholders at several levels of the educational sector in The Gambia. The informants were asked about action possibilities related to DHIS2, upon which they explained what they have done so far and what aspirations they have for the future. Affordances were identified in the transcribed interviews, coded, and categorized before a model that illustrates the interdependency of DHIS2-EMIS affordances was created. During the analysis work, I developed the affordance identification framework (AIF).

Findings. After grouping the affordances thematically, four overarching DHIS2-EMIS affordances remained. Most affordances were related to technology use, but the informants also perceived other possibilities that the use of DHIS2-EMIS may afford. They spoke of societal-level changes, and the analyses indicate that to achieve such societal-level changes, the meso-level processability affordance must first be actualized. The actualization of the processability affordance entails activities such as data processing, analysis, and interpretation. Furthermore, we show how affordances themselves can serve as enabling and stimulating conditions. They are enabling in the sense that the outcome of the actualization of an affordance triggers the emergence of

subsequent affordances. Similarly, by perceiving future affordances, potential outcomes of affordances that have not yet been actualized can still serve as stimulating conditions for preceding affordances. Figure 5-2 illustrates how the DHIS2-EMIS affordances both feed back and stimulate preceding affordances and enable subsequent affordances. The paper confirms the theorizing and findings from paper 3 and emphasizes the importance of the meso-level processability affordance.

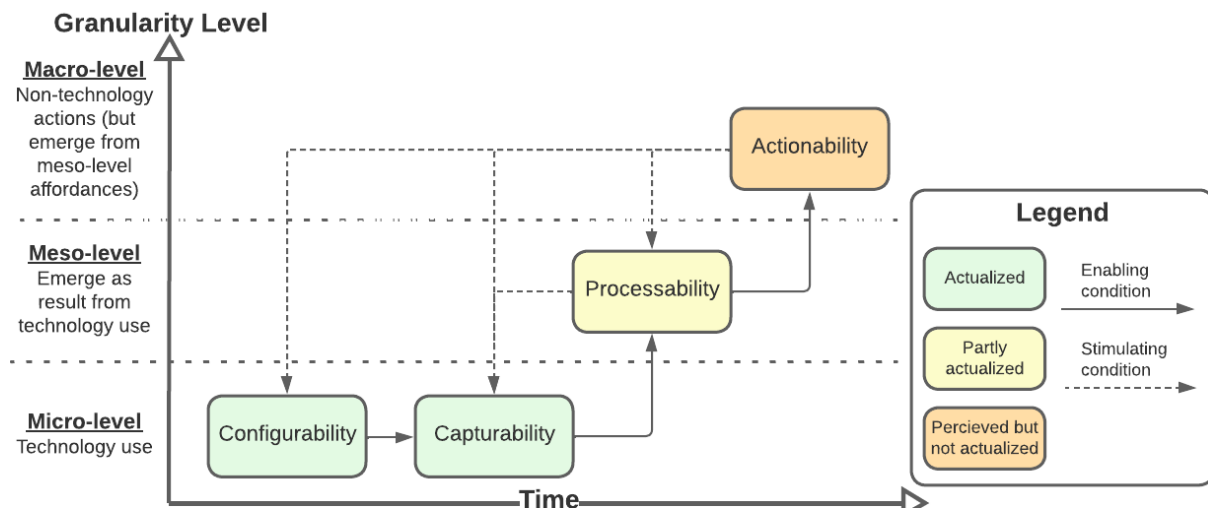


Figure 5-2. The DHIS2-EMIS affordances and their interdependencies in terms of enabling and stimulating conditions (presented in paper 4).

Research implications. The affordance identification framework (AIF; Table 5-3) serves as a useful tool for IS researchers who want to study meso-level affordances, as it helps us lead the focus away from mere technology use. The AIF also attempts to lead IS researchers away from labeling technology artifacts and technology properties as affordances. The findings in the paper further corroborate the theorizing in paper 3, confirming the important role of meso-level affordances in an organization's quest for macro-level changes. While the findings themselves do not necessarily affect the way IS scholars do our research, they do indeed emphasize that studying affordances at a higher level than mere technology use will help us understand technology-caused organizational changes better. In this paper, we changed the terms lower-, mid-, and higher-level affordances to micro-, meso-, and macro-level affordances to better convey the understanding of the general nature of the affordances at the different levels. Lower-level technology use affordances are mostly related to individuals' use of technology, while meso-level affordances in IS research tend to relate to action possibilities at an organizational level. Furthermore, macro-level affordances are typically action possibilities with the potential for societal-level impact. However, I realize that this change in terminologies might be more confusing than clarifying. I regret this paper's attempt on change of terminologies and suggest that we use low, mid, and high to speak

about the three major granularity levels of affordances. I return to this in the synthesis below (section 5.2.3).

Table 5-3. The affordance identification framework (AIF; adapted from paper 4; the original terminology used in the paper to describe the affordance granularity levels [micro-, meso-, and macro-level] has been substituted with lower-, mid-, and higher-level).

Step	Explanation	Case Examples
1. Identify actualized affordances	Affordances are action possibilities. An actualized affordance is thus a performed action and can be identified by looking for or asking the interviewees about realized activities.	Entering data: “We are entering the attendance of these children.” (Head teacher 1) Reporting data: “[Within] 15 days, we were able to report all the data.” (EMIS head)
2. Identify latent affordances	Affordances that are not yet enacted can be identified by looking for or asking the interviewees about potential use scenarios.	Delivering data: “It’s going to be very flexible now to take the paper to the ministry.” (ICT teacher) Analyzing data: “You can do some data mining and see this kind of student is performing this way when you compare this type of background.” (EMIS technical advisor)
3. Categorise lower-level affordances	Lower-level affordances relate to individuals’ basic use of a technology, such as direct use of a specific technology feature.	Data entry; data syncing; accessing data; data reporting
4. Categorise mid-level affordances	Mid-level affordances are not pure technology use, but the technology has a facilitating role, serving as a tool to solve the actions at hand. Facilitated by the actualization of lower-level affordances, mid-level affordances entail more-advanced technology use.	Information processing; analyzing data; informing parents; avoiding time-consuming tasks
5. Categorise higher-level affordances	Higher-level affordances are action possibilities made possible by the virtue of the preceding actualization of lower- and mid-level affordances. The technology does not play a vital role in the enactment of higher-level affordances, and identifying technology-facilitated higher-level affordances directly can thus be challenging.	Reducing resources; decentralizing the work; improving performance; improving quality in education

Practical implications. Through analysis of the empirical data, this paper confirms the suggestions in paper 3, namely that emphasis on meso-level affordances is a necessity in order to attain higher-level societal goals. By giving priority to organizational-level analytical activities, it is easier to reach well-informed decisions, which in turn can be acted upon, giving rise to important changes in the educational sector in particular and, with time, the society at large.

Contribution to overarching research aim. This paper further corroborates the suggestions from paper 3, highlighting the important role of meso-level affordances in an LMIC public actor's quest for societal changes. The paper also pulls together the findings from all the previous papers. The literature review (paper 2) indicates that technology use affordances are mostly enacted by individuals and benefit themselves and the organizations in which they work. By introducing the notions of micro-, meso-, and macro-level affordances, we attempt to convey the same impression, distinguishing basic micro-level affordances from meso-level affordances at an organizational level, whose actualization, in turn, may result in the emergence of macro-level affordances with the potential of generating macro-level consequences.

5.2 Synthesis of Research Findings

The theoretical ideas that were developed during the work with paper 2 were further developed and corroborated using empirical data from case studies. Table 5-4 shows how relevant concepts have been used in the papers in this thesis. Notably, the affordance categorization introduced in paper 2 lays the foundation for my introduction of the notion of mid-level affordances and the subsequent development of the NAP and the AIF. While paper 1 is disconnected from the affordance focus, the affordance categorization serves as a bridge between paper 1 and the rest of the papers, as it demonstrates how affordances can be an interesting lens through which the effects of technology use on a large scale, such as the platformization process of an EMIS (outlined in paper 1), can be understood.

5.2.1 Towards re-calibrating the IS-notion of affordances

The findings from the literature review (paper 2) show that there is no unified understanding of affordances among IS scholars. Despite the apparent fundamental agreement on the concept of an affordance as an action possibility, various researchers have designated technology artifacts, properties, and features as affordances, even by adopting nouns to describe them. We may thus agree in theory, but there is quite some ambiguity when it comes to the practical use of the affordance lens (see also Leidner et al., 2018). Another challenge in extant IS research relates to the shift in the focus of affordance studies in IS research. While affordance papers from the initial years of the

“IS affordance era” (2010-2013) identify affordances that are actualized by groups of individuals and benefit the organizations in which the individuals are embedded, the affordances in later IS research (from 2014 onwards) are shifting towards having single individual enactors, often benefitting the enactors themselves (Figure 5-3). This shift raises questions like, “Is IS research becoming more individually concerned? Or is the affordance concept so confusing that it nudges the researchers towards investigating individuals’ practice while forgetting the overarching goal of understanding organizational change?”

Table 5-4. *How concepts are used in the papers that are included in the thesis.*

Term	Papers			
	1	2	3	4
EMIS platformization (i.e., DHIS2-EMIS)	X		X	X
Society-level impact (e.g., SDG attainment)	X		X	X
Granularity levels		X	X	X
The notion of mid-level affordances		X	X	X
Nested Affordance Process model (NAP)		X		X
Affordance Identification Framework (AIF)				X
Affordance Loops		X		X

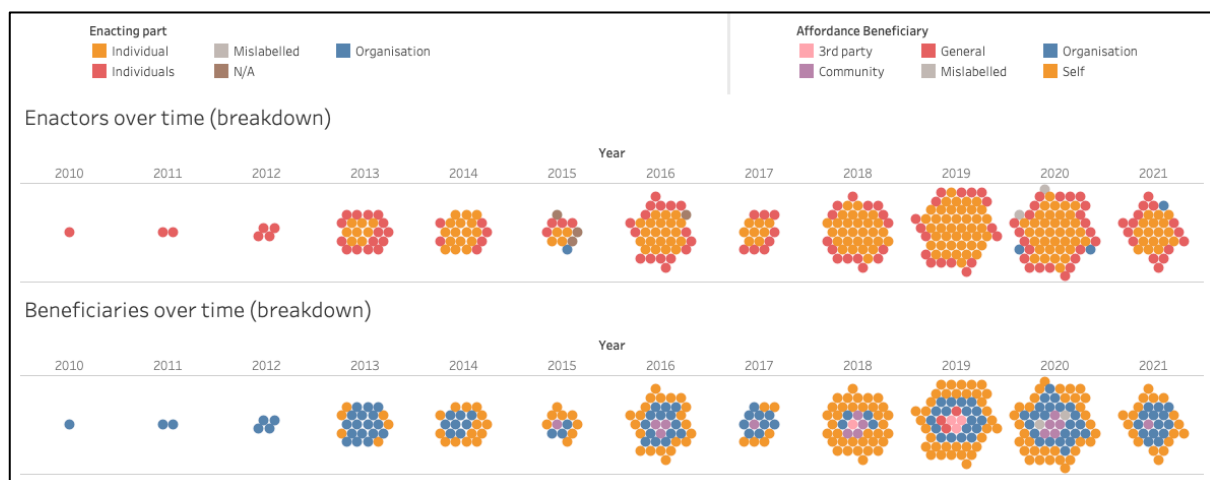


Figure 5-3. *Enactors and beneficiaries of affordances in IS research.*

My research initiates a re-calibration process of the understanding and application of the notion of affordances among IS researchers. As a concept initially developed to describe what an actor could do with an object, it needed to be heavily modified to fit

the context of a multitude of heterogeneous actors using a plethora of complex technological tools. Instead of focusing on which action possibilities exist for individual actors using simple tools, we must strive to uncover action possibilities that actors embedded in organizations perceive in various technological artifacts. And as we should be concerned with organizational change, studying an individual's basic technology action, such as entering data into a computer system, is not sufficient. We need to think further and strive to find the answers to questions like, "In the long run, what can an organization's use of a specific technology afford?" The answers should not be the "simple" ones, like that a computer system allows us to store data. We need to pursue the effects of this. If we store the data, then what? If the storage of the data allows us to analyze the data, then what? The data analysis might reveal information that we can act upon. And then what? Do these actions contribute to organizational change? Are these actions the first steps toward societal-level impact? Those are the questions we should try to address using an affordance theory in IS research.

Most IS scholars agree that affordances are relational. But, as shown in this thesis, the affordance definitions provided to the IS community (Table 2-1) are formulated in a way that may lead IS scholars to focus on direct technology use instead of "actions in the world that involve technology" (Faraj & Azad, 2012, p. 255). I subscribe to the relational view of affordances being a possibility for action that arises from the relationship between an actor(s) with a set of capabilities and a technology with a set of features and properties. This view caters for affordances at all three major affordance granularity levels. Lower-level affordances are easily perceivable as they denote an actor's basic and concrete use of a technology feature. Mid-level affordances are affordances where technology plays a role but where it is hard to pinpoint one single technology feature being used. As for higher-level affordances, they do not require the usage of technology, but they do nevertheless arise from the relationship between actors and technology. That is, if it were not for the technology and previously actualized lower- and mid-level affordances, these higher-level affordances would not have emerged. Although a technology's properties and features may indicate possible actions a user can perform with the technology, the properties and features are not themselves affordances. I am motivated by Faraj and Azad as well as Leidner et al.'s (2018) urge to look beyond mere technology use when identifying affordances, and I contribute with the NAP and the AIF as a means to guide IS researchers in our work with affordances, nudging us towards identifying affordances at an appropriate level of granularity for IS research. The NAP and the AIF will be addressed in detail later (see 6.1 and 6.2).

A plethora of ideas and frameworks have been introduced in IS researchers' quest of adapting affordance theory to a usable tool for our research field. The three complexities identified in paper 2 (granularity, trajectory, and composability) are areas in which IS scholars have developed different concepts and terminology to describe similar ideas.

For instance, nested affordances (Gaver, 1991), the decomposition of affordances (Markus & Silver, 2008), composite affordances (Bernardi, 2016), and ensembles of clustered affordances (Thapa & Sein, 2018) are all IS-variations of Shaw and Bransford's (1977) explication of how an affordance may consist of sub-affordances. In their example, Shaw and Bransford explain how the eating affordance consists of the sub-affordances biting, chewing, and swallowing (p. 42).

Paper 2 emphasizes that if we as researchers should build on each other's work and accumulate knowledge, there is a need for a common ground. Still, researchers continue to present the same ideas in new wrappings, and the paper raises the question of whether we need all these similar frameworks or if they could be united in a single framework. The main motivation for developing the NAP was thus to unite the plethora of concepts describing the same ideas in IS affordance research.

5.2.2 From technology use to societal-level effect

Empirical data from field studies were used to corroborate, strengthen, and test the ideas developed through the literature review (paper 2). By following the initial stages of the implementation of DHIS2-EMIS in The Gambia, I applied the affordance lens while analyzing the empirical data. Coherently with extant IS research, I found that identifying basic technology use affordances was not difficult. Through document analysis, field observations, and interviews, the hands-on use of DHIS2-EMIS is easily identifiable and perceivable. But then what? The interview guides used for the data collection for paper 4 were articulated so that the informants had to envision future possibilities that could emerge from the use of DHIS2-EMIS. The NAP (from paper 2) was used to categorize these identified affordances. Since the NAP does not include step-by-step guidance on identifying the affordances at different granularity levels, paper 4 develops an affordance identification framework (AIF) to illustrate how affordances are categorized according to granularity levels. The NAP is presented in greater detail in section 6.2.

The analysis of the empirical data confirms that basic technology use obviously affords more advanced action possibilities at a later stage. But at the same time, I found that future affordances that are not yet enacted and their potential outcome serve as a motivation for the actualization of lower-level affordances. For instance, some informants perceived the possibility of enhancing teacher attendance due to timely attendance data collection and reporting at earlier stages. Figure 5-2 illustrates how the four identified overarching DHIS2-EMIS affordances relate to each other in terms of enabling and stimulating conditions.

In The Gambia, MoBSE wanted to enhance their EMIS to respond to demands for more granular data with the end goal of attaining the SDG 4. When introduced to DHIS2, key stakeholders perceived the possibilities that the flexible DHIS2 software platform and

the associated HISP ecosystem could afford. The perceived future affordances thus motivated them to initiate the configurability and rollout of DHIS2-EMIS. Through training and introduction to DHIS2, practitioners on the ground responsible for data collection and reporting also perceived the possibilities of enhancing the education system through timely data collection, reporting, and analysis, thus motivating them to actualize the lower-level capturability affordance. Once the data is in the system, politicians and analysts are eager to further process the data and extract actionable knowledge. The final outcome of the mid-level processability affordance affords informed actions, which in turn, over time, have the potential of improving the education sector in particular, and the Gambian society at large. Through increased knowledge and informed actions, MoBSE now perceives a real possibility of attaining the SDG 4.

5.2.3 Micro, meso, and macro, or low, mid, and high?

In paper 4, we changed the terminology to denote the affordance granularity levels from low, mid, and high to micro, meso, and macro. The idea behind this was to convey the idea that often, at least in the case presented in the paper, lower-level affordances relate to individuals' actions (micro-level), mid-level affordances reflect organizational-level (meso-level) activities, while high-level affordances refer to potential activities at a societal level with macro-level consequences. However, I realize that this is more confusing than clarifying. Especially since both mid- and higher-level affordances can indeed be actualized at several societal levels. For instance, an individual (at micro-level) can enact an inputting affordance (lower-level) as part of a job information reachability affordance (mid-level). Thus, when discussing the granularity levels of affordances, I suggest that IS scholars use low, mid, and high.

6 Contributions and Implications

The findings in this thesis point out a highly ambiguous use of the affordance lens among IS researchers. Echoing Volkoff and Strong's (2017) suggestion to study affordances at an appropriate level of granularity, Leidner et al. (2018) call for a focus on affordances that emerge as consequences of technology use. Although there exists literature that separates affordances into granularity levels (e.g., Burton-Jones & Volkoff, 2017; Strong et al., 2014), there does not exist any frameworks that guide IS researchers in identifying and categorizing affordances. There is, hence, a great variation in what is categorized as affordances. This thesis introduces the NAP and the AIF to the IS research community to help us apply the affordance concept in a more unified manner in our studies.

This chapter proceeds as follows. In sections 6.1 and 6.2, I give a detailed description of the NAP and the AIF, respectively. I proceed to discuss the implications these frameworks have for IS researchers (6.3) and practitioners (6.4). I conclude the chapter with section 6.5, presenting challenges related to the appropriation process of the affordance theory to the IS field.

6.1 The Nested Affordance Process Model (NAP)

The nested affordance process model (NAP) has been developed through several iterations. It started as a suggestion from a reviewer in a journal to which an earlier version of paper 2 was submitted. In the work with the empirical data from my field trips to The Gambia, I used the NAP to analyze the data and realized that I could extend the model based on discoveries in the empirical data. For instance, affordance loops were first introduced in paper 4 and were taken in as a supplementary element in the model. Revisiting the papers in the review set, I found that extant research also supported the notion of affordance loops. Affordance loops is also, therefore, introduced in paper 2.

Nevertheless, the purpose of offering the NAP to the IS community is to provide a tool that can help nudge IS researchers towards a unified way of understanding and talking about affordances in IS research so that we can have a common base on which we build further developments of AT. A multitude of frameworks and concepts exist addressing both similar and distinct ideas, although without building significantly on each other. The NAP unites existing frameworks and ideas into one coherent framework. In the following sub-sections, I will explain the elements in the NAP by highlighting how the NAP draws on and extends extant IS research.

6.1.1 Affordances in IS research

A natural place to start is to define affordances – or perhaps more precisely, my view of affordances – in IS research. As the literature review (paper 2) reveals, numerous affordance definitions are introduced in IS research (Table 2-1), with nuanced distinctions, and the understanding of affordances varies. For instance, Markus and Silver (2008) describe functional affordances as the relationship between an actor and technology, focusing on specific actions that can be performed. On the other hand, Leidner et al. (2018) emphasize the distinction between technology use and the affordances that emerge from it. While Volkoff and Strong’s (2013) definition is widely accepted, it is also disputed, with IS scholars suggesting a broader perspective beyond immediate and concrete outcomes (Du et al., 2019). When studying organizational change, it is essential to consider longitudinal processes rather than solely observable technology use outcomes. By providing theoretical frameworks, my contributions position IS researchers to study affordances at appropriate levels of granularity, considering the effects of technology use on organizations. I am thus leaning towards an understanding of IS affordances as action possibilities that arise from the relationship between an actor (or actors) and a technology (Figure 6-1). These action possibilities may or may not relate to concrete technology use. As IS affordances may relate to longitudinal change processes, the outcomes of actualized IS affordances are not necessarily direct and concrete (Du et al., 2019). A consequence of this understanding

Depicting the relational nature of IS affordances in the NAP

Figure 6-1 illustrates how the relational property of IS affordances are brought into the NAP (Figure 5-1). Note that there are three arrows in Figure 5-1 pointing from the actor-technology relationship towards lower-level, mid-level, and higher-level affordances. Also note how IS affordances are depicted using a layered illustration. This layered representation is intended to symbolize the nested nature of affordances and that there is not a one-to-one relationship between affordances (see 6.1.3 and 6.1.4).

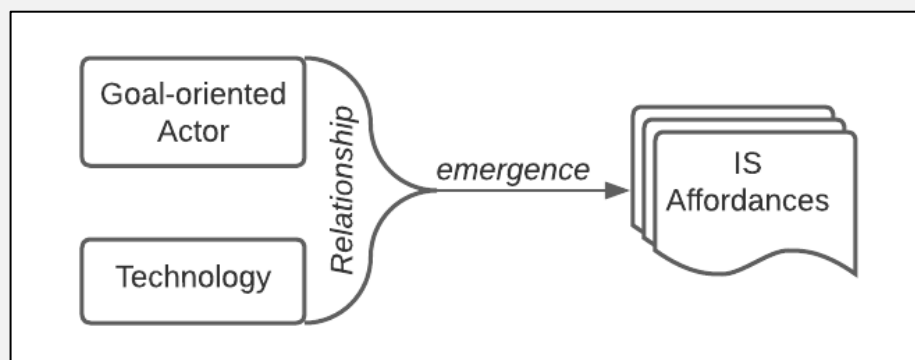


Figure 6-1. IS Affordances arise from the relationship between an actor (or actors) and a technology.

of IS affordances is that we must distinguish between granularity levels when identifying affordances. The following subsection regards the three major granularity levels I have identified in my research and incorporated into the NAP.

6.1.2 Three major granularity levels

There is, to the best of my knowledge, no existing research that clearly states the differences between granularity levels of affordances. Cheikh-Ammar (2018) does indeed mention three levels of abstraction (lower, medium, high), but he does not outline any fundamental difference between his lower-level affordances (replying and/or forwarding messages) and medium-level affordances (sending and receiving messages). Other IS scholars speak of lower and higher levels (e.g., Burton-Jones & Volkoff, 2017), first- and second-order affordances (Leidner et al., 2018), and basic and more advanced affordances (Strong et al., 2014), but neither explains the difference in granularity levels or how to go about to identify affordances at various granularity levels. A prescribing framework on how to distinguish granularity levels and how to identify affordances at these levels is missing.

Although the term “granularity levels” has not been widely used in IS research using the affordance lens, the idea of affordances at separate levels of abstractions has been alluded to by several IS scholars as they have suggested solutions to how we can extend the affordance concept to make it more appropriate for IS studies on technology-driven organizational change. For instance, Zheng and Yu (2016) draw on Fayard and Weeks’ (2014) notion of “affordances for practice” as they seek “to understand social practices in society beyond the immediate context of human-computer interaction” (Zheng & Yu, 2016, p. 291). Related to this, Faraj and Azad (2012) suggest that we “need to abandon the view that affordances are about a technology or an object. They are about actions in the world that involve technology” (p. 255). Similarly, Leidner et al. (2018) suggest that technology use is not an affordance but that “the use of technology features provide affordances” (p. 120). Technology features arguably afford action possibilities to the actors. Instead of refusing to acknowledge technology feature use as affordances, I propose three major granularity levels for IS affordances. The lower level relates to technology use, often referred to as functional affordances (Markus & Silver, 2008). The mid-level entails affordances that emerge through the use of technology features. These affordances are the affordances for practice that are channeled through functional affordances (Zheng & Yu, 2016, p. 308). They are “actions in the world that involve technology” (Faraj & Azad, 2012, p. 255). Finally, the higher level is further away from the immediacy of human-computer interaction and relates to action possibilities that are channeled through mid-level affordances. That is, affordances emerging from technology use without involving technology use themselves. We could combine expressions from Zheng and Yu and Faraj and Azad and think of higher-level affordances as “channeled through actions in the world that involve technology.” The

differences between the granularity levels can be a bit blurry and it may be hard to unequivocally determine to which granularity level an affordance pertains. In the following, I will outline the major differences between the three proposed granularity levels. The three granularity levels are summed up in Table 6-1

Lower-level affordances. I will use Leidner et al.'s (2018) train ride example to demonstrate the idea better. They differentiate between actually riding the train (i.e., mere technology use) and action possibilities made possible *because of* the train ride, such as working and meditating. Lower-level IS affordances relate to mere technology use. In the papers and elsewhere in this thesis, I also refer to such lower-level affordances as basic and concrete technology use. With these terms, I attempt to convey the notion of a very hands-on, easily observable action where an individual uses a specific technology or technology feature. Examples of lower-level affordances are data entry (using a data entry feature to enter data) and liking a social media post (clicking the like button). Markus and Silver (2008) refer to such affordances as functional affordances, describing what actors can do with an object. Functional affordances focus “solely on issues related to technical functionality” (p. 622).

Mid-level affordances. With Leidner et al.'s (2018) train ride example still in mind, mid-level affordances are affordances that denote a more indirect and abstract use of the technology in the same way as Leidner et al.'s examples of *working* and *meditating* are more indirect and abstract ways of using the train. Mid-level affordances thus depend on the actualization of lower-level affordances. Using the train ride to meditate would not be possible if one did not embark on the train in the first place. Translated to the IS domain, a mid-level affordance is an affordance that, in some way or other, is aided by technology. That is, a mid-level IS affordance is an affordance where technology plays a role, although it is difficult to pinpoint a specific technology or technology feature used in the actualization of the affordance. Hatakka et al.'s (2020) *job information reachability* affordance serves as a good example of a mid-level IS affordance. The affordance refers to a person who uses ICT to find available jobs. There is no doubt that technology is used, but there is no particular technology feature use that can be pinpointed in the same way as for lower-level affordances. Job information reachability is thus a more indirect and abstract way of using technology than the lower-level affordances of data entering and liking a social media post. For a mid-level IS affordance, it is often apparent that it depends on previously actualized affordances and/or is a nested composite affordance comprising one or more sub-affordances (nested and sequential affordances are treated in greater detail in sub-sections 6.1.3 and 6.1.4 below). For the job information reachability affordance, the interviewees explain that one can find job information online and that “it is important to know about computers when you search for a job” (p. 680). To actualize the job information

reachability affordance, the person must thus first actualize the more basic, hands-on, easily observable (i.e., lower-level) *searchability* affordance.

While Leidner et al. suggest that technology use itself is not an affordance, but that “the use of technology features provide affordances” (p. 120), I suggest that we rather distinguish between different granularity levels and follow Volkoff and Strong’s (2017) call to study affordances at an appropriate level of granularity. Affordances at the mid-level are typically what Fayard and Weeks (2014) denote as affordances *for* practice. Leidner et al.’s working and meditating affordances are just that – the worker uses the train *for* working and *for* meditating.

Higher-level affordances are affordances at an even higher level of abstraction than mid-level affordances. In the same way as mid-level affordances depend on the actualization of lower-level affordances, higher-level affordances depend on the actualization of mid-level affordances. For illustrational purposes, I will extend Leidner et al.’s (2018) train ride example. Keep in mind that the mid-level affordances *working* and *meditating* have emerged from the actualization of the *riding the train* affordance (which is a lower-level affordance). Working and meditating are answers to the question, “What does riding the train afford to us?” Similarly, we can approach the next level of abstraction by asking, “What does meditating on the train afford to us?” Leidner et al. suggest that the outcome of actualizing the meditating affordance is that “this individual arrives at work in a relaxed state of mind” (p. 120). When s/he arrives at work in a relaxed state of mind, s/he will perhaps be able to work more efficiently. Now, working efficiently does seemingly not have any direct relation to the train ride. However – since we know that because of the meditating on the train, s/he is able to be more effective at work – there is a clear relation to the train. The train is nevertheless not involved in any way in the processes at work. Translated to the IS domain, it is interesting to follow the consequences of actualized affordances towards a higher level of abstraction. In paper 5, we argue how lower-level technology use affordances, such as data entry and data reporting, cause the analyzability and processability affordances to emerge. The outcome of the latter affordances is good data that serves as a foundation for stakeholders to act upon (actionability). The actionability affordance does, however, not involve technology use, although it depends heavily on it. The actionability affordance would, in this case, simply not have emerged if it were not for the actualization of the processability affordance.

An important epistemological question remains: Can a higher-level affordance be considered an IS affordance when there is no technology involved in actualizing it? In paper 2, we argue, with reference to Gibson (1979), that affordances do not necessarily relate to the direct and concrete use of an object. Gibson explains that air affords “unimpeded locomotion” (p. 130). There is, however, a significant difference in the

direct way an actor applies a knife for cutting and his more indirect use of the air to locomote. Furthermore, Gibson explains that not only objects but also places may have affordances (p. 136) determined by the properties of the places. A place may afford hiding but like the abstract use of the air to locomote, hiding is a rather abstract use of a place. Nevertheless, the place affords hiding, and hiding is thus an affordance. Translated to the IS domain, we argue in paper 2 that higher-level affordances are potentials for actions made possible by the technology. If it were not for the technology with its properties and actors' preceding use of technology, the higher-level affordances would not have emerged. Drawing on expressions used by Zheng and Yu (2016) and Faraj and Azad (2012), we could say that higher-level affordances are affordances that are channeled through actions in the world that involve technology. They relate to "practice enacted ... within an environment" (Fayard & Weeks, 2014, p. 247). In an earlier study by Fayard and Weeks (2007), they draw on Gaver's (1996) description of how the environment's material properties affect people's interaction as they explore how affordance theory can be used to describe *informal interaction* in photocopier rooms. They introduce the notion of social affordances to describe behaviors shaped by the interaction of "physical and social elements of the environment" (p. 627). As people go to the photocopier room to get their printouts or make copies, they meet other people there and engage in informal interaction. A prerequisite for the social affordance of informal interaction to emerge is that the workers have actualized the *printing* affordance or are about to actualize the *copying* affordance afforded by the photocopier.

Notwithstanding, since there is no obvious relation between the actor and the technology during the actualization of a higher-level affordance – although the higher-level affordance has emerged because of preceding technology use – I do realize that the affordance definition might be stretched to its limits and perhaps beyond. Thus, when contemplating higher-level affordances, we should consider that the actualization process often does not involve technology, thereby challenging our conventional understanding of affordances. However, whether we call the higher-level action possibilities for IS affordances, social affordances, or just action-possibilities remains an epistemological question. What is most important for understanding how technology contributes to organizational and societal changes is that higher-level affordances are real. Nevertheless, this epistemological challenge is opening new avenues for research, which I encourage IS scholars to pursue. Avenues for future research are discussed in section 6.3.3.

Table 6-1. Overview of the three major granularity levels.

Granularity	Explanation	Related concepts	Examples
Lower-level affordances	Direct technology use; “what the user may be able to do with the object” (Markus & Silver, 2008, p. 622)	Functional affordances (Markus & Silver, 2008);	Accessing data; entering data; reporting
Mid-level affordances	Aided by technology use; “possibilities of using ... combinations of features”; “actions in the world that involve technology” (Faraj & Azad, 2012, p. 254,255); channeled through functional affordances (Zheng & Yu, 2016); “the use of technology features provide affordances” (Leidner et al., 2018, p. 120)	Affordances for practice (Fayard & Weeks, 2014)	Analysing; Monitoring; Processing
Higher-level affordances	Emerging from technology use, although not necessarily involving technology use; “practice enacted ... within an environment” (Fayard & Weeks, 2014, p. 247)	Social affordances (Fayard & Weeks, 2007)	Actionability; Informed decision-making

Depicting granularity levels in the NAP

The granularity levels are illustrated by placing the representations of lower-level, mid-level, and higher-level affordances on separate levels in the figure (Figure 5-1). Also, there is an arrow pointing upwards on the left hand side indicating granularity levels with supporting explanations for each of the three major granularity levels.

6.1.3 Nested and composite affordances

An inherent property of affordances is that they are nested. That is, an affordance comprises sub-affordances. Gaver (1991) coined the notion of nested affordances as “affordances that are grouped in space” and explains with an example that “only by seeing the affordance of pulling the handle as nested within an affordance of pulling the door can opening the door be a perceptible affordance” (p. 82; see also Figure 6-2). Bernardi (2016) refers to the same idea as composite affordances and explains how the *self-presentation* and *narration* affordances are important elements constituting the composite affordance *building a support network* (Figure 6-2). Similarly, Markus and Silver (2008) mention DeSanctis and Poole’s (1994) “repeating decomposition problem: there are features within features” (DeSanctis & Poole, 1994, p. 124) and followingly there will be affordances within affordances. The notion of nested affordances originates nevertheless from Gibson (1966) himself, as s/he explains how *biting*, *chewing*, and *swallowing food* are components of the *eating* affordance (p. 138). Other IS scholars have also embraced the nested nature of affordances. For instance, Cheikh-Ammar (2018) explains how an affordance can be decomposed into sub-affordances with an example of a *collaborating with others* affordance, which comprises the sub-affordance *sending and receiving messages*, which again comprises *replying and forwarding messages* (p. 285; see also Figure 6-2). Thapa and Sein’s (2018) ensemble of affordances also resembles the notion of nested affordances. They explain how the *volunteerability* and *virtual co-localizability* affordances cluster together to form an ensemble of affordances. It should be noted that a volunteerability affordance might of course emerge without the need of being virtually co-located. However, in their paper, the volunteerability affordance depends on the “properties of NTMP (Audio/Video transfer; Remote interaction)” (p. 808 [Figure 6]), and the authors state that “a plausible interpretation is that ‘volunteerability’ emerged from the actualization of ‘virtual co-localisability’” (p. 813). I will also argue that not only is volunteerability dependent on co-localizability, but co-localizability is also an essential part of volunteerability (in this specific case) – one cannot volunteer (remotely) without at the same time being virtually co-located.

There are, however, some nuances that should be addressed when it comes to the choice of terminology. Thapa and Sein’s (2018) cluster or ensemble of affordances conveys the understanding that the clustered affordances are independent of each other. Similarly, a composite is “something that is made of various different parts”²¹, while nested means how one can “fit one object inside another”²², like with nested coffee tables. Cheikh-Ammar’s (2018) *collaborating with others* affordance (Figure 6-2) thus serves as a good example of how IS affordances are nested in that they can be repeatedly

²¹ <https://dictionary.cambridge.org/dictionary/english/composite>

²² <https://dictionary.cambridge.org/dictionary/english/nested>

decomposed. The example also serves as a good example of how nested affordance can comprise hierarchical sub-affordances – that is, sub-affordances at distinct levels of granularity. Note, however, that nested affordances may comprise sub-affordances at the same (major) granularity level, such as Gaver’s (1991) *pulling the door* affordance comprising the *pulling the door handle* affordance. Both affordances would be referred to as technology use in an IS setting, thus pertaining to the lower granularity level.

To convey the hierarchical interdependency between affordances, the framework is called the *Nested Affordance Process* model. However, since affordances may also cluster together and form ensembles or composite affordances consisting of non-dependent sub-affordances, I suggest we continue to talk about composite affordances as well. Nevertheless, we should indeed have the distinction between nested and composite affordances in mind.

As a means to escape the repeating decomposition problem, Markus and Silver (2008) suggest that “the researcher may hypothesize that the system as a whole, rather than one or more component parts, provides an affordance” (p. 628). While alluding to the nested nature of affordances, their statement also relates to the importance of choosing an appropriate level of granularity for an IS study.

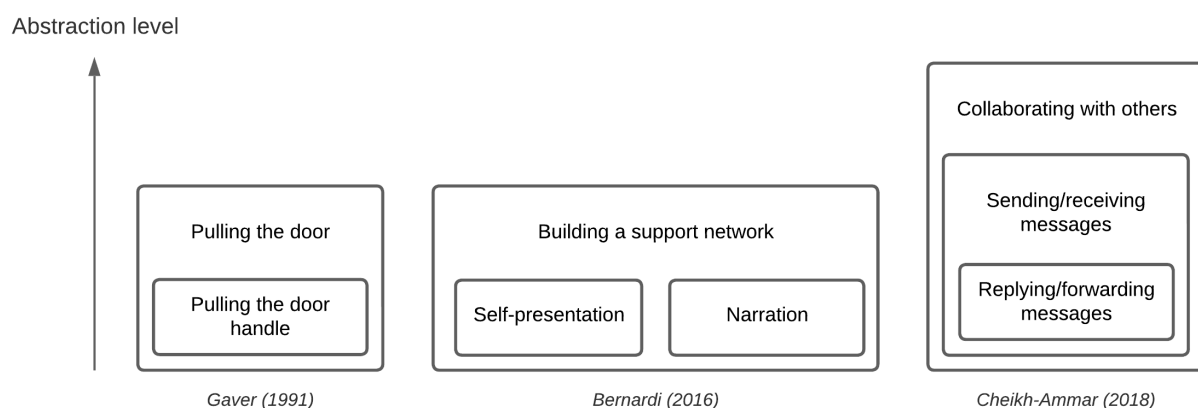


Figure 6-2. Examples of composite affordances (presented in paper 2)

Depicting composite affordances in the NAP

The layered representation of lower-, mid-, and higher-level affordances in the NAP (Figure 5-1) illustrates a composite affordance. The composite affordance may or may not comprise interdependent sub-affordances (Figure 6-2).

6.1.4 Trajectory of affordances

Trajectory of affordances is a term that was coined by Thapa and Sein (2018) to denote the trajectory along which affordances travel, “specifying the process and conditions through which affordances are perceived leading to actualization of affordances” (p. 811). In other words, “the actualization of an affordance can be a pathway to the emergence of new affordances” (p. 808). As they hint to themselves, referring to Strong et al. (2014), this is not a particularly new idea. Strong et al.’s affordance dependency diagram illustrates “the observed temporal sequence in which affordances were actualized” (p. 75). Similarly, Burton-Jones and Volkoff (2017) coin the idea of an affordance network, which explains how “affordances and outcomes depend on each other across time and organizational levels” (p. 470). Furthermore, more than three decades ago, Gaver (1991) wrote about “groups of affordances that are sequential in time” (p. 79) and explained that “acting on a perceptible affordance leads to information indicating new affordances” (p. 82). Gibson (1966) also alludes to this causal dependency between affordances as he states, “food-getting ... consists of a whole chain of activities — finding food, taking it, biting or chewing it, ... swallowing it” (p. 138). Whether we call it a chain of affordances, sequential affordances (Gaver, 1991), affordance dependencies (Strong et al., 2014), affordance network (Burton-Jones & Volkoff, 2017), or trajectory of affordances (Thapa & Sein, 2018), they all allude to the same core idea, namely that the actualization of one affordance may lead to the emergence of subsequent affordances. Figure 6-3 visualizes the interdependency of some affordances from the review set in paper 2. As the figure indicates, the actualization of an affordance may trigger the emergence of an affordance at the same or higher granularity level. The actualization of an affordance may also cause several other affordances to emerge, indicating that the actualization and emergence of affordance is seldom a one-to-one causality; the actualization of one affordance may trigger the emergence of one or several new affordances, and similarly, an affordance may require the actualization of one or many preceding affordances (Figure 6-3). Thus, combined with the introduction of three major granularity levels and the notion of nested and composite affordances, the NAP accounts for affordance dependency within and across granularity levels, conflating the several notions that relate to affordance dependency.

Depicting the trajectory of affordances in the NAP

The trajectories along which affordances travel are simply illustrated by solid arrows in the NAP (Figure 5-1). Note that there are solid arrows labelled “Feedback” as well. Feedback loops are discussed in section 0.

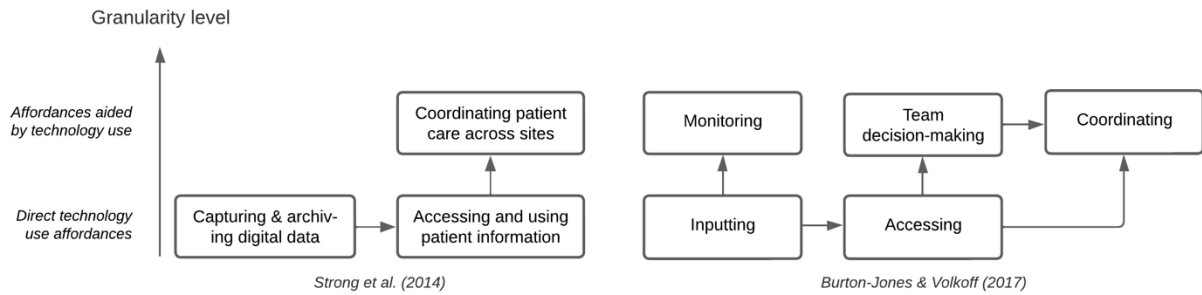


Figure 6-3. Examples of affordance interdependencies (presented in paper 2).

6.1.5 Complex composite affordances

It is worth emphasizing that a composite affordance may comprise both sequential and/or nested sub-affordances. In paper 3, we explain this by using Gaver’s (1991) example on opening a door as a starting point. The *door opening* affordance consists of the affordances *pulling the door handle* and *pulling the door*. Furthermore, the door handle affords turning *after* the grasping affordance (i.e., grasping the door handle) has been actualized. This is illustrated in Figure 6-4.

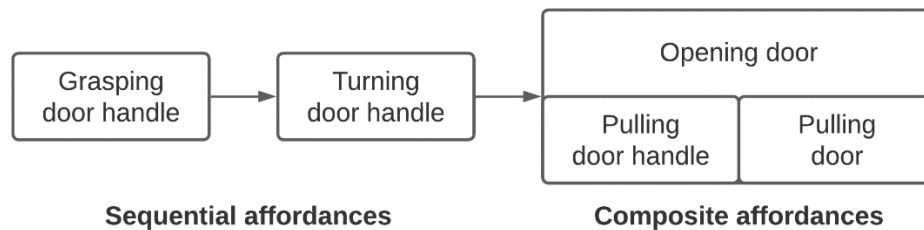


Figure 6-4. Conceptual framework derived from Gaver (1991), using Gaver’s affordances (presented in paper 3)

While Gaver’s (1991) *opening door* affordance comprises two sub-affordances that are actualized simultaneously (i.e., pulling the door handle and pulling the door), it is also evident that composite affordances may consist of sequential sub-affordances. Consider for instance, Gibson’s (1966) *eating* affordance, which comprises the sequential sub-affordances of *biting*, *chewing*, and *swallowing* (p. 138). We also found support for this in our empirical data, as the *decentralizing data access* affordance comprises the sequential sub-affordances of *developing addon*, *integrating addon*, and *accessing data*. Thus, we could extend the derived framework from Gaver’s affordances to a more generic framework. Figure 6-5 illustrates how a complex composite affordance could be.

Depicting complex composite affordances in the NAP

The layered representation of lower-, mid-, and higher-level affordances in the NAP (Figure 5-1) illustrates a composite affordance. If we zoom in on an IS affordance, it could look something like Figure 6-5, visualizing how an IS affordance may comprise a multitude of sub-affordances, both individual, sequential, and nested.

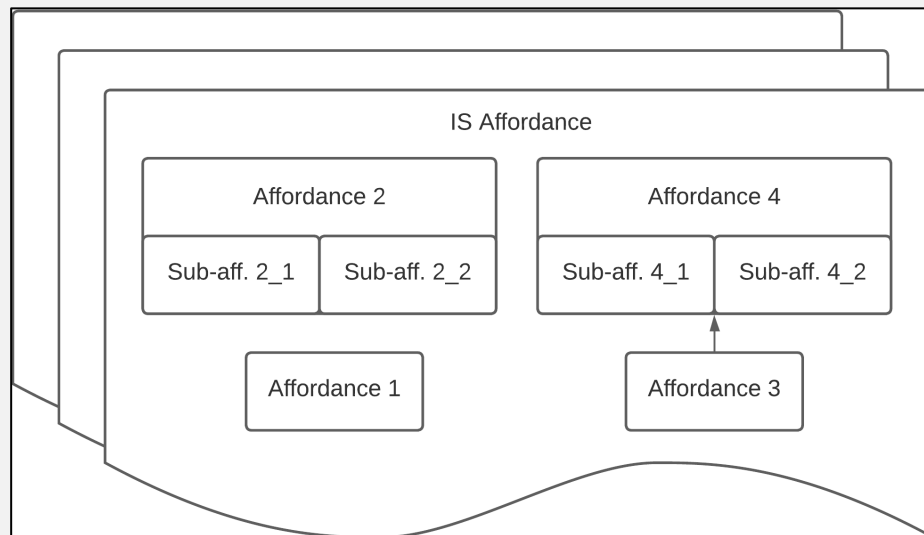


Figure 6-5. A complex composite affordance

6.1.6 Feedback loops

Burton-Jones and Volkoff (2017) encourage researchers to “map out the network of affordances and the connections and feedback loops among the affordance-outcome units” (p. 482). Several IS scholars point out that the outcome of an actualized affordance might change the behavior and the way an affordance is actualized. For instance, Strong et al. (2014) explain how the outcome of actualized affordances “provide feedback for adjusting (as needed) those individual actions as well as adjusting the elements giving rise to the affordance ” (p. 70). Furthermore, Tim et al. (2018) note that unintended consequences of technology use also “provide feedback for adjusting the actions of actors and thus the uses of technology” (p. 69). Notably, feedback loops follow a longitudinal trajectory. That is, the actual outcome of an affordance might change the way a preceding (or the same) affordance is actualized next time around, at a later point in time. Both Strong et al. and Burton-Jones and Volkoff have depicted

feedback loops in their illustrations. It is hence not a new concept, but the NAP illustrates it in a bigger picture.

Depicting feedback loops in the NAP

Feedback loops are illustrated using solid arrows going from the outcome of an actualized affordance back to an affordance. The outcome of an affordance at a higher granularity level may feed back to the same affordance and all preceding affordances across granularity levels.

6.1.7 Facilitating conditions

The organizational context affects the goals and actions of the actors (Strong et al., 2014), and the affordances are actualized in a social context and not in a vacuum (Volkoff & Strong, 2017). Bygstad et al. (2016) call social mechanisms the context beyond affordances, serving as “enabling/constraining, stimulating or releasing conditions” (p. 92). Similarly, Thapa and Sein (2018) use the term facilitating conditions to refer to the conditions that serve as a prerequisite for actualizing an affordance. In the NAP, I remain with the term facilitating conditions to denote motivating, stimulating, and facilitating factors supporting the affordance actualizations. In the following, I will introduce the notion of affordance loops, a special case of feedback loops that, at the same time, serve as facilitating conditions.

Depicting facilitating conditions in the NAP

Facilitating conditions are represented by a dotted arrow in the NAP (Figure 5-1). Since facilitating conditions are prerequisite for an affordance to be actualized, the dotted arrow points to the “trajectory arrow” between the boxes that indicate perception and actualization of affordances (Figure 6-6). Note that there are dotted arrows pointing at the “Facilitating Conditions” label as well (Figure 5-1). These arrows represent affordance loops – a special case of feedback loops – and will be discussed in the following.

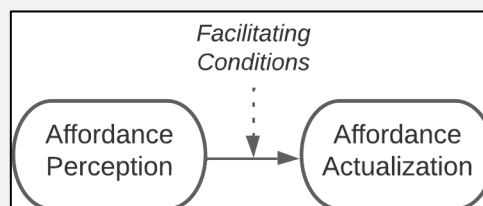


Figure 6-6. *Facilitating conditions*

6.1.8 Affordance loops

Affordance loops is a concept that I first derived from the empirical findings from The Gambia during work with paper 5. I later revisited the review set from paper 2 and found that this notion could also be derived from existing IS literature. The concept of enabling, stimulating, and releasing conditions is defined by Volkoff and Strong (2013) as the “presence and degree of actualization of other affordances” (p. 828). The authors explain that the actualization of an affordance can facilitate the realization of more advanced affordances. They emphasize that appropriately actualized basic affordances serve as the enabling conditions for exercising other affordances. But would the basic affordances have been realized without the perception of a compelling outcome of a more-advanced, not-yet-existing affordance? What would motivate or stimulate the actualization of the basic affordance “setting up models for automated analysis by the solver (Aff 1)” (p. 827)? Presumably, the perception of the more advanced analysis affordances and their possible outcomes played a role as stimulating conditions. This presumption corresponds well with what Burton-Jones and Volkoff (2017) observed in their study of an EHR system, namely that “these affordances relate to outcomes that these users wish to attain and these affordance-outcome units can weave together across the organization to reflect how affordances and outcomes depend on each other across time and organizational levels” (p. 470). There are, of course, situations where the only goal is the immediate outcome of a particular affordance actualization. But as alluded to by Burton-Jones and Volkoff and supported by the empirical data from The Gambia, actors are capable of perceiving a chain of affordances. It follows from this that even the potential outcome of affordances that have not yet emerged may stimulate the actualization of preceding affordances. I incorporate this special case of feedback loops in the NAP. To avoid muddling these kinds of feedback loops with “normal” feedback loops that follow a longitudinal trajectory, I call these special case feedback loops for *affordance loops*. For “normal” feedback loops, the actual outcome of an actualized affordance affects the way an affordance is actualized the next time. For affordance loops, on the other hand, the potential outcome of a not-yet enacted affordance motivates the actualization of a preceding affordance, before the very first time that affordance is actualized. Figure 6-8 illustrates – in a very simplified manner – the differences between how (the outcomes of) affordances both enable and stimulate (the actualization of) other affordances (see also Figure 5-2).

Also worth mentioning is that the perceiver and the enactor are not necessarily the same actor. Gibson (1979) explains the importance of the ability to perceive affordances for others when a child begins to be socialized. Although Gibson’s example is meant to explain that someone can perceive an affordance that they themselves can actualize by first perceiving it for others, it demonstrates that it is indeed possible to perceive affordances for others. Thus – to use a hypothetical example from The Gambian

educational sector – by perceiving the future affordance of fair teacher distribution planning at the regional level enacted by the employees at the regional office, a school director may be motivated to ensure that the teacher registering attendance is indeed actualized at their school so that their school might receive more or better-qualified teachers for the next school year. In ecological psychology, Michaels (2003) proposes that “perceiving an affordance is seeing that some action can be engaged in by the perceiver–actor himself or herself; it is not perceiving what actions others can engage in” (p. 146). The affordance loops concept challenges Michaels’ stance. An enactor does, of course, perceive an affordance before s/he consciously actualizes it. But if an enactor is capable of perceiving an affordance, another individual could also be capable of perceiving the same affordance on behalf of others. As pointed out by Lanamäki et al. (2016) in their analysis of the *potential affordances* stance, “someone who is capable of performing the actualization must exist for the affordance to have any meaning, but that person need not be identified” (p. 131). In my example from The Gambia, the school director might perceive the possibility that someone at the regional office enacts the fair teacher distribution planning affordance without identifying a particular individual.

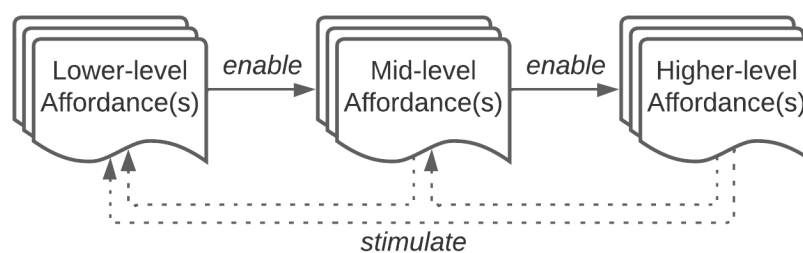


Figure 6-8. *Affordance loops (presented in paper 2)*

Depicting affordance loops in the NAP

Affordance loops are represented by a dotted arrow going from the outcome of an actualized affordance back to the “Facilitating conditions” label (Figure 6-7). This illustrates that the perceived potential outcome of an affordance may serve as a facilitating condition for the actualization of one or several preceding affordances across granularity levels.

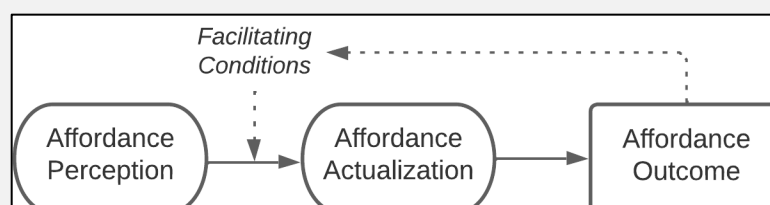


Figure 6-7. *Affordance loops in the NAP*

6.1.9 Limitations of the NAP

The NAP conflates and extends existing ideas and frameworks into one overarching framework. There are, however, a few things that are not easily inscribed into a framework. In the following, I list the shortcomings of the framework.

Naming conventions. One of the findings in the literature review (paper 2) was that naming conventions used to denote affordances were quite ambiguous. I have revisited the data material and delved deeper into the naming conventions used. Table 6-2 shows the variation in naming convention in the review set. Notably, most of the nouns pertain to the nominalization sub-class. Nominalizations are verbs and adjectives that function as nouns. Thus, 92% of the identified affordances are described using either verbs or nominalizations. Notably, the “possibility” naming convention (i.e., nominalizations ending with -bility) is less common than nominalizations ending with -ion.

Table 6-2. Affordance naming conventions in IS research

Naming convention	Frequency	Examples from the review set
Verb	61%	
Gerund	45%	Wearing; enabling face-to-face communication
Infinitive	16%	Reduce resource cost; prioritize vulnerable children at school
Present	0.3%	Provides information about seminars and lectures
Noun	39%	
Nominalizations	31%	
-ion-nominalizations	14%	Communication; self-presentation
-bility-nominalizations	9.5%	Presentability; educability
Other nominalizations	8.2%	Group management; interactivity; information retrieval
Other nouns	7.5%	Add-ons; guilds; forums

I used gerund (paper 3) and -bility (paper 4) in this thesis. It should be noted, however, that the name of a child does not affect the personality of the child. Similarly, affordances are what they are, regardless of how we name them. That being said, I believe the IS community would benefit from a common way of naming affordances so that it is easier to identify and understand affordances presented by other scholars, let alone build on each other’s work.

While the -bility naming convention clearly conveys the inherent action *possibility* of an affordance, it might also be confusing. After all, most words ending in -bility in the English language are nominalizations formed from adjectives (often ending in -ble; e.g., capable, responsible). It can thus be hard for the reader to distinguish “-bility affordances” from regular nominalizations (e.g., capability; responsibility). Furthermore, since an affordance is an action possibility, the naming of it should convey which action is needed to actualize it. For “-bility affordances,” it may be somewhat hard to conclude which action possibility an affordance refers to and also whether it is an affordance at all or a property of the technology (e.g., visibility [Argyris & Ransbotham, 2016]; malleability [Ciriello et al., 2019]). Similar arguments could be put forth for the -ion nominalizations (e.g., animation [Lankton et al., 2015]; visualization [Leonardi et al., 2019]) – are they affordances or functionalities?

Strong et al. (2014) name their affordances “as a gerund associated with the actions that would be taken to actualize that affordance” (p. 67). Since an affordance denotes a possibility for action, I find Strong et al.’s reasoning compelling. For instance, there is a possibility of *shifting work across roles*, and once the actor shifts work across roles, the affordance is actualized. This naming convention clearly conveys the action possibility the affordance refers to, thus indicating what the actors must do to actualize the affordance. After all, an action *possibility* is an action that is not yet actualized. Why should we name affordances using words that are hard to relate to the actions they refer to? Thus, even though naming conventions are not emphasized in the NAP, I am proposing gerund as a common way of naming affordances.

Perceiving affordances on behalf of others. The NAP does not clearly convey whether the perceiver and enactor are the same. Obviously, if a goal-oriented actor actualizes an affordance with the intention of achieving a goal (immediate or not), s/he has perceived the affordance first. But I argue in section 6.1.8 (Affordance loops) that it is possible to perceive an affordance on behalf of others. One of the goals of the Gambian DHIS2-EMIS implementation, as explained by Idowu, is to get something that everybody uses without anyone in particular controlling the system so that “data is just used” (Idowu, section 3.3.3). Idowu has some clear aspirations and perceptions for the possibilities following a DHIS2-EMIS implementation. S/he does not speak only for him-/herself but has other stakeholders in mind, such as head teachers and regional directors. In other words, Idowu perceived the *data using* affordance on behalf of others. However, for others to be able to actualize the *data using* affordance, the system must be *configured*, and people must be trained so that they can actualize the *data capturing* and the *data processing* affordances. This chain of affordances are affordances actualized by distinct actors. HISP WCA consultants actualized the configuring affordance in collaboration with Gambian EMIS employees, the *data capturing* affordance is actualized by school teachers, while the *data processing* and *data using* affordances are actualized by

stakeholders at all levels to achieve actionable data to inform decisions they can act further on.

The NAP might convey the understanding that it is the same actor (or group of actors) that has to be involved in the interdependent affordances. But as the abovementioned example illustrates, that is clearly not the case. The perceiver is not necessarily the enactor and the enactor of an affordance is not necessarily the enactor of another interdependent affordance.

I welcome further development of the NAP to address these limitations.

6.1.10 The NAP summed up

In summary, the NAP brings together existing frameworks and ideas in extant research that allude to the same core ideas and introduces new concepts to further support IS scholars in research using the AT lens (see Table 6-3). The NAP thus equips researchers with a tool that can be used to describe nested, composite, and interdependent affordances at different granularity levels with a unified terminology, affording proper knowledge accumulation of an IS-appropriated affordance theory. To determine the granularity level of an affordance, the application of the AIF should supplement the NAP. The AIF is described in the following.

6.2 The Affordance Identification Framework (AIF)

As I was analyzing the empirical data from The Gambia using the NAP, I was missing a tool to properly categorize affordances into granularity levels. I thus developed the affordance identification framework (AIF) as a tool to make the categorization process easier. The framework was first introduced in Valbø (2022) as a *stepwise framework for affordance categorization*. The framework is inspired by Bygstad et al.'s (2016) fourth step in their stepwise framework for critical realist data analysis (p. 89). The AIF was first published in paper 4. The AIF serves two purposes. First, it is a useful tool to help identify and categorize affordances into the three major granularity levels. Second, when the categorization is done, we should reflect on the affordances identified. If the majority are lower-level affordances, will they still serve as a good foundation for further analysis of our case, or should we emphasize identifying more mid- and higher-level affordances?

The AIF consists of two elements – a table presenting the steps in the identification and categorization process (Table 5-3) and a flow-chart illustrating the important questions that need to be asked during this process (Figure 6-9). In the following, I will go through the steps of the AIF.

Table 6-3. How the affordance identification framework (AIF) and the nested affordance process model (NAP) are positioned with respect to extant IS research.

Concepts Extant IS literature	(De)com- posability/ Nested Affordances	Trajectory/ Sequential Affordances	Granu- larity	Mid-level Affordances	Feedback Loops	Affordance Loops
Gibson (1977, 1979)	X	X				
Gaver (1991)	X	X				
Markus and Silver (2008)	X					
Volkoff and Strong (2013)			X			
Strong et al. (2014)		X (Affordance dependency diagram)	X		X (Aff.- actuali- zation concept)	
Bernardi (2016)	X	X				
Burton-Jones and Volkoff (2017)		X (Affordance network)	X		X (Aff. network)	
Volkoff and Strong (2017)	X	X	X			
Cheikh-Ammar (2018)	X		X			
Thapa and Sein (2018)	X (Ensemble of aff.)	X (Trajectory of aff.)				
Hatakka et al. (2020)		X				
AIF			X	X		
NAP	X	X	X	X	X	X

6.2.1 Step 1: Identify actualized affordances

An action possibility is a possibility only until it is actualized. And if we look at it the other way, a realized action was, until it was realized, just an action possibility. The first step of the AIF thus focuses on identifying actualized affordances. That is, identify actions that are already realized. In a case study, one can identify such actions by studying what actors do or asking interviewees about what action they do (and have done) in their work. To avoid bias towards lower-level technology use affordances, too much emphasis should not be put on what they do *with* the technology. Rather, we should emphasize what technology use affords to the users. What new tasks can they do thanks to the technology?

6.2.2 Step 2: Identify latent affordances

Latent affordances are affordances that are not yet actualized. To identify these, we should ask the interviewees which possibilities they observe thanks to the technology. What aspirations do they have for their future work? As researchers, we can, of course, also do our own observations and derive latent affordances.

6.2.3 Step 3: Categorize lower-level affordances

After having identified affordances in the two preceding steps, we should now categorize the affordances into the three major granularity levels (described in section 6.1.2). This can be a challenging task, and the key questions in Figure 6-9 can be a helpful starting point. First, we should decide whether an affordance is indeed an affordance. This can be done by reflecting upon the first question, “Does it describe an action?” Since it has already been categorized as an affordance by a skilled IS scholar, the answer is probably “yes,” and we can move on to the next question, “Does it describe a concrete use of a technology feature?” One could raise the question of whether technology use is anything but concrete. The idea, however, is to decide whether the identified affordance relates to a very basic use of a technology feature, as described in section 6.1.2. Perhaps having Markus and Silver’s (2008) definition of functional affordances in mind will be of help to someone. If the answer is “yes,” we can label it as a lower-level affordance. If the answer is “no,” we must proceed to step 4.

6.2.4 Step 4: Categorize mid-level affordances

If we have concluded that the affordance in question is not a lower-level affordance, we want to determine if it relates to an action where technology is involved, although without being able to pinpoint any concrete technology feature being used. Faraj and Azad (2012) speak of “actions in the world that involve technology” (p. 255), which I find to be a fitting description of mid-level affordances. A question we may ask ourselves to identify mid-level affordances is, “Does it involve a more abstract use of technology?” *Abstract* is perhaps a somewhat hazy word. The idea, however, is that

mid-level affordances indeed refer to a somewhat abstract and hazy use of technology. Let us again consider Hatakka et al.'s (2020) *job information reachability* affordance as an example. While it is obvious that reaching job information is an action “that involve[s] technology” (Faraj & Azad, 2012, p. 255), it still remains unclear how exactly they do that. On the contrary, for Burton-Jones and Volkoff's (2017) *inputting* affordance, it remains very clear that the affordance is realized by using a data inputting (data entry) feature (i.e., lower-level affordance). Thus, if the answer is “yes” to this third question, we can label it as a mid-level affordance. If the answer is “no,” we proceed to the last step.

6.2.5 Step 5: Categorize higher-level affordances

If the affordance in question is neither a lower-level nor a mid-level affordance, it might be a higher-level affordance. Higher-level affordances relate to action possibilities that emerge from the actualization of mid-level affordances. Higher-level affordances do not themselves necessarily involve technology use but rely heavily on preceding technology use. One way to determine if it is a higher-level affordance, is thus to reflect on the question, “Is it realizable because of preceding use of technology?” If we can conclude that the affordance in question is indeed an action possibility depending on previous technology use without itself being technology use, we can label the affordance as a higher-level affordance. On the contrary, if this affordance describes an action possibility that might emerge without depending on preceding technology use, it is simply not an IS affordance. The version of the key questions flowchart presented in an earlier version of paper 4 (Valbø, 2022) suggests that IS researchers start over if the answer to the last question is “no.” However, we should rather conclude that the affordance is not an IS affordance. I have taken in this update in Figure 6-9.

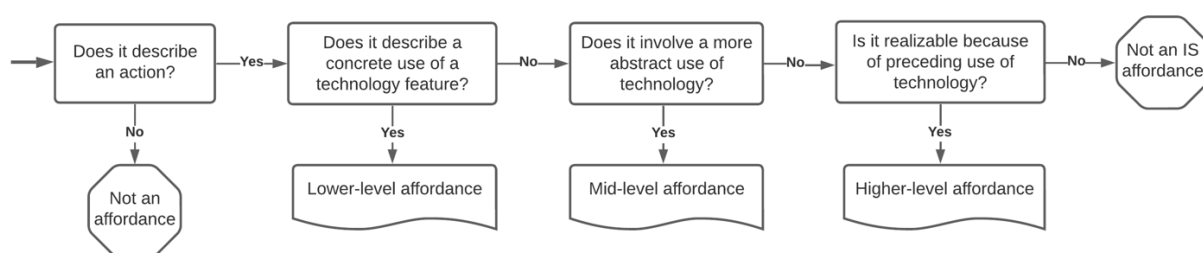


Figure 6-9. Key questions in the affordance identification framework (AIF; adapted from Valbø [2022])

6.3 Implications for IS Research

Applying the frameworks developed in this thesis will have positive implications for IS researchers.

6.3.1 Keeping an organizational focus

First, in our quest to understand technology-caused organizational changes, the frameworks help us maintain an organizational-level focus in our studies. Observing individuals performing actions using technology is simple and might explain the overweight of affordances with individual actors in recent IS research (Figure 5-3). However, when studying organizational change, we should not be too concerned about individuals' actions but more about the organizational consequences of these. The AIF and NAP are, in that regard, useful tools to nudge IS researchers towards lifting our focus to organizational-level actions and consequences. If too many affordances in our studies are "direct use of a technology or a specific technology feature" (Figure 6-9), then we should start reflecting on the consequences of the actualization of these affordances by asking questions like, "What new action possibilities do the technology-use affordances enable, and what are the consequences of those?"

6.3.2 Reducing ambiguity, facilitating knowledge accumulation

The progress of research relies heavily on accumulated knowledge. This layering of knowledge enables us to develop more complex theories and models and refine established ones. However, if researchers define or measure theoretical concepts in a variety of ways, findings might not be comparable, and theoretical frameworks and extensions might not be harmonious, thus effectively hindering appropriate knowledge accumulation. The AIF thus serves as a useful tool insofar as it can be used to (1) filter out research objects that are not really affordances (e.g., forums; listserv groups [Alam & Campbell, 2017]) and (2) categorize the affordances in terms of granularity levels. This, in turn, will result in a more unified application of the affordance lens in IS research, reduce the ambiguous use of the concept, and facilitate knowledge accumulation. Furthermore, if IS researchers apply the NAP in our analysis of the affordances in our studies, we will have a unified way of talking about IS affordances.

6.3.3 Opening new avenues for research

The introduction of the three granularity levels challenges extant ways of looking at IS research affordances. The idea of granularity levels is not new, but the way they are separated into three major levels and accordingly defined in this thesis may challenge our conventional understanding of affordances – especially when it comes to the notion of higher-level affordances. To present a suggestion for further theory development, I will draw on Mesgari et al. (2023). After reviewing affordance-based IS research, they identify "three distinct research agendas concerning affordances in the literature" (p.

37), namely technical, organizational, and socio-behavioral. In IS research that falls within the technical agenda, affordances are considered designed into the artifact and appear to be relatively independent of the context in which the IT artifact is embedded. The organizational research agenda, on the other hand, focuses on affordances at a higher level of abstraction, “[addressing] the consequences of using technology for organizational processes, routines, and practices” (p. 39). Finally, the socio-behavioral research agenda has a more holistic focus, studying the consequences of technology use for individuals within their context. Figure 6-10 illustrates the important elements for affordance emergence in each of the research agendas. Notably – although not surprisingly in IS studies – technology plays a vital role in the affordance emergence in all three research agendas.

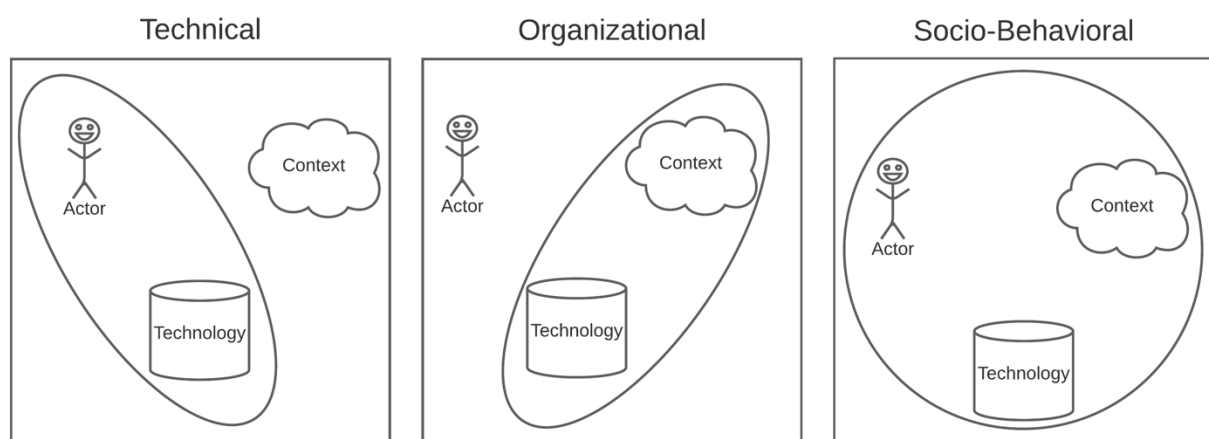


Figure 6-10. Three distinct IS research agendas (adapted from Mesgari et al., 2023, p. 38)

The illustrations of the research agendas (Figure 6-10) also demonstrate the differences in granularity levels to a reasonable extent. Lower-level affordances are technology-centric affordances, where users apply technology features in the actualization of affordances. Such affordances are normally quite context-independent. Mid-level affordances emerge as a consequence of technology use, which coincides with Mesgari et al.’s (2023) description of the organizational research agenda, “[addressing] the consequences of using technology for organizational processes, routines, and practices” (p. 39). When it comes to the socio-behavioral research agenda, I would argue that this agenda’s holistic focus reflects how IS researchers should approach their studies, focusing both on the individuals as well as processes, routines, and practices in organizations. An illustration of higher-level affordances is, however, missing. Drawing on Fayard and Weeks’ (2007) photocopier study, where the *informal interactions* affordance were actualized around – and because of – the photocopier, but notably without applying it directly, Figure 6-11 attempts to convey that technology is quite detached from the actualization of higher-level affordances. Nonetheless, it is part of the picture (no pun intended) and plays – as has been argued – an important role in the emergence of higher-level affordances. Combining these illustrations into a whole,

Figure 6-12 depicts a holistic perspective on affordance-based IS research. The figure illustrates the interdependencies among affordances across granularity levels. Note, however, that this is still an underdeveloped idea and meant for illustrational purposes only to illustrate how the interplay of lower-, mid-, and higher-level affordances in IS research *could* look like when studying organizational changes. Contrary to Mesgari et al.'s description of the organizational research agenda, mid-level affordances are not necessarily related to “organizational processes, routines, and practices” (p. 39). In paper 5, we attempted to relate lower-, mid-, and higher-level affordances to a micro, meso, and macro level, correspondingly, and termed the affordances micro-, meso-, and macro-level affordances. According to how I have defined lower-, mid-, and higher-level affordances in this thesis (section 6.1.2), such a mapping cannot be done. Yet, in Figure 6-12, I have used the terms micro-, meso-, and macro-level affordances to convey their relation to the levels of analysis presented by Mesgari et al.

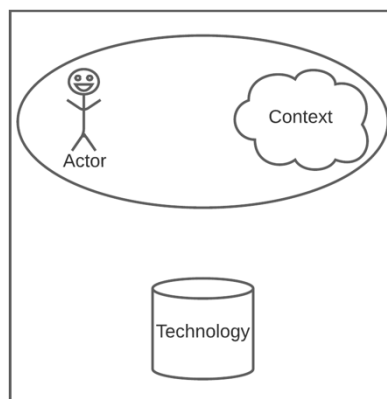


Figure 6-11. *Higher-level affordances*

Higher-level affordances – whether actualized in an organizational context or at a societal level – are of great interest for IS research. We study how individuals interact with technology and how technology affects organizations. We are also concerned with the consequences or effects of this. But instead of drawing on other theories to talk about this, I believe affordance theory could be a good fit. The terminology is there, it is just a matter of adapting it to suit our needs. Therefore, we should not abandon higher-level affordances but rather find ways of talking about these using affordance terminology. Fayard and Weeks’ (2007) notion of social affordances could be a good starting point. After all, higher-level affordances are more social than technological. Their emergence is nonetheless dependent on technology, and they should, therefore, have a place in IS research. I encourage other IS scholars to pick up on this and further develop this line of thought.

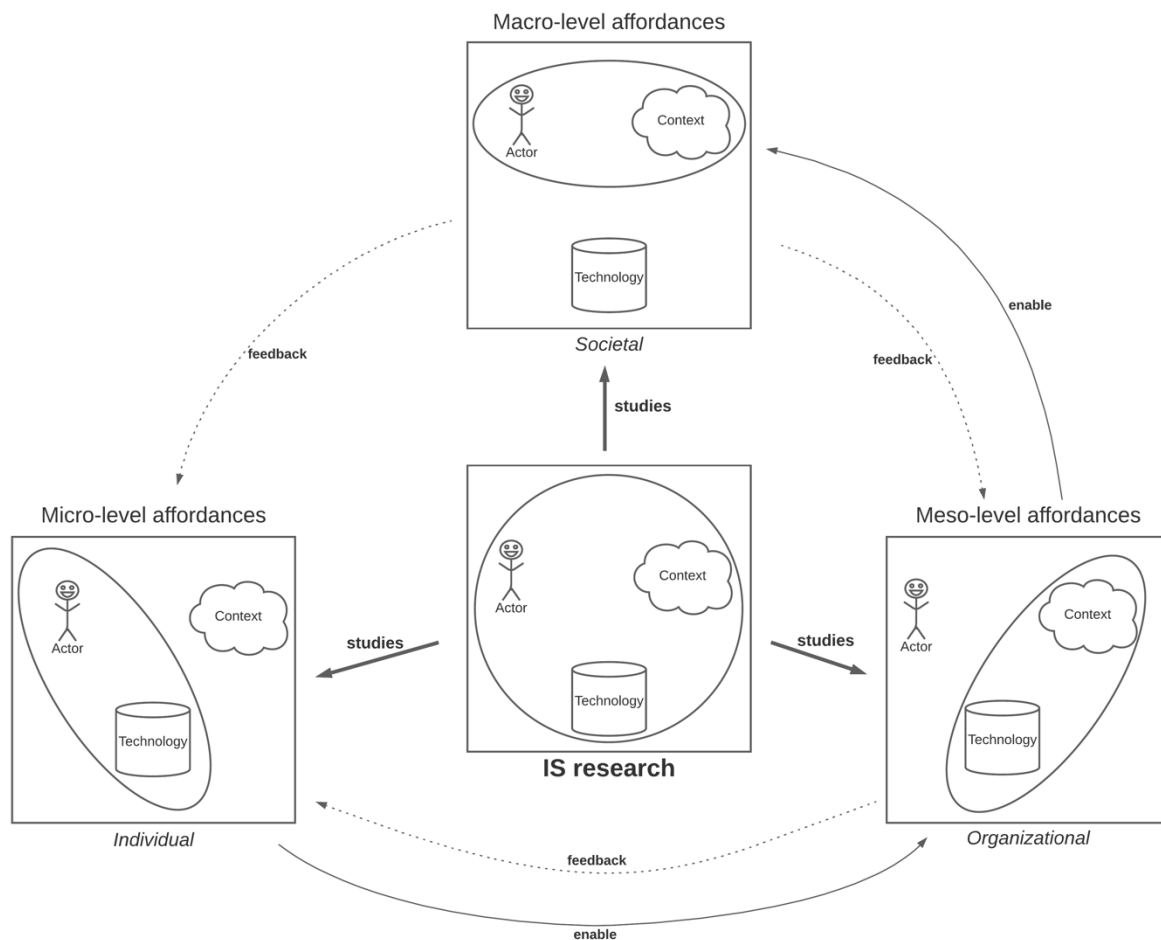


Figure 6-12. *Affordance-based IS research*

6.4 Implications for practitioners

Being theoretical constructs, the NAP and the AIF do not themselves cause any direct implications for practitioners. The findings derived through applying the NAP and the AIF may, however, provide useful suggestions for practitioners.

By introducing the affordance loops concept, I have argued that the perception of mid- and higher-level affordances and the potential consequences of their actualization feed back to lower-level affordances as stimulating conditions. In other words, if a practitioner perceives the possibility of a positive long-term effect emerging from the use of the technology, they will be more motivated to use the technology. For instance, a teacher in The Gambia will likely be more willing to commit to registering teacher attendance if they perceive the new possibilities that their data-entry affords (i.e., the consequences of his actions). But for the teacher to perceive that, they should have to go through proper training. Thus, in this case, MoBSE should prioritize capacity building not only on technology use but also focusing on teaching the technology users what their technology use may afford in the long term. If such capacity building is

carried out properly, societal consequences may indeed “emerge from the development, deployment, or use of IT” (Faik et al., 2020, p. 1361). Essen and Värlander (2019) conclude in their paper that “the introduction and evolution of a technological artifact in an institutional setting contributes, under specified conditions and through a recursive mechanism, to change not only at the local level but also institutionally at the field level” (p. 1173). The findings in this thesis confirm and extend their claim. Given adequate capacity building for all practitioners involved, a national dissemination of a technology solution has the potential of causing long-term societal-level consequences.

6.5 Appropriation Challenges

Since actors’ use of objects is at the essence of the affordance theory, it is understandable that the IS community – studying actors’ use of technology – has embarked on an appropriation process, exploring the theory’s usability in the IS domain. However, since the theory was not yet fully developed in its original domain before human-computer interaction (HCI) and IS researchers started to use it (Fromm et al., 2020; Michaels, 2003), there is – as highlighted in this thesis – quite some ambiguous use of the theory. During a research theory appropriation process from one field of study to another, there must necessarily be tradeoffs. Most researchers would agree that sticking to the original idea is both respectful and useful. Nevertheless, research theories are ever-evolving, and in fields as different as ecological psychology and IS, it would be quite surprising if there were no differences in the application of the affordance theory. When adapting and adding to a research theory, however, we should constantly reflect on whether the theoretical extensions also weaken the usefulness of the theory. What do we achieve by expanding the theoretical concepts? What do we lose? The following subsections reflect on these important issues.

6.5.1 Multilayered affordances

While basic technology use is arguably actualization of affordances, they are usually not the actions that IS researchers should put most of our focus on. We should rather follow Leidner et al.’s (2018) suggestion to look beyond mere technology use. The AIF can be used to make IS researchers aware of the granularity level of the affordances we are studying. If we realize that some of the identified affordances that we are using to build an argument are lower-level technology-use affordances, it could be worthwhile reflecting upon whether identifying mid-level affordances could add valuable contributions to the study.

For instance, Karahanna et al. (2018) explain how different affordances contribute to fulfilling technology users’ psychological needs. In doing so, the authors use both low-level affordances (e.g., content sharing) and mid-level affordances (e.g., relationship

formation). The authors contend that the actualization of the *content sharing* affordance contributes to “help users fulfill their *autonomy* need by enabling individuals to freely choose what to share” and that the *relationship formation* affordance “can help fulfill users’ need for relatedness by creating *broader social connections*” (p. 748). Now, while relationship formation is an affordance that emerges from the more basic *joining an online community* affordance, the content sharing affordance is simply just a basic technology-use affordance and a tautological rephrasing of the *sharing links* affordance. By actualizing the basic technology-use affordance joining an online community, the users are able to form relations, which in turn helps them fulfill the need for relatedness. However, by actualizing the basic technology-use affordance sharing links/content sharing, one could question whether that helps fulfill the need for autonomy. It would have been interesting to see a further reflection on which affordances content sharing could constitute or provide at a higher level of granularity. Perhaps *opinion broadcasting* could be a better fit instead of content sharing.

Some might argue that introducing granularity levels and higher-level affordances without any immediate and concrete outcome is watering out the original idea of affordances. There is arguably quite some distance and difference between a basic cutting affordance (Gibson, 1977) and a higher-level actionability affordance (paper 4). Nevertheless, in an IS setting, affordances are what the technology “*provides* or *furnishes*” (Gibson, 1979, p. 127). While the knife allows a chef to cut a cucumber, DHIS2-EMIS furnishes the Gambian stakeholders with the knowledge they need to take action. Hence, the actionability affordance does indeed “[imply] the complementarity of” (Gibson, 1979, p. 127) the Gambian stakeholders and DHIS2-EMIS insofar as DHIS2-EMIS enables the Gambian stakeholders to function effectively. Thus, I contend that higher-level action possibilities that emerge due to the actualization of low- and mid-level affordances involving a specific technology should indeed be considered affordances of that technology, even though the action possibilities themselves do not involve direct use of the technology. As long as they are provided or furnished by (the interaction between) the technology (and its users), they are indeed affordances of that technology. Nonetheless, the epistemological issue regarding how we categorize these higher-level affordances should be addressed to ensure a common way of talking about these in future research.

Following these arguments, I believe that the IS community will benefit from the two frameworks introduced to help us reflect on the objects we are studying. If we are studying how employees are grappling with introducing a new computer system, then lower-level affordances are probably useful to analyse. But if we want to learn how a new computer system affects organizational work practices, we should indeed lift our focus and strive to identify mid- and higher-level affordances.

6.5.2 Ambiguous use – is it a problem?

Research theories should help us understand and explain reality. Thus, as long as the application of a theory in a study contributes to understanding and explaining the case, one can argue that ambiguous use in different studies is not a real problem. But if we consider the joint theory development or appropriation of a theory from one field of study to another, the joint work and knowledge accumulation process will become very cumbersome if the basic concepts of the theory are understood differently. If some researchers understand the core concept of affordances as technology artifacts (e.g., forums; listserv groups [2017]), others as inherent properties of the technologies (e.g., open access [Arazy & Gellatly, 2012]; dynamism [Lankton et al., 2015]), yet others as action possibilities (e.g., inputting data [Burton-Jones & Volkoff, 2017]; assess wildlife distribution [Pan et al., 2020]), then a common way forward will be hard to stake out. Michaels (2003) touches upon the same challenge in the field of ecological psychology when she criticizes Gibson's inaccuracy when defining affordances, as Gibson speaks of actions (e.g., walking, climbing) but also non-actions (e.g., danger, nutrition; p. 137). In the end, Michaels suggests that researchers stick to the understanding that affordances are action potentials (p. 146).

Independently of how IS researchers decide to use the affordance theory in our studies, it is arguably a powerful theory for our sociotechnical field when trying to understand and explain how technology affects organizations and societies. I hope that I have managed to contribute with “conceptual cleaning” (Czarniawska, 2016, p. 618) of the affordance concept and that other researchers will find this work useful.

7 Concluding Remarks

In this thesis, I highlight the ambiguous use of the affordance concept among IS scholars and suggest means to re-calibrate our understanding and use of the concept. The nested affordance process model (NAP) divides affordances into three major granularity layers. Lower-level affordances are technology-use affordances enacted by individuals in their embedded work settings. Mid-level affordances are affordances that emerge as a result of the actualization of lower-level affordances. These affordances are action possibilities made possible by direct technology use and include actions aided by technology and what is often referred to as organizational IT capabilities. The actualization of mid-level affordances further enables the emergence of higher-level affordances whose actualization causes ripple effects at a societal level. To help identify affordances at these three levels, I developed the affordance identification framework (AIF), providing concrete suggestions on how to identify affordances at these three levels.

The developed frameworks were applied to empirical data from the educational sector in The Gambia. The analysis of the empirical data supports and strengthens the theoretical models and gives rise to the notion of affordance loops, as the findings illustrate the interplay between layered affordances in terms of enabling and stimulating conditions. That is – coherent with extant research – the actualization of an affordance may enable the emergence of a subsequent affordance. Furthermore, a perceived future affordance may stimulate the actualization of a preceding affordance. The findings also demonstrate the importance of mid-level affordances, serving as a bridge between basic technology-use affordances and higher-level affordances with societal-level effects. Practically, in the Gambian DHIS2-EMIS case, the findings suggest that training people in technology use so that the lower-level affordances can be enacted is a good spending of resources, but even more important is that people are trained in data processing and interpretation, that roles are defined, and political agendas are drafted. Also, if practitioners perceive the possibility of positive long-term effects emerging from their use of the technology, they will be more motivated to use the technology (i.e., actualize the lower-level affordances), thus causing the mid-level affordances to emerge. Hence, technology use can indeed lead to societal-level outcomes if capacity building in terms of user skills and knowledge is prioritized.

7.1 Limitations and Suggestions for Future Research

This thesis is part of a Ph.D. program with fixed deadlines, and the research had to be carried out within a time span of three years. Additionally, the worldwide Covid-19

pandemic affected both the DHIS2-EMIS rollout in The Gambia and my initial plans for fieldwork.

The analysis in the literature review paper was based on papers from the eight journals in the Senior Scholars' Basket of Journals. A broader set of literature could have been reviewed to obtain more nuanced results. Also, I did the review single-handedly before bringing in a co-author in the latest revision. Nevertheless, given the relatively high number of analyzed papers in top journals and several review iterations, I believe the findings and analysis presented are plausible. I do, however, encourage other researchers to build on and extend the review further.

Since DHIS2-EMIS was not fully rolled out in The Gambia at the time of my research, many affordances that the theorizing in this thesis is based on are only perceived possibilities that are not yet enacted. And if they are action possibilities that will never have the potential of being realized in a context, one could question whether or not they are affordances. Some might argue that basing theoretical affordance frameworks on presumed affordances is speculative. I thus welcome others to further develop and test these frameworks in other empirical settings, both ICT4D and non-ICT4D settings.

Some might argue that the higher-level affordances referred to in this thesis are not really IS affordances since they do not involve an actor's use of technology. However, these higher-level affordances emerge due to the actualization of technology-centric affordances and would likely not be achievable without the actualization of the technology-centric affordances. Following the same argument as proposed in Leidner et al.'s (2018) train ride example, it can thus be argued that the technology affords the higher-level affordances. I encourage researchers to delve deeper into this line of thought.

The main contribution of this thesis is to the IS community at large. As illustrated, the theoretical contributions have implications for the ICT4D field as well. I encourage other researchers to explore how the NAP and the AIF can contribute to an enhanced understanding of technology's contribution to societal changes in LMICs.

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Appendices: The Papers

1. Sanner, T. A., Amuha, M., Jallow, S. A., Masiero, S., & Valbø, B. (2023). *Meeting the Education Data Crisis: A Research Agenda on Digital Platforms for Education Management* [Manuscript in review]. Department of Informatics, University of Oslo.
2. Valbø, B. & Sanner, T. A. (2023). *Information Systems Affordances: A Descriptive Literature Review and a Derived Conceptual Model* [Manuscript in review]. Department of Informatics, University of Oslo.
3. Valbø, B., & Sanner, T. A. (2022). Investigating Mid-level IT Affordances as Drivers for Societal Change: Addressing the Education Data Challenge in The Gambia. In Y. Zheng, P. Abbott, & J. A. Robles-Flores (Eds.), *Freedom and Social Inclusion in a Connected World. ICT4D 2022. IFIP Advances in Information and Communication Technology*, vol 657 (pp. 471–489). Springer International Publishing. https://doi.org/10.1007/978-3-031-19429-0_28
4. Valbø, B., & Sanner, T. A. (2023). Informing Sustainable Development in Education: Identification and Actualization of Layered IS Affordances. *The Electronic Journal of Information Systems in Developing Countries*, e12302. <https://doi.org/10.1002/isd2.12302>

Meeting the Education Data Crisis:

A Research Agenda on Digital Platforms for Education Management

Abstract

Quality data is needed to plan and monitor interventions in the pursuit of education sector policy goals. This includes the United Nations' Sustainable Development Goal (SDG) 4, which calls for significant improvement in learning outcomes and equitable access to education. Millions of children fail to develop basic literacy and numeracy skills. Yet, governments in low income countries lack data about learners and the factors that inhibit them from accessing education or from learning whilst in school. Developing robust, yet flexible, Education Management Information Systems (EMISs) can mitigate the education data crisis by affording timely and relevant data in the hands of decision makers. Despite their societal importance, EMISs in low-income countries are underfunded and remain understudied by Information Systems (IS) research and academia broadly. We propose a research agenda that extends current IS research on digital platforms for education management. A digital platform approach to EMIS strengthening, based on values of openness, local innovation, participation and social development, can potentially mitigate the education data crisis in low income countries, while providing fertile ground for further theorising digital platforms in the public sector.

Keywords: education management; research agenda; SDG4; digital platform

1 Introduction

Public sector education management, while essential to the delivery of inclusive, equitable and quality education, occupies a relatively marginal position in the IS field. A search for scientific publications on “education management information system” in 2020 and 2021 in Web of Science, returned *five* papers. In comparison, the search string “health management information system” returned 94 publications in the same period. Research on how to strengthen education management information systems is critical to social development, especially in low-income countries where governments struggle to obtain reliable data and monitor progress towards adequate education for all (Powell, 2006). 250 million children, out

of the world's 650 million primary school age children, fail to obtain basic numeracy and literacy skills (UNESCO, 2014). UNICEF's executive director refers to the situation as "an unmistakable learning crisis" (UNESCO, 2020a, p. 23). A gateway to mitigate the persistent *learning crisis* is to address the education *data crisis*. There is a lack of information on who is learning and who is not. Furthermore, managers have limited access to information about teacher qualifications, what teachers do in the classroom and, in some cases, whether they even show up.

Ministries of education around the world conduct expensive surveys and produce statistical yearbooks. However, these are often published with a significant time lag and have limited formative value (UNESCO, 2020a). Education data is often not integrated across different sources, nor is it presented in a user friendly or actionable format. Data collectors rarely get to see the reporting burden experienced at the school being translated into locally relevant action. Knowledge about which data is important, and how to collect, report and analyse data is often lacking. Consequently, use of education data is limited beyond paper based routines at school level (Tolley & Shulruf, 2009). In the past, scholars have noted that "many educational administrators do not have a clue about interpreting and effectively using data in decision making" (Chapman, 1998, p. 620). Without access to responsive information systems and training in data processing and analysis, such statements still ring true today (UNESCO, 2021).

Well-functioning Education Management Information Systems (EMISs) monitor the performance of education systems, inform effective training and posting of teachers, ensure equitable access and learning opportunities, and identify priority areas for allocation of scarce education sector resources (Wako, 2003). The education sector needs resilient EMISs that respond to education planners' changing information needs (Abdul-Hamid, 2014). EMIS challenges are particularly pronounced in countries characterised by systemic resource constraints, which in turn has a negative impact on the delivery of quality education to "the less materially advantaged members of those societies" (Walsham, 2017, p. 18). The COVID-19 pandemic has both highlighted and exacerbated education management challenges. Remote learning, such as through radio and television, was implemented to minimise the effects of enforced school closures. Yet, governments were unprepared for such a shift in education service provision, although measures have been taken to support out-of-school children outcomes. This demonstrates the dire need for research that can inform the development of resilient and responsive EMISs.

Against this backdrop, we propose an EMIS research agenda. We draw on illustrative examples from implementation research to strengthen EMISs in The Gambia and Uganda. Theoretically, we relate our proposed research agenda to digital platforms, which constitute the “technological building blocks” on which third parties can build complements on top of a platform’s core (Cusumano et al., 2019). In terms of software architecture, a digital platform offers a generic core on which new contents, applications or services can be developed and shared. The interplay between the generic platform core and its complements are regulated through stable interfaces, referred to as boundary resources such as Application Programming Interfaces (APIs), Software Development Kits (SDKs), open standards and documentation (Ghazawneh & Henfridsson, 2013; Dal Bianco, 2014; Eaton et al., 2015; Foerderer et al., 2019). Boundary resources afford *generativity*, which is the ability to share, recombine and reuse applications, services, processes, intellectual property, and other innovation assets by platform complementors involved in distributed innovation processes (Nambisan & Sawhney, 2011, p. 44).

Digital platform architecture alone offers limited generativity, without a thriving ecosystem to develop and extend platform complements through implementation and local configuration. Hence, the digital platform’s value co-creation potential and flexibility for local adaptation reside with platform complementors who integrate available resources to accommodate emergent local needs. Companies such as Facebook (now Meta), Google, Microsoft, Apple and SAP have experienced a tremendous upside from the realisation of value co-creation potential in digital innovation platform ecosystems. However, profit maximising agendas, fierce market competition, and risks of hostile agendas also limit the level of openness and participation exhibited by commercial digital innovation platforms (Karhu et al., 2018).

By approaching EMISs from a digital innovation platform perspective, we unveil significant potential to derive theoretical insights on the design, governance and impact of such platforms predominantly with a social development agenda. To date, the vast majority of digital platforms studied from a developing country or development perspective have been digital *transaction* platforms, such as M-Pesa, Kiva, Ushahidi, Mercado Libre, GoJek and others (Bonina et al., 2021). By way of contrast, the value co-creation potential associated with digital *innovation* platforms in the public sector in developing countries has yet to be explored (Bonina et al., 2021: 878). IS researchers are well positioned to describe digital innovation platform development and governance challenges in the public sector and identify approaches that

promote openness, knowledge sharing, and participation to enhance the accessibility of education data, facilitate data-driven scrutiny of education system performance, enable integration of fragmented education data sources, and strengthen informed decision making throughout education systems. The paper is informed by the following research questions:

What are the EMIS knowledge gaps to be tackled by an IS research agenda?

How can EMIS research advance our understanding of digital innovation platforms for social development?

The remainder of the paper is organised as follows. First we describe what an EMIS is, and how the current EMIS landscape fails to meet education sector information needs. We then present two empirical examples from The Gambia and Uganda, to illustrate the pressing need for an “EMIS shift” to tackle the education data crisis. We then draw on a digital innovation platform perspective to position EMIS as an object of IS research. Our framing foregrounds *generativity* and *openness* as digital platform characteristics that invite participation in value co-creation for social development. Based on the platform perspective proposed, we develop a research agenda for engaging EMIS within the IS field.

2 EMIS core concepts and knowledge gaps

While EMISs have been designed and implemented for decades, they are surprisingly understudied in the IS field. There is a practice-oriented body of knowledge concerned with EMIS, albeit mostly in the form of education sector grey literature. An EMIS goes beyond infrastructure utilised for collection, management and analysis of data to include the entire education data ecosystem (UNESCO, 2020b). The development of an effective EMIS is a complex and expensive undertaking, and during the process “it is important to consider the needs of all the groups that will rely on the information, including central ministry planners, officials of other national ministries (for example, ministries of finance), regional and district education officials, donors, and NGOs” (IIEP, 2010, p. 156).

As noted in Cassidy (2006, p. 2), “there is no universally-accepted definition of EMIS. The acronym, EMIS, means different things to different people”. Cassidy goes on to provide an extensive definition of EMIS, which has been widely adopted (e.g., Abdul-Hamid, 2014; Bhatti & Adnan, 2010; UNESCO, 2007), as

“a system for the collection, integration, processing, maintenance and dissemination of data and information to support decision making, policy-analysis and formulation, planning, monitoring and management at all levels of an education system. It is a system of people, technology, models, methods, processes, procedures, rules and regulations that function together to provide education leaders, decision makers and managers at all levels with a comprehensive, integrated set of relevant, reliable, unambiguous, and timely data and information to support them in completion of their responsibilities.” (Cassidy, 2006, p. 27)

In this paper, we adopt Cassidy’s definition in virtue of its comprehensive nature which explicates inputs, functions and outputs of an EMIS. Education data can be used to monitor progress at individual schools, as well as within an entire national education system (Bhatti & Adnan, 2010; Hua & Herstein, 2003; Wako, 2003). EMIS data is useful for allocation of education staff, school supply and other resources (Chapman, 1991; Hua & Herstein, 2003; Wako, 2003); management strengthening (Chapman, 1991); and policy planning and formulation (Hua & Herstein, 2003; Wako, 2003). Key EMIS challenges include the lack of timely and reliable data, limited data integration and sharing, and meagre utilisation of existing data (Hua & Herstein, 2003). Finally, the education sector lacks robust and flexible digitised EMIS solutions, which respond to heterogeneous and changing education sector needs across local settings. We elaborate on these four key venues for EMIS strengthening below.

Timely production of reliable data. EMIS data produced regularly must meet the needs of education planning and budgeting, educational services, monitoring and evaluation, and international collaboration and communication, all in a timely fashion (Hua & Herstein, 2003). Data reliability can be affected by a number of data production steps, including the design of data collection tools, clarity of descriptions, data collection methods, training and human capacity, data aggregation methods, and data processing procedures. Digital data collection tools can mitigate data reliability issues by introducing data validation at the point of collection and responsive interfaces that alert data handlers to potential data quality issues. Similarly, analysts can run automated completeness, consistency and correctness checks to ensure that basic data quality standards are met. Use of unreliable or outdated data leads to inadequate resource allocation, missed intervention opportunities and distrust from information users. In turn, distrust might trigger a vicious cycle of discouraged support for maintaining the EMIS and hence diminished information production and analysis capacity. To date, there is limited knowledge about how locally appropriate education data collection and analysis tools can be

developed and sustained to support decentralised data collection, analysis and decision-making in resource constrained settings. There is a long standing tension between local flexibility to support different practices, workflows and capacities on the one hand, and maintainability of such solutions at national scale on the other.

Data integration and harmonisation. As noted in Hua and Herstein (2003), “[data integration] means that data from multiple sources (human resource, exam results, school census), multiple years, and multiple levels (student, teacher, or school level) can be linked, integrated, or merged” (p. 6). Data integration is a prerequisite to high-level and high-quality data analysis. The multiple units within Ministries of Education have traditionally maintained their own databases (e.g., human resource, national exams, gender equality, social inclusion, policy and planning), rarely shared with other units. Without integration, it is not possible to calculate indicators such as “the impact of teacher qualifications on student performance” (Abdul-Hamid, 2014, p. 18). Furthermore, the lack of integration means that major efficiency and equity issues are overlooked. So is the opportunity to identify and study schools that rise above the odds and make progress with limited resources. To date, there is a paucity in knowledge pertaining to how different software tools and databases for education management may be governed as one harmonized national education data ecosystem. A call for the development of architectural blueprints to guide national health IS development was made more than a decade ago in the health sector (Stansfield et al., 2008). Similar concerns are now voiced by EMIS data stakeholders such as the World Bank and the Global Partnership for Education.

Effective use of education data. Chapman (1998) points out that many Asian countries have improved the “availability, relevance and timeliness of data about their education system”, but that there still exists a lack of knowledge on “how to use the information to improve the educational process” (pp. 620-621). This sentiment is echoed in recent literature (e.g., Hua & Herstein, 2003; Luena, 2012; Powell, 2006). Despite constant calls for more granular education data, most of the EMIS data currently being collected is underutilised. This makes it important to ask, how and to what extent can good practices of education information use scale? A fundamental challenge to information use in the education sector is that data collection does not target the information needs of frontline data users, such as school managers, teachers or Parent and Teacher Associations (PTAs). Existing EMISs extract data from schools to national and global levels, with limited relevance for tackling local problems. Consequently, there is limited demand for data. EMISs also typically do not produce comprehensive reports, even for education policy makers and planners, detailing relevant

dynamics within communities (pupil enrolment, persistence, learning, teachers, finances, poverty and health). Critical education data is often unavailable, and the data that is available is “often hard to understand, analyse, and utilise” (Abdul-Hamid, 2014, p. 16).

Leveraging digital public goods. At the international level, the education sector lacks an “off the shelf” EMIS software. There is no software package or digital platform utilised across a critical mass of organisations or countries. Without a *de facto* industry standard, there is no well-coordinated global community of implementers, non-government organisations (NGOs), or user organisations to develop or share software innovations and exchange implementation experience and knowledge pertaining to national EMIS strengthening. This has led many EMIS initiatives to fizzle out after a few years, as software tools either do not lend themselves to easy customisation or the capacity to configure systems is too scarce to keep up with changing information demands. Recently, governments in low income countries have shown interest in building sustainable IS configuration and maintenance capacity across sectors, by leveraging open source *digital public goods* (DPGs). By utilising the same digital platform across different public sector services, capacity and experiences developed in either health, agriculture, education, transport, or another government function may be shared and leveraged across sectors and departments. However, to date, there is little knowledge about how cross-sectoral public sector management information system capacity strengthening and data utilisation initiatives may be established, funded and coordinated in a sustainable manner.

3 Experience from EMIS implementations in The Gambia and Uganda

To further illuminate the EMIS knowledge gaps outlined above, this section offers exemplifications from EMIS strengthening initiatives, drawing on field data from implementations in The Gambia and Uganda. The implementations described here are based on the District Health Information Software 2 (DHIS2), an open source digital innovation platform governed by the Health Information Systems Programme (HISP) at the University of Oslo. For the past 25 years, DHIS2 has afforded the possibility to collect, report, analyse and act on timely data in the public health domain. North-South-South University partnerships have played a central role in cultivating global and in-country human capacity to design, implement and maintain DHIS2 in more than 70 countries. This has further informed DHIS2 adoption in new domains such as logistics management, agriculture, road safety, and recently education

management. In this light, DHIS2 for Education (DHIS2-EMIS) is an initiative extending the development and use of the DHIS2 platform to the education sector.

The development of the DHIS2 platform core is coordinated by HISP Oslo, while implementers across the globe contribute with development of modules (application extensions) to the platform, accessible through the DHIS2 App-hub or shared directly between actors. In user organisations, an instance of the generic DHIS2 core is configured according to local requirements and expectations, without any programming. Software innovations and implementation knowledge is shared in a globally distributed network involving software developers, domain experts, funders, academic institutions, implementers and user organisations (Braa et al., 2004; Roland et al., 2017). With participatory design, open source code, workplace democracy, local empowerment, and knowledge sharing as prominent ideals, the HISP network has solidified into a vibrant digital platform ecosystem.

Our illustration of EMIS concepts and challenges is conducted through two examples from ongoing DHIS2-EMIS implementations in The Gambia and Uganda. The implementations receive implementation and capacity building support from HISP West and Central Africa and HISP Uganda, two of the HISP groups that constitute the global HISP network. The two groups engage with the ministry of education in the respective countries to build software customisation, data management and data analysis capacity through participatory approaches such as iterative prototyping, development of user scenarios, capacity building workshops and on the job training and support.

3.1. From aggregate reporting to local data use in The Gambia

Historically, the international education agenda has focused on universal access, including the World Declaration for Education in Jomtien 1990 and the Education for All (EFA) framework of the Millennium Development Goals (MDGs). Priority indicators have been access related, such as Enrolment Rates, Completion Rates and Proportion of (qualified) Teachers. The explosive growth in learner enrollment over the past few decades has outpaced many governments' efforts to construct classrooms, train and recruit teachers, and provide essential resources to schools. With the United Nations' Sustainable Development Goals (SDGs), the focus shifted decisively towards the need to "ensure inclusive and equitable quality education and promote lifelong learning opportunities for all" (United Nations, n.d.). Target 4.5 particularly stresses the

need for “vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations” (United Nations, n.d.). However, there is no institutionalised SDG 4 reporting framework in most African countries, including The Gambia, and no flexible information system tool that is used to collect, process and report data on progress related to SDG 4 implementation (ADEA, 2019).

The Gambian ministry of basic and secondary education (MoBSE) has made ‘equitable, inclusive and quality education’ a top priority in its Education policy for 2016-30. The national EMIS is deemed an important infrastructure for the purpose of monitoring and evaluation and tasked with meeting education policy data needs, which include the development of a national teacher register and a learner identification system. The implications of the new policy goals are that data needs to be disaggregated by gender, location, wealth quintile and other factors, such as disability and financial situation (UNICEF, 2019). EMISs must increasingly be capable of handling individual learner data in order to disaggregate by a wide range of socio-economic factors.

The DHIS2-EMIS initiative in The Gambia started in early 2019. Using DHIS2, which has been used by the ministry of health in The Gambia since 2010 (Valbø, 2010), MoBSE designed individual learner modules which capture learners' socio-economic data, attendance history, continuous assessment, and their disciplinary record. In 2020, MoBSE successfully piloted the individual student admission and registration component in 200 schools using Chromebooks. Thereafter, MoBSE leveraged the existing resources from the pilot, including the 200 Chromebooks, to collect and register students throughout the country. The national EMIS team, which has been trained on DHIS2 configuration and maintenance by HISP West and Central Africa, have configured thematic dashboards and analysis tools on the digital platform. This allows schools to visualise their own data and school cluster monitors (i.e., school inspectors) to inspect reporting rates from schools and attendance data for teachers and learners.

As part of the DHIS2-EMIS initiative, MoBSE has digitised their existing School Report Card (SRC). The SRC is a school-level information product intended to promote community participation and increase accountability and transparency. The first version of the Gambian SRC was developed in 2008 using Microsoft Excel macros and Microsoft Access. Despite challenges in interpreting and utilising the rather complex SRCs, the tool has gained widespread recognition and is thoroughly embedded in EMIS practice. With the original Excel-

based version, sub-national levels only had access to printouts distributed from the central level. However, the data represented in the SRCs has a broad potential audience ranging from planners, regional officers, head teachers, parents, and community leaders. The tool highlights priority areas for the coming year and informs the preparation of school improvement plans. With DHIS2-EMIS, the SRC was developed as a compliment to the DHIS2 platform (i.e. a web app). This has allowed for decentralised digital access with improved availability and use. Without any technical dependencies, apart from the open DHIS2 API, the DHIS2-EMIS SRC is in principle highly configurable. This allows for local flexibility in how school performance is presented to community members, such as parents with low literacy and numeracy skills. The DHIS2-EMIS SRC is currently being considered for cross-border adoption and adaptation by EMIS stakeholders in Uganda.

3.2. Experiences from a decentralised EMIS implementation in Uganda

In Uganda, EMIS was first conceptualised in 1993, as part of the Primary Education Reform Program, to enhance the management capacity of the education sector in the areas of planning, budgeting, policy development, monitoring and evaluation. After two decades, the EMIS in Uganda had not lived up to expectations. A 2016 EMIS peer review report highlighted key challenges with the current EMIS; standalone database with vendor locked-in software, availability of only basic primary and secondary school statistics, limited interoperability, manual data management at district level due to non-operational decentralised EMIS module, a weak policy and legal framework, slow EMIS cycle with time lags of 6-10 months leaving the central level and districts to use outdated data for planning and budgeting (ADEA, 2019).

An EMIS task force was constituted in 2017 by the Ministry of Education and Sports (MoES) to oversee the realisation of a robust and reliable EMIS capable of addressing the challenges and thus providing timely and quality data (MoES, 2017b). However, the from-scratch development of a “robust EMIS” has taken more than five years. To date, EMIS is still centrally managed by the MoES and largely dependent on manual data management processes at district level and central data processing. The last EMIS census was conducted in 2017, which has further limited the availability of timely and reliable data to inform planning and decision making. Since then, the MoES has relied on frequent ad-hoc data calls to the districts and schools to gather data to guide plans, budgets, and resource allocation.

In Uganda, there is a need for a dynamic and flexible EMIS that responds to changing data needs and is able to withstand exogenous shocks such as the COVID-19 pandemic, which exacerbated challenges with new data to report and kept learners out of school for prolonged periods (ADEA, 2019). In 2019, the MoES, with support from The Norwegian Agency for Development Cooperation (NORAD), initiated a pilot project to support a decentralised EMIS in 10 implementation sites in four out of 135 districts in Uganda. The project aimed to generate evidence of how decentralisation of EMIS can support the data management process at district level and empower the district teams to generate timely and reliable data for evidence-based decision making. In February 2020, an assessment of the pilot was conducted and findings indicate that the DHIS2-EMIS pilot has had a positive outcome with buy-in from the MoES central level and improved management and use of education data. The MoES central level, through overall guidance and stewardship, is committed to support the implementation of DHIS2-EMIS, in line with the Education Sector Strategic Plan to “strengthen the [EMIS] to collect and process more accurate and timely data for use by decision-makers” (MoES, 2017a, p. 24).

Through training and support supervision conducted during the pilot, the districts were empowered to collect, enter, validate, present and use data from DHIS2-EMIS to inform decision making. Data from DHIS2-EMIS has been used by the districts as a basis for decision making, in distribution of desks, allocation of teachers, and building new latrine stances and classroom blocks. In addition, data from DHIS2-EMIS is used to guide planning and budgeting, has enabled cross-sector synergies between health and education by improving joint planning for cross sector interventions such as vaccination and deworming programs, and supported the school-based COVID-19 surveillance.

Building on the generic core, the implementation team has been able to customise DHIS2 to support management and use of education data in Uganda and The Gambia. Developing applications on top of the platform has allowed implementers to meet local stakeholders’ requirements and expectations. The digital platform, owing to its vibrant ecosystem of distributed implementation capacity and knowledge, has further demonstrated the ability to respond to emergent data needs. In Uganda, the DHIS2-EMIS was adapted to support a national data call on COVID-19 response to inform planning and allocation of resources such as self-study materials for learners at home. In addition, a school-based surveillance module has been added to support timely monitoring and reporting on COVID-19 related symptoms amongst learners and staff. Moving forward, the intention of the programme is to further

strengthen and document data use practices in the four implementation districts so as to understand the characteristics of “districts of excellence” in terms of education data use.

As highlighted in the descriptions from the Gambia and Uganda, EMISs have high practical relevance in ensuring the effectiveness and responsiveness of education systems. EMISs emerge as an important, yet understudied, object of IS research, especially in the context of developing economies. Below we propose an approach to EMIS from a digital platform perspective, informing an EMIS research agenda.

4 EMIS: Meeting the education data crisis through digital platforms

We have identified four areas for EMIS strengthening: 1) timely production of reliable data, 2) data integration and harmonisation within and across sectors, 3) use of education data for decentralised decision making, and 4) the need for digital public good platforms in education. In this section, we reflect on how a digital platform approach to EMIS, exemplified by our empirical narratives from The Gambia and Uganda, shows promise in framing EMIS as an object of IS research, with reference to each of the four areas of concern.

4.1. Timely production of reliable data

Despite constant calls for more granular education data, most of the EMIS data currently being collected is severely underutilised. There is a persistent knowledge gap pertaining to how productive data use practices, tools and routines may be identified and scaled up across schools, districts, departments, ministries and countries. Historically, EMIS has been characterised by collection and production of aggregate data that has fed into the generation of statistical yearbooks. Processing, analysis and feedback have generally been delayed to such an extent that the data has had little formative or operational value at schools.

As we illustrated with the information use innovation in The Gambia and Uganda, timely production and sharing of data is often simply about granting education data stakeholders access to already collected and processed data, in the right format, at the right time. The digitisation of the School Report Card and attendance registration involved incremental data collection and use innovations built on top of existing MoBSE routines and procedures.

However, EMIS strengthening could also constitute a comprehensive digitalisation process that signifies a radical shift in the management and delivery of equitable quality education. The “EMIS Shift” towards the recording and utilisation of 350.000 individual learner records in The Gambia constitutes one such comprehensive digitalisation process, with a significant increase in data granularity and frequency. The shift is ushered in by international and national calls for data that can inform more equitable and inclusive education, which necessitates a holistic representation of individual learners and their experienced barriers to quality education. IS is hence playing a key enabling role in the transformation of the education sector in low income countries, whereby the attention shifts from access-centred indicators to learner data produced and monitored with much higher frequency.

4.2. Data integration and harmonisation within and across sectors

To date, there is a paucity of knowledge pertaining to how different software tools and databases for education management may be governed and integrated into a national education data ecosystem. There is little knowledge about how such inter-departmental and cross-sectoral management information system capacity strengthening and data utilisation initiatives may be established and coordinated to facilitate heightened sustainability in developing countries broadly (Madon, 2009). In the health sector, digital platforms have been leveraged in efforts to move from fragmented health information systems to increased demand and use of integrated health data at all levels (Karuri et.al, 2014; Many et al., 2018; Vincent et al., 2014).

Building on the successful implementation and capacity building in health, platforms with a social development agenda, such as DHIS2, can be exploited to further support harmonisation of education data in resource-constrained contexts. Both implementations described above were able to capitalise on domestic experiences with the health sector. This allowed the project to explore synergies between health and education in responding to COVID-19, including innovations for school-based surveillance, data driven distribution of education commodities to children out of school, and informed reopening of schools in districts in Uganda. In fact, COVID-19 has illustrated the need for tighter collaboration between health and education sectors. This has informed an interest in both Uganda and The Gambia for information use innovations that integrate data across sectors.

In The Gambia, a Memorandum of Understanding between the Ministry of Health and MoBSE committed the parties to collaborate in building government sector capacity on DHIS2 configuration, maintenance and innovation together. This is in addition to an agreement to seek opportunities to integrate health and education data to inform education and health sector management. So far, a data mapping shows that there are a number of data sets gathered by the ministry of health about under five-year-old, which can allow the education sector to project and plan better.

4.3. Use of education data for decentralised decision making

The role of the education district in data-driven decision making has remained ambiguous. There is a need to recognise the potential role of empowered education district officers in aligning education policy goals with operational realities on the ground. To perform this task, the education district requires more frequent and granular data than what has been historically collected through annual school census and surveys. Furthermore, there is a need for EMIS tools that can assist in the processing and analysis of data in a flexible and meaningful way. Thus, in shifting from annual census and survey data to individual records and transactional data, which many governments are currently aiming towards, the education sector also needs to consider carefully the need for decentralisation. There is a need to invest in decentralised capacity to customise EMIS outputs and analyse data in a context-sensitive way. Not only do we need more granular and integrated data, but also a flexible EMIS and the decentralised capacity to mould and shape EMIS tools and procedures over time.

District education teams often have limited data management capacity, due in part to the traditional, centralised management of EMIS. The proximity of districts and inspectors to schools facilitates data validation and better data quality improves confidence. Data use can be promoted through simple actions that have a big impact on data availability, such as visualisation of key indicators on up-to-date dashboards. This can be enabled through the participatory development of responsive web applications, on top of a digital innovation platform.

A key area for further investigation is the managerial use of analyses built on top of individual learner records and transactional data. These new streams of rich education sector data calls for decentralised use of data for evidence based planning, resource allocation and monitoring.

What are the digital platform characteristics that can be leveraged to sustain the long awaited and much needed EMIS decentralisation?

4.4. The need for digital public good platforms in education

Cassidy (2006) indicates that it is important to balance attention to the technical issues with serious and significant efforts to build end-user skills and to address the organisational issues that have persistently constrained EMIS development. Most capacity building initiatives for IS in developing countries have been short-term “technical assistance” efforts focused on initial capacity to use such systems. However, to cope with rapidly changing demands and shifting priorities, information systems capacity building ought to be a continuous *process* encompassing a range of human resource capacities (Msiska & Nielsen, 2017). Furthermore, an emphasis needs to be put not only on building capacity to use systems, but also to develop and maintain systems over time. Digital innovation platforms feature a standardised core made of common components that remain stable across different contexts and customisable components that can vary across contexts and over time. This allows for capacity building to be modularised and targeted towards specific roles and mandates, including server and database maintenance, data analytics and use, software configuration and implementation, and app development.

Innovations in The Gambia and Uganda involve a digital global public good platform as a foundational product on which local innovations are developed, maintained and shared. The platform consists of a range of flexible standard applications or core modules, which can be customised to meet heterogeneous local needs. The ability to “fit” these flexible modules to local requirement and needs relies on expert knowledge both about the software and about the local context. Real value is realised when such a fit is exploited by translating DHIS2 design possibilities into a relevant and useful service for end users. Key enablers of these adaptations are the long-term investments in capacity building and community resources that shorten the distance between design and information use innovations and allow for local value co-creation. In the following, we propose a few directions in which we believe EMIS and digital innovation platforms in the public sector needs further empirical investigations and theorising.

5 Digital platforms for education management: a research agenda

This paper illustrates the need for an EMIS research agenda in the IS field. We draw on Bonina et al. (2021) in noting that the value co-creation potential associated with digital innovation platforms in developing countries still needs exploration. Specifically, Bonina et al (2021) raise concerns regarding the extent to which platform boundary resources developed primarily in the global North are effective to nurture and foster a local ecosystem of complementors and South-South innovation.

5.1. Building local capacity to exploit digital innovation platform design possibilities

The key enablers of local flexibility and adaptation in a digital innovation platform ecosystem are the platform's boundary resources (Eaton et al., 2015; Ghazawneh & Henfridsson, 2013). Boundary resources include application programming interfaces (APIs), software development kits (SDKs), open standards, documentation and sometimes more dynamic and social resources, including workshops and seminars. These resources are put in place to enable complementors, such as consultants or ministries of education, to develop platform complements. In complex public sector organisations, such as the ministries of education in The Gambia and Uganda, the available capacity to develop useful complements in a participatory manner is limited. This is further exacerbated in a developing country context, where scarcity of expertise challenges the local realisation of the value co-creation potential associated with digital innovation platforms.

The initiative explored here has focused on building implementation and configuration capacity within the ministries of education in Uganda and The Gambia, for the EMIS teams to appropriate and adapt innovations to different political, economic, social and cultural contexts and participate in the co-creation of the information system services they need. When configuration of the standard software modules are insufficient to meet local needs, local application development is an option. Apps that utilise the open APIs can be developed locally and shared with the wider community.

The question, then, is how responsive the platform ecosystem is to different organisations' requirements across domains and implementation contexts. This responsiveness emerges from the combination of the generic qualities of the platform modules (configurable), the flexibility to build custom applications when needed (custom innovation), and the capacity to

translate this vast design flexibility into useful services in situated contexts of use (knowledge). Custom applications are decoupled from the platform core development process and can be developed and modified quickly to meet diverse and emergent local needs in a participatory manner. This makes them ideal for experimentation and local innovation within the boundaries of implementation project budgets and timeframes. Still, more empirical studies and more theorisation is required to fully appreciate the different capacities needed to align the development of global platform boundary resources with implementation needs in local contexts of use across public sector domains, countries and settings.

5.2. Strengthening EMIS through local innovation and knowledge sharing

EMISs include practices, human capacities, routines and technology that together constitute national education data ecosystems. These national data ecosystems, such as in The Gambia and Uganda, can be strengthened through the utilisation of digital innovation platforms. De Reuver et al. (2018) present two views on digital innovation platforms: a technical one, as an “extensible codebase to which complementary third-party modules can be added” (Tiwana, 2013), and a sociotechnical one, including software and hardware components as well as the social organisations and processes associated with them. Recognising the merit of both perspectives, we consider digital innovation platforms in terms of their core-complements architecture combined with their role in coordinating different actors and organisations engaged in generative relationships to integrate resources and co-create value.

The *global* digital innovation platform ecosystem (software development) is distinct from particular *national* education data ecosystems (information production and use). However, the two different types of ecosystems interplay. As our two empirical examples illustrate, custodians of national education data ecosystems can leverage digital innovation platforms, such as DHIS2, to implement general EMIS functionality, while maintaining the flexibility to develop locally relevant complements, such as the custom School Report Card in The Gambia and the COVID-19 surveillance tools in Uganda. A generic digital innovation platform can be utilised as a backbone across national education data ecosystems to generate value in use. The value co-creation processes afforded by the digital innovation platforms both strengthen national EMISs and refine the generic digital platform complements through feedback loops and consolidation of local innovations in the wider digital innovation platform ecosystem.

As defined by Zittrain (2008), generativity “is a system’s capacity to produce unanticipated change through unfiltered contributions from broad and varied audiences” (p. 70). Studies of the social and technical dimensions of generativity in a developing country context (e.g., Msiska & Nielsen, 2017) highlight the importance of participation and value co-creation to realize the design potential of digital platforms and ensure local relevance and usefulness of innovation. In particular, Heeks (2002) highlights *design-reality gaps*, meaning disjuncture between the vision of technology designers and the lived reality of users, as causes of failure of IS initiatives in a development context. In a context of distance between user and designer, the platform architecture affords the making of custom compliments that can mitigate design-reality gaps: a modular architecture affords a solution to the problem of generating content that is both locally relevant, while also potentially contributing to the further refinement and cultivation of shared and reusable digital platform resources (i.e., digital public goods).

The two cases narrated above illuminate the relevance of generativity in building content that, building on the common core, produces locally relevant content for The Gambia and Uganda. In The Gambia, school-level information products like the SRC are enabled by the ability to build content on the platform, devising content whose granularity reaches down to the school level. In Uganda, district-level modules afford a form of empowerment that entails liberation from political bias, leading education managers to allocate resources according to data rather than according to the preferences of politically powerful individuals (Amuha & Masiero, 2022). The instances illustrate how, offering a common core on which additional complements can be generatively built, EMIS digital innovation platform properties allow to fill EMIS gaps in the two countries.

6 Conclusion

This paper has positioned EMIS as an object of IS research. EMIS strengthening has high practical relevance for data management in education, particularly in low income countries that experience an ongoing data crisis. The data crisis is exacerbated by systemic resource constraints. EMIS brings about research questions on data management, but also and especially on its consequences on education actors and beneficiaries. The turn of ICT4D research to issues of power and justice (Heeks & Wall, 2018) is reflected in the focus on EMIS, which can result in crucial forms of empowerment for students and education managers in developing country settings.

While affordable through EMIS, such routes to empowerment are by no means automatic, and require careful adaptation to the reality of beneficiaries (Heeks, 2018) to be fulfilled. Our proposed agenda explores viable routes to decentralisation and empowerment. Given the limited engagement with EMIS in IS literature, we hope the directions proposed can offer a useful basis for exploration of an artefact that, if properly designed and implemented, has decisive influence in the pursuit of global and national development goals.

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**Information Systems Affordances: A Literature Review and
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Information Systems Affordances: A Literature Review and a Derived Conceptual Model

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Abstract:

Affordances have gained significant traction in information systems (IS) research, yet IS scholars interpret and apply the theoretical construct differently. This calls for an analysis of how the affordance lens has been applied to socio-technical IS phenomena. Specifically, IS scholars have extended the affordance construct along three dimensions to account for the realization of affordances over time, the composite nature of affordances, and the identification and realization of affordances at various levels of abstraction. Extending the affordance construct, originating from the study of immediate relations between animals and their environment, is necessary for it to have analytical leverage in the study of complex IS phenomena. However, to enable knowledge generation across IS studies, there is need for convergence on how the construct is appropriated. This paper takes stock of IS researchers' appropriation of the affordance lens by analyzing 306 different affordances across 54 papers in the AIS Senior Scholars' basket of eight journals. Based on IS scholars' various adaptations of the affordance construct, we propose a nested affordance process model that synthesizes proposed extensions along the three dimensions identified. Our model serves as a possible point of departure for concise appropriation and application of the affordance lens in IS research.

Keywords: Affordance theory, affordances, literature review, theory extension, nested affordance process model.

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1 Introduction

Affordances describe the action possibilities that emerge in the relation between a subject and an object. It was first coined by perceptual psychologist James J. Gibson (1966, 1977, 1979) to describe the relation between an animal and its environment “in a way that no existing term does” (1979, p. 127). According to Gibson, the animal does not see an object as its shape, but rather what it can afford to the animal. To Gibson, affordances exist regardless of whether they are perceived. For example, a cave can afford shelter for an animal, regardless of whether the animal notices the cave and perceives its “shelter-ability”. Similarly, a knife affords cutting to a person, regardless of whether the person perceives and actualizes the possibility of cutting something. Thus, to be of any use, an affordance must be perceived and actualized.

In the past two decades, affordance theory (AT) has gained traction in information systems (IS) research, and scholars have attempted to adapt it to the IS field (Valbø, 2021). However, due to the complexity of the phenomena we attempt to theorize (Volkoff & Strong, 2017), and the fact that the theory was not fully developed in its original field before IS researchers started to apply it (Fromm, Stieglitz, & Mirbabaie, 2020), we have seen divergent use of the construct (Leidner, Gonzalez, & Koch, 2018; Volkoff & Strong, 2017). The appropriation of AT to IS has required the affordance definition to be stretched along multiple dimensions. If we wish to accumulate a coherent body of knowledge regarding affordances in IS research, we will need convergence on *how* and in what directions we should extend the construct of affordances. To date, there is no such consensus (Leidner et al., 2018).

Volkoff and Strong (2017) acknowledge “the challenge of translating Affordance Theory from its origins as an examination of individual actors engaging with discrete objects to a study of groups of organizational actors engaging with complex, somewhat opaque objects, namely information systems” (p. 3). They propose six principles for how AT should be used in IS research. Two of these principles address IS-specific adaptations of AT, namely principle 4, “Select an appropriate level(s) of granularity for the affordances”, and principle 5, “Identify all salient affordances and how they interact”. The appropriate granularity level, in turn, will depend on the research question and the level of analysis. In human-computer interaction (HCI) research, scholars are concerned with affordances that relate to direct use of technology. In IS research, scholars are not so interested in how technology is used, but the consequences thereof. In other words, we are concerned with affordances at a higher level of *granularity* than mere technology use (Leidner et al., 2018). Regarding their fifth principle, Volkoff and Strong refer to Strong et al. (2014), who presented a *dependence network* of affordances, illustrating how affordances interact and can depend on each other. The differences in granularity levels and dependency over time are also related to the *composite* nature of affordances. For instance, Volkoff and Strong refer to Gibson’s explanation of how the eating affordance is a composite affordance, consisting of the lower-level affordances of biting, chewing, and swallowing (p. 5).

A question then arises. Have IS researchers adhered to the suggestions by Volkoff and Strong (2017)? Do we see convergence in the application of the affordance lens in IS research? In this literature review, we investigate how IS research adheres to these IS-specific suggestions for AT application. We analyze existing publications with regards to the suggestions in Volkoff and Strong’s (2017) fourth and fifth principles. We derive three key dimensions from the abovementioned concerns raised by Volkoff and Strong. First, *granularity* determines the level of granularity of the affordances. Second, *trajectory* refers to the sequential dependency between different affordances. Third, *composability* captures the idea that an affordance can be composed of sub-affordances. Through this literature review, we uncover IS researchers’ extensions of AT along these three dimensions. We find that similar efforts to extend AT fail to build clearly on each other in a cumulative manner. We also observe a lack of consistency in the perception of how immediate the outcomes of an affordance realization should be and how abstract the relation between an affordance and an IT artifact might be. As a contribution to this discussion, we integrate the identified extensions of AT to present an “IS-flavored” conceptual model of AT. We consider this model a synthesis and a step towards a more congruent “IS flavored” AT.

In IS research, several definitions of affordances have been proposed (see Table 6). Most of them open for an organizational view, taking into consideration that user groups or organizations, with their aligned actions and goals, can enact affordances. This extension is essential to the idea of affordances in IS research and allows us to consider not only affordances for the individual, but also organizational affordances. A widely accepted definition of affordances among IS researchers, is that affordances are “the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors” (Volkoff & Strong, 2013, p. 823). Although Faraj and Azad (2012) warn that it might be counterproductive to attempt to identify “one true meaning” of affordances,

they still “highlight the need to further develop, in as precise a way as possible, the assigned and distinctive focal meaning(s) for the term technology affordances so that the concept becomes useful for understanding technology-organization change” (p. 255).

The divergent use of the affordance concept in IS research and the limited accumulation of a consistent AT lens and a congruent body of knowledge warrant a closer review. The question motivating our literature review is thus the following:

RQ: What adaptations have IS researchers made to affordance theory and how might these adaptations be consolidated?

To answer this question, we have conducted a descriptive literature review on IS research. The rest of this paper proceeds as follows: The next section presents the research method used for the literature review. In section 3, we present the paper trend findings and report on the papers' contributions to the appropriation process of AT to IS. In section 4 we delve deeper into the analysis as we zoom in on the identified affordances in the review set. Then, in section 5, we synthesize the findings and discuss how the findings can inform future IS research. As a part of this discussion and synthesis, we propose a framework; the nested affordance process (NAP) model. Finally, in section 6, we provide some concluding remarks and reflect on this study's limitations.

2 Methodology

To answer the research question, we performed a descriptive literature review (Paré, Trudel, Jaana, & Kitsiou, 2015), as its aim is to “determine the extent to which a body of empirical studies [the review set] in a specific research area [IS research] supports or reveals any interpretable patterns or trends with respect to pre-existing propositions, theories [affordance theory], methodologies or findings” (p. 186). We have followed a three-phased sequential approach of 1) input (searching), 2) processing (analyzing and synthesizing), and 3) output (writing; Levy & Ellis, 2006; Vom Brocke et al., 2015). One author “[carried out] the literature search ... before analyzing and synthesizing the literature” (Vom Brocke et al., 2015, p. 9). Both authors took part in the subsequent synthesizing of the literature and the identification of three key dimensions along which the affordance lens has been extended to better account for action possibilities in the context of complex IS phenomena. The steps are explained in detail in the following.

2.1 Step 1: Input – Searching with defined Keywords and Scope

2.1.1 Scope

As pointed out by Vom Brocke et al. (2015), “the challenge of performing literature reviews has shifted from collecting literature to interpreting it”, due to the ever-increasing number of publications (p. 9). Paré et al. (2015) note that the aim of a descriptive review is not to be comprehensive but rather present “a representative sample of a larger group of published works” (p. 189). For this study, we thus considered the top ranked IS journals comprising the AIS Senior Scholars' basket of eight journals (SSB), namely, *European Journal of Information Systems (EJIS)*, *Information Systems Journal (ISJ)*, *Information Systems Research (ISR)*, *Journal of AIS (JAIS)*, *Journal of Information Technology (JIT)*, *Journal of MIS (JMIS)*, *Journal of Strategic Information Systems (JSIS)*, and *MIS Quarterly (MISQ)*. We thus assume that the most ambitious contributions to the appropriation of AT to the IS field can be found in these top journals.

2.1.2 Keywords

“Affordance” is not a common everyday word, and since the aim of this study is to map out how IS scholars have applied the affordance concept, the keywords for the literature search were simply “affordance” and the plural form “affordances”. Web of Science was used as a search engine to find publications containing the keywords. Since a common approach when doing literature reviews is to read abstracts to determine whether to include or exclude an article in the review set, the first author simply searched for the keywords in titles and/or abstract. The following search term was used in an “advanced search” in Web of Science:

(TI=affordance\$ OR AB=affordance\$) AND (SO=(EUROPEAN JOURNAL OF INFORMATION SYSTEMS) OR SO=(INFORMATION SYSTEMS JOURNAL) OR SO=(INFORMATION SYSTEMS RESEARCH) OR SO=(JOURNAL OF INFORMATION TECHNOLOGY) OR SO=(JOURNAL OF MANAGEMENT INFORMATION SYSTEMS) OR SO=(JOURNAL OF

STRATEGIC INFORMATION SYSTEMS) OR SO=(JOURNAL OF THE ASSOCIATION FOR INFORMATION SYSTEMS) OR SO=(MIS QUARTERLY))

The special character "\$" in the search term represents zero or one character, hence "affordance\$" will match both "affordance" and "affordances". The search, which was done April 8th, 2021, yielded 71 results. Web of Science categorized 67 of them as "article", two of them as "editorial material", and the final two as "review". The papers and their Web of Science categorization are listed in Table A1 in the Appendix. The journals' databases were searched for additional papers but yielded no extra results.

2.1.3 Timeframe

The timeframe for the search had no limits and included all papers ever published in the selected journals, effectively resulting in papers published from 1999 to March 2021. Since the search was performed in April 2021, the five articles published in 2021 were omitted from the trend analysis but included in the literature review and the corresponding coding process.

2.2 Step 2: Processing – Analyzing and Synthesizing with defined Coding Schemes

2.2.1 Exclusion Criteria

The aim of this study is to understand how IS researchers have extended the notion of affordances. Thus, the two editorials, reflecting on their journal issues' content, were removed from the review set, resulting in 69 remaining articles. Further, as this paper reports on both publication trends analysis and affordance analysis, it was necessary with two separate subsets for these analyses. Since the article search was performed in April 2021, the five articles published in 2021 were removed from the first subset, resulting in a subset of 64 articles. For the affordance analysis, the 15 articles that did not present any affordance findings were removed from the second subset, resulting in a subset of 54 articles.

2.2.2 Paper Classification Scheme

Inspired by Glass et al. (2004), we started the analysis by developing a classification scheme. The classification scheme coincides with that of Glass et al., categorizing the publications by (1) research type, (2) research method, (3) level of analysis, and (4) whether the study is prescriptive or descriptive. The various kinds of research types and research methodologies were added to the scheme as the articles were read. The articles were categorized by research type and method to better understand in which kind of research the affordance lens has been most used. The identified research types were empirical, ethnography, narrative, method development, and theory development. The methods used in the studies were action design research, archival research, case study, design science research, literature review, survey, and revealed casual mapping.

Third, because AT was initially developed to characterize individual organisms and their relationship with the environment, AT has been adapted to suit IS research, which is focused on organizational contexts. The articles were therefore also categorized by level of analysis (individual or organizational). Fourth, the distribution of descriptive and prescriptive articles should indicate whether researchers are merely using the affordance lens in their research or contribute to further development of an IS-flavored AT.

The classification scheme laid the foundation for the development of the emergent concept matrix (Table 1) and the coding process (Vom Brocke et al., 2015), which is explained in the following.

2.2.3 Affordance Categorization

The classification and coding processes were done in an iterative process. After having classified the articles, a new iteration was done to identify the affordances. The 327 identified affordances are affordances that the authors of the papers themselves have called affordances. When all affordances were identified, each of the affordances were then coded. Before starting to code the affordances, a concept matrix was developed. The four dimensions used in the concept matrix are (1) enactor, (2) beneficiary, (3) granularity level, and (4) naming convention. These dimensions were predefined based on the focus of the study. In the following we justify the choice of these dimensions.

Dimensions 1 and 2: Enactors and beneficiaries. As pointed out by Volkoff and Strong (2017), IS research concerns how technology is used "by individuals or groups of organizational actors, and the resulting changes in organizational processes and structures" (p. 2). It is thus natural to explore who the enactors

(i.e., the ones actualizing, or enacting, the affordances) and beneficiaries (the ones benefitting from the outcome of the actualized affordances) of the identified affordances are. This coding dimension is interesting, because it addresses one of the most pertinent differences between affordance theory in ecological psychology and IS, namely “individual actors engaging with discrete objects” in ecological psychology versus “groups of organizational actors engaging with complex, somewhat opaque objects, namely information systems” (p. 3). The types of enactors that were identified and added to the concept matrix as the articles were read, were individuals, groups (of individuals), organizations, and N/A (i.e., not possible to identify enactor). The identified types of beneficiaries that were identified and added to the concept matrix as the articles were read, were self (i.e., the enactor and the beneficiary is the same person), organizations, community, third-party (individual other than the enactor), and general (no specific beneficiary). For the affordances where it is obvious that they can be enacted by a singular actor (e.g., data recording; editability), the affordances were coded with the singular term individual. For the affordances which would require multiple actors to be actualized (e.g., linking new business partner; peer-based governance), the term group was used in the coding process.

Dimension 3: Granularity levels. The third dimension relates to Volkoff and Strong’s (2017) fourth principle for using AT in IS research, namely to study affordances on an appropriate level of granularity. Along the same vein, Leidner et al. (2018) point out that IS scholars do not differ between technology use and technology affordances. Hence, we decided to code the affordances according to their granularity levels. Since there does not exist a framework for identifying granularity levels, we started somewhat wide and asked ourselves which nature the identified affordances have. Is the affordance in question an action possibility? If yes, how does it relate to technology? Does it describe a concrete usage of a technology, or does it denote a more abstract use of technology? If the identified affordance does not describe a potential for action, what is the nature of the affordance? A more suitable term for this dimension could perhaps have been *nature of the affordances*, but since the aim was to find which granularity level the affordances pertain to, we remained with *granularity level* as the name of this category. The various “granularity levels”/natures that were identified as we read the papers, were added to the concept matrix and later abstracted to three overarching categories, in addition to “definition-bending affordances” and “non-technology-related affordances” (see Table 9).

Definition-bending affordances are the authors’ claimed affordances that, according to current definitions, are not really affordances that can be enacted. Technology properties and technology artefacts fall into this category, along with mislabeled affordances. For instance, Argyris and Ransbotham’s (2016) persistence affordance is not really an affordance that can be enacted but a technology property that allows for other actions, such as “review content at any time” (p. 235). A technology property is not something that can be enacted and is hence not an action possibility. An object’s properties are necessary conditions (Heft, 2003, p. 173) for affordances, but they are not affordances in and on themselves. Similarly, Alam and Campbell’s (2017) forums and listserv groups are mere technological constructs, with technology properties, providing possibilities for the users, such as “interaction between volunteers” (p. 754). For two of Li et al.’s (2020) three claimed affordances (patient satisfaction with teleconsultation; patient-perceived media richness) it was not possible to assign neither an enactor nor a beneficiary. Who can enact satisfaction and media richness? And who are the beneficiaries of these? As such, these affordances were simply coded as mislabeled affordances.

Non-technology-related affordances are affordances where technology use could not be associated with the affordance. Examples are Waizenegger et al.’s (2020) *workplace environmental affordances* (e.g., sharing and consuming food and drinks), used to distinguish the non-technology-related affordances from the technology-related affordances in their study.

Table 1 shows some examples from the concept matrix. For the coding of all affordances, see Table B1 in the Appendix. The identified “granularity levels”/natures are presented in

Table 2 along with some examples from the articles. A more detailed elaboration of the granularity levels is presented in section 4.2.

Dimension 4: Naming conventions. As a means to understand the consistency of the use of the affordance concept in IS research, the fourth dimension were chosen in order to map out the various naming conventions used by IS researchers to label affordances. For instance, Strong et al. (2014) suggest using gerunds to convey the action associated with the affordance actualization, while Thapa and Sein (2018) use verbs ending in “-bility” to convey the action possibility (e.g., volunteerability; earnability). The naming

conventions were added to the coding matrix as they were identified: gerund, infinitive, possibility, present, and noun.

Table 1. Examples from the Concept Matrix

Dimension Affordance	Enactor				Beneficiary				Granularity Level				Naming				
	ind	gro	org	N/A	slf	org	com	...	prop	f.use	abs	high	...	ger	in	nou	...
Tagging	X				X					X				X			
Optimize the patrol routes		X				X					X				X		
Harmonious IT affordance			X			X						X				X	
Open boundaries				X			X		X							X	
...																	
Enactor: ind = individual; gro = group; org = organization; N/A = not applicable Beneficiary: slf = self; org = organization; com = community Granularity Level: prop = technology property; f.use = technology feature use; abs = abstract; high = higher-level category Naming: ger = gerund; inf = infinitive; nou = noun ... = removed affordances/dimensions to fit the table onto the page																	

Table 2. Identified Granularity Levels

Granularity level (Nature of affordance)	Example
Technology artefact	Forums; listserv groups (Alam & Campbell, 2017)
Technology property	Dynamism (Lankton, Mcknight, & Tripp, 2015); Open access (Arazy & Gellatly, 2012)
Technology feature	Automation (Deng & Joshi, 2016); Membership (Mckenna, 2020)
Technology feature use	Animatability (Ciriello, Richter, & Schwabe, 2019); Inputting data (Burton-Jones & Volkoff, 2017)
Technology use	Connecting members (Sæbø, Federici, & Braccini, 2020); Reaching out virtually (Waizenegger et al., 2020)
Abstract	Assess wildlife distribution (Pan, Li, Pee, & Sandeep, 2020); Social connection (Jiang & Cameron, 2020)
Higher-level category	Organizational memory affordance (Chatterjee, Moody, Lowry, Chakraborty, & Hardin, 2015); Reflective disclosure (Seidel, Recker, & Vom Brocke, 2013)
Non-technology affordance	Practice improvability (Hatakka, Thapa, & Sæbø, 2020); Wearing (Benbunan-Fich, 2019)
Workplace environmental affordance	Ad-hoc information exchange; Sharing and consuming food and drinks (Waizenegger et al., 2020)
Mislabeled	Patient-perceived media richness; Patient satisfaction with teleconsultation (Li et al., 2020)

Omitted dimensions. We identify three complexities (granularity, trajectory, composability), but we only used granularity in the coding process. The granularity level, or at least the nature, of a claimed affordance is somewhat easily identifiable. With respect to trajectory, it is however not easy to determine where, or if, an affordance is part of a sequence, or trajectory, of affordances. As for the composability complexity, it will not make sense to code an affordance along this dimension, since affordances can be decomposed into sub-affordances (see the repeating decomposition problem [Markus & Silver, 2008]).

Removal of duplicates. 327 affordances were identified in the review set. However, because researchers cite both themselves and each other, some affordances were identical across different papers. For instance, the association affordance was found in four papers (Argyris & Ransbotham, 2016; Chan, Cheung, & Wong, 2019; Nan & Lu, 2014; Van Osch & Steinfield, 2016), but they all refer to the same source (Treem &

Leonardi, 2012, 2013)¹. Another kind of duplication is when affordances are identified separately in several papers. An example of such is the collaboration affordance, identified in three papers (Cheikh-Ammar, 2018; Karahanna, Xu, Xu, & Zhang, 2018; Steffen, Gaskin, Meservy, Jenkins, & Wolman, 2019)² without reference to a common source. After removing the duplicate affordances, 306 unique affordances remain. To ensure that the affordances were truly duplicates, the affordance duplication removal was done after the coding of the affordances, to be sure they had the same enactor, beneficiary, and classification. Naming convention was not considered in this regard since an affordance's name only reflects the preferences of the authors and not the nature of the affordance.

The literature review process is summed up in Table 3.

Table 3. The Literature Review Process

Step	Action	Outcome
1: Input	Keyword search in SSB journals with Web of Science	71 articles
	Keyword search in the SSB journals' databases	0 additional articles
	Excluded two editorials	69 articles
	Excluded five 2021-articles from trend analysis ^{*)}	64 articles
	Excluded 15 articles with no identified affordances from the affordance analysis ^{**)}	54 articles
2: Processing	Developed classification scheme	Four categories
	Classified articles	
	Performed trend analysis	
	Identified affordances	327 affordances
	Developed coding scheme	Four dimensions
	Coded affordances	
	Removed duplicate affordances	306 affordances
	Performed affordance analysis	
3: Output	Writing and publishing the findings	
^{*)} The five 2021-articles were included in the analysis of the affordances ^{**)} The 15 articles with no identified affordances were included in the trend analysis		

2.3 Step 3: Output – Writing and Publishing the Findings

Levy and Ellis' (2006) last step of the literature review process regards the writing of the literature review. In the following, the findings are presented (sections 3 and 4) and discussed (section 5).

3 Paper Analysis

In this section, we present the quantitative trends and findings related to the reviewed papers. This is followed by an overview of extensions and new concepts introduced to AT. Essentially, IS scholars have appropriated and extended AT to better account for affordances in complex socio-technical organizational settings. However, theoretical extensions have often been highly context-dependent and thus limited in their applicability and reuse across studies. In section 4, we delve further into the negative consequences of this trend in terms of knowledge accumulation, before we provide a synthesis of affordance extensions along the three dimensions granularity, trajectory and composability.

3.1 Trend Analysis

The findings show that there has been a significant increase in the number of affordance articles since the first appearance in an SSB journal back in 1999. From 1 article per year in the SSB during the four first years of appearance (1999, 2005, 2008 and 2009), the number of published affordance articles has

¹ Treem and Leonardi (2012, 2013) is the same source, but somehow it is referred to in two different ways by the authors.

² Cheikh-Ammar (2018) names the affordance *collaborating with others*.

increased tenfold to 10 articles per year in 2019 and 2020. Figure 1 illustrates this increasing trend of published affordance articles.

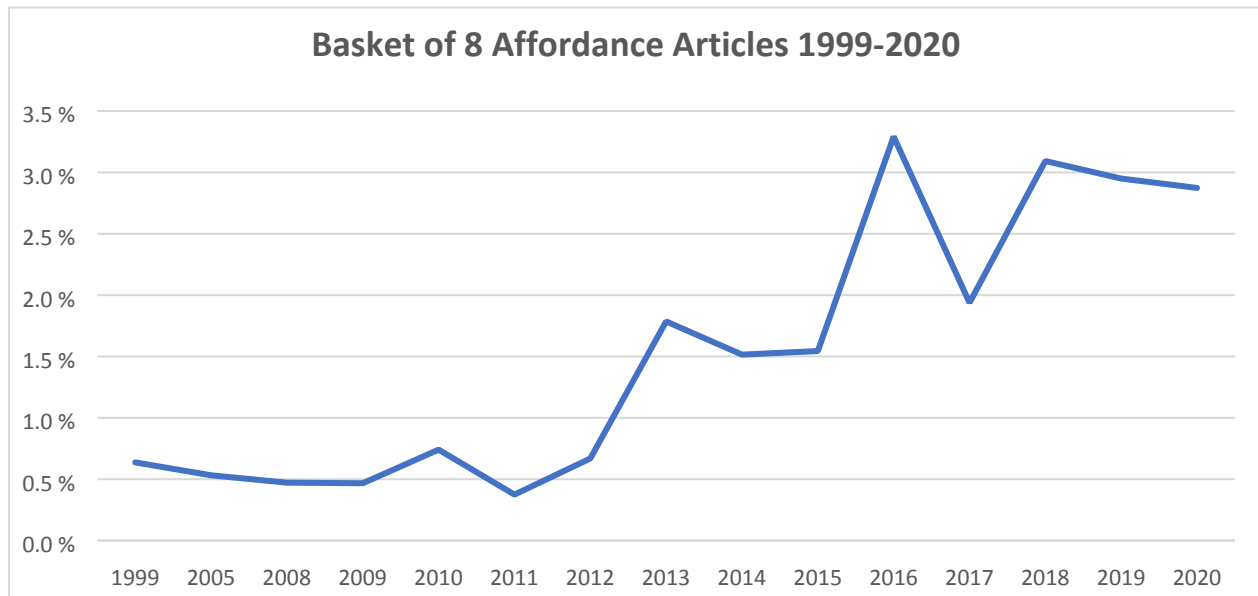


Figure 1. The Number of Affordance Articles Published in the Basket of 8 Journals Until 2020. The Omitted Years (<1999; 2000-2004; 2006-2007) Did not Have any Published Affordance Articles.

3.1.1 Publications and Citations

The 64 articles that were reviewed had publication years spanning from 1999 to 2020. In SSB, the two first affordance articles were published in 1999 and 2005, and from 2008 onwards there were consecutive yearly publications in SSB. The 2008 article which kicked off the yearly consecutive publication trend was Markus and Silver (2008). To date, this is the second most cited affordance article amongst the SSB affordance articles, only exceeded by Leonardi's (2011) seminal paper. Table 4 gives an overview of the articles with the most citation links within the review set. The number of citation links is the sum of a paper's citations (within the review set) and how many other papers (in the review set) the paper itself has cited.

In SSB, MIS Quarterly is the journal that has published the largest number of highly cited affordance articles. 6 out of their 11 affordance articles from 2011-2019 have a yearly citation rate of 10 or more. MIS Quarterly is also the journal with the most articles with more than 100 citations in total. See

Table 5 for an overview of the SSB affordance articles' citation rates.

The majority of the articles are case studies ($n=43$), followed by textual analysis³ ($n=12$) and surveys ($n=9$). For a complete overview of the coding on each article, see Table A1 in the Appendix. Furthermore, the findings reveal that until 2018 there has been a relatively clear organizational focus, while the majority of the articles since 2019 have shifted the focus towards individuals.

3.1.2 Describing and Prescribing

Of the 69 articles, 52 were coded to be descriptive articles, focusing more on describing the authors' work rather than giving prescriptions for others. 7 articles were found to be mostly prescriptive, while 5 were both descriptive and prescriptive. The high number of descriptive articles may indicate that IS scholars have been more concerned with using AT in their own studies rather than contributing to an accumulated body of shared knowledge around the topic. This is also supported by the number of citations for the articles in the review set. Many of the most cited papers are indeed prescriptive papers (e.g., Bygstad et al., 2016; Markus & Silver, 2008; Strong et al., 2014; Volkoff & Strong, 2013).

³ Textual analysis includes literature review ($n=8$), archival research ($n=3$) and historical analysis ($n=1$)

Table 4. Articles With 15 or More Citation Links Within the Review Set

Article	Citation links	Cited by
Markus and Silver (2008)	40	40 (56%)
Leonardi (2011)	38	37 (52%)
Volkoff and Strong (2013)	28	26 (37%)
Strong et al. (2014)	27	24 (34%)
Leonardi (2013)	18	15 (21%)
Seidel et al. (2013)	17	15 (21%)
Sæbø et al. (2020)	16	0
Bygstad et al. (2016)	15	11 (15%)
Note: The last column shows the papers' citations (by others)		

Table 5. Basket of 8 Affordance Articles (1999 - 2020) and Their Citation Rates

Journal	Papers	Highly cited papers	
		(>= 10/year)	(> 100 in total)
European Journal of Information Systems	11	1	-
MIS Quarterly	11	6	5
Journal of the Association for Information Systems	11	2	2
Information Systems Journal	11	-	-
Journal of Management Information Systems	7	1	1
Journal of Strategic Information Systems	6	2	-
Information Systems Research	4	1	-
Journal of Information Technology	3	1	-
TOTAL	64	14	8

3.2 Adapting Affordance Theory to Information Systems

3.2.1 The Variety of IS-flavored Affordance Definitions

The IS-flavored definitions of affordances have gone through several modifications. However, in terms of distinguishing affordances from technology use, features and attributes, most of these definitions are ambiguous. Most IS-flavored definitions of affordances that IS scholars have used (and provided) do not indicate that affordances are something notably different from technology use. Table 6 gives an overview of the affordance definitions that are used by the articles in the review set, along with other frequently cited definitions, and highlights the parts of the definitions that can be interpreted as technology use. The most cited affordance definition in the review set is Markus and Silver's (2008) more formal definition of functional affordances, followed by Volkoff and Strong's (2013) and Strong et al.'s (2014) definition.

The main recurring theme in the definitions is that affordances are possibilities or potential for action. While some claim that affordances arise or emerge *from* a relationship (Faraj & Azad, 2012; Strong et al., 2014; Volkoff & Strong, 2013), others state that affordances *are* relationships (Markus & Silver, 2008; Seidel, Kruse, Székely, Gau, & Stieger, 2018). Markus and Silver state that affordances are both (1) action possibilities *and* (2) a type of relationships that identifies action possibilities (p. 622). So, how should we understand affordances? Are they relationships, or are they action possibilities arising *from* the relationships? Gibson (1979) "[means] by it something that refers to both the environment and the animal *in a way that no existing term does* [emphasis added]" (p. 127). But what exactly does Gibson mean by that? It is tempting to draw the conclusion that if something can be described using another term, it cannot be an affordance. But because Gibson himself explains that cutting (i.e., the actual usage of a knife) can be considered an affordance, such conclusion would be erroneous. Leidner et al. (2018) thus contradict Gibson when they call for a separation of technology use and affordances. Adhering to Gibson's example, technology use is arguably an affordance.

Table 6. IS-flavored Affordance Definitions

Cited affordance definitions in the review set, sorted by popularity	Source	Ambiguous part	What is an affordance?
functional affordances are defined as the possibilities for goal-oriented action afforded to specified user groups by technical objects	Markus and Silver (2008, p. 622)	...possibilities for <i>goal-oriented action</i> ...	Possibility for action
the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artefact) and a goal-oriented actor or actors	Volkoff and Strong (2013, p. 823)	...the potential for <i>behaviours</i> ...	Potential for behavior
	Strong et al. (2014, p. 69)		
Functional affordances are a type of relationship between a technical object and a specified user (or user group) that identifies what the user may be able to do with the object, given the user's capabilities and goals	Markus and Silver (2008, p. 622)	...what the user may be able to do <i>with the object</i> ...	Relationship identifying action possibility
affordances are relationships between actors and technical objects) and dispositional (i.e., affordances are a property of the technical object) nature of affordances	Seidel et al. (2018)	...property of the technical object...	Relationship
Cited affordance definitions not from the review set			
the possibilities for goal-oriented action recognized by a specified user group	Carlo et al. (2012, p. 1084)	...goal-oriented action...	Possibility for action
action possibilities allowed by material properties existent in information systems	Seidel et al. (2013, p. 1279)	... <i>action possibilities</i> allowed by material properties...	Possibility for action
Technology affordances are action possibilities and opportunities that emerge from actors engaging with a focal technology	Faraj and Azad (2012)	...action possibilities...	Possibility for action
the mutuality of actor intentions and technology capabilities that provide the potential for a particular action	Majchrzak, Faraj, et al. (2013, p. 39)	...potential for a particular action...	Mutuality providing potential for action
a concept to describe the perceived properties of an artifact, primarily the fundamental properties that determine just how a technology could possibly be used	Norman (1990)	...perceived <i>properties of an artifact</i> ...	Properties of an artefact
Not cited in the review set, though frequently cited in other IS literature			
the term affordance refers to the perceived and actual properties of the thing, primarily those fundamental properties that determine just how the thing could possibly be used.	Norman (1988, p. 9)	...actual <i>properties of the thing</i> ...	Properties of a thing
affordances are functional and relational aspects which frame, while not determining, the possibilities for agentic action in relation to an object	Hutchby (2001, p. 444)	...the possibilities for agentic action...	Functional and relational aspects framing possibility for action
The concept of technology affordance refers to an action potential, that is, to what an individual or organization with a particular purpose can do with a technology or information system	Majchrzak and Markus (2013, p. 1)	...what an individual or organization ... <i>can do with a technology</i> ...	Potential for action

Leidner et al. (2018) claim that IS scholars agree that affordances are fundamentally different from technology use and technology feature use. But looking at the definitions on which they base their claim (Table 6), one can argue that those definitions rather underline the *reason* for the divergent applications of AT in IS research. As Table 6 indicates, distinguishing technology affordance from technology use might be a challenging task with the existing definitions. Take inputting data into an electronic healthcare record (EHR) system as an example of technology use (borrowed from Burton-Jones and Volkoff [2017]). Now, if the goal of the clinician is to obtain relevant data in her EHR system, she performs the data input, the data is stored, and she has relevant data input. Taking the definitions into consideration, one can argue that in the relationship between the goal-oriented clinician with her abilities and the EHR with its features, there is a possibility to perform the action of inputting data. A non-health worker would not know which data to input, and another computer system would not allow the clinician to input and store the relevant data. Thus, the action possibility of inputting relevant data in order to obtain relevant data stored in the EHR system, is undoubtedly constitutive to the relationship between the clinician and the EHR.

Turning to the two most cited definitions in the review set, it is possible to argue that inputting data is an action possibility “afforded to specified user groups [the clinician] by technical objects [the EHR system]” (Markus & Silver, 2008, p. 622) and that inputting data is a potential behavior “associated with achieving an immediate concrete outcome [stored data] and arising from the relation between an object (e.g., an IT artefact [the EHR system]) and a goal-oriented actor or actors [the clinician]” (Strong et al., 2014, p. 69; Volkoff & Strong, 2013, p. 823). Thus, it is not surprising that more than half of the reviewed articles (n=37) interpret technology use as affordance. And as it is consistent with Gibson’s (1977, 1979) original theory, why should they not?

Although not explicitly stating it, Leidner et al. (2018) indicate that affordances do not arise in the relationship between the actor and the technology itself, but that they emerge in the relationship between the actor and the technology *use*. In their example of commuting to work by riding the train, they state that “working, sleeping, meditating, or conversing are ... affordances made possible by the train *ride* [emphasis added]” (p. 120). However, if considering Gibson’s (1977, 1979) cutting affordance, it is hard to argue that the train ride itself is not the actualization of an affordance. Leidner et al. do nevertheless make a valid point, namely that the interesting part to study is not the train ride itself (i.e., the technology use) but the action possibilities that emerge from the train ride. This also resonates with Volkoff and Strong’s (2017) recommendation to identify the appropriate level of affordance granularity.

3.2.2 Affordance Theory Appropriation

To adapt AT to IS research, several IS scholars have contributed with new theoretical concepts and extensions. A presentation of the concepts introduced in the review set is given in Table 7, along with comments on how the papers in which the concepts and extensions are presented relate to the three complexities (granularity, trajectory, and composability). How the papers address these complexities is discussed in the following subsections.

Although none of the papers in Table 7 address all three dimensions directly, we can see that, when brought together, all three complexities are thoroughly addressed by IS scholars’ attempts to extend the affordance lens.

Granularity. With reference to Volkoff and Strong (2013), Cheikh-Ammar (2018) acknowledges that affordances exist on different levels of abstraction and exemplifies this with the collaborating with others affordance, which can be decomposed into the medium-level affordances sending and receiving messages, which again can be decomposed into the lower-level affordances replying and/or forwarding messages. We observe that Cheikh-Ammar’s lower- and medium-level affordances are related to the concrete use of a technology feature, such as an e-mail client’s sending and receiving features, while the same is not true for the higher-level affordance collaborating with others. However, the collaborating with other affordance is actualized by virtue of actualizing the sub-affordances at a lower level of abstraction. Figure 2 demonstrates the relationship between these three affordances. Notably, these affordances also serve as a good example of how affordances can be composite. We will return to the composability dimension below. The other papers do not explicitly address granularity. However, upon examining the identified affordances in the papers in Table 7, we observe a difference in granularity levels. While some papers — much like in the HCI community — speak about affordances as the potential for basic technology (feature) use (Markus & Silver, 2008; Mettler et al., 2017), other papers identify affordances at a higher level of abstraction, such as educability (Hatakka et al., 2020) and volunteerability (Thapa & Sein, 2018). Additionally, the three remaining papers address affordances at different levels of granularity. While Karahanna et al. (2018) do

not distinguish between lower-level technology feature use affordances (e.g., browsing other's content) and higher-level affordances of a more abstract nature (e.g., relationship formation) when proposing their needs-affordance-features (NAF) perspective, Strong et al. (2014) and Burton-Jones and Volkoff (2017) demonstrate how the actualization of lower-level (technology feature use) affordances can cause subsequent higher-level affordances to emerge at a later point in time. This longitudinal affordance dependency relates to the trajectory complexity, which we turn to next.

Table 7. Theoretical Concepts Introduced in the Reviewed Affordance Articles and Their Relation to the Complexities Identified

New theoretical concepts	Description	Source	Relation to complexities
Needs-affordances-features (NAF) perspective	"The NAF perspective, based on motivation-needs theories ..., submits that people high on a psychological need (e.g., relatedness) will be motivated to use social media applications that have affordances (e.g., relationship formation) that can satisfy that need"	Karahanna et al. (2018)	G: The paper identifies affordances at various granularity levels (e.g., browsing other's content; collaboration), although without the authors acknowledging it. T: N/A (no longitudinal interaction) C: N/A (no indication of composite affordances)
Technical objects	"IT artifacts and their component parts", including "the <i>outputs</i> of information systems, such as documents, drawings, transcripts, and representations"	Markus and Silver (2008)	No identified affordances in the paper. G: Functional affordances relate to concrete use of technology. T: N/A C: A system may be considered as a whole to avoid the repeating decomposition problem.
Symbolic expressions	"the communicative possibilities of a technical object for a specified user group"		
Conversion factors	"enable or restrict individuals' ability to gain new capabilities and make choices"	Hatakka et al. (2020)	G: Most affordances at somewhat abstract level (e.g., using computers to find and apply for jobs). T: The actualization of an affordance may reveal new affordances. C: N/A
Ensemble of affordances	Affordances can cluster to form ensembles of affordances. The role of an ensemble of affordances is to actualize concrete outcome.	Thapa and Sein (2018)	G: Affordances at somewhat abstract level (e.g., volunteerability) T: Trajectory of affordances. "The actualisation of an affordance can be a pathway to the emergence of new affordances" (p. 808). C: Affordances may cluster together to form an ensemble of affordances (e.g., volunteerability and virtual co-localisability cluster together. But in reality, volunteerability both depends on and comprises co-localisability).
Facilitating conditions	Conditions that serve as a prerequisite for an affordance to be actualized.		
Trajectory of affordances	the trajectory along which affordances travel, "specifying the process and conditions through which affordances are perceived leading to actualization of affordances."		
Niches	With reference to Gibson: "a <i>set of affordances</i> for a particular animal." In their own case: "a group of end-users in which all	Mettler et al. (2017)	No identified affordances in the paper. G: Speaks about affordances as if they are technology use-affordances. T: N/A C: N/A

	members have similar perceptions of and similar uses for service robots.”		
Affordance actualization lens	“a theory of affordances is incomplete without a corresponding theory of how those affordances are actualized. Based on our data, we developed the concepts comprising affordance actualization, which explain how individual actions connect to organizational outcomes.”	Strong et al. (2014)	G: The paper identifies affordances at various granularity levels and refer to them as basic and more-advanced affordances (e.g., archiving data; coordinating care). T: Affordance dependency diagram. “Shows the observed temporal sequence in which affordances were actualized” (p. 75). C: N/A
Affordance dependency diagram	“shows the observed temporal sequence in which affordances were actualized” and depicts the dependency between them		
Affordance network	“allows us to describe how larger outcomes are achieved in organizations through a linked set of more immediate concrete outcomes. For instance, a decision-making affordance at time 3 may require the achievement of at least two prior outcomes (right data entered at time 1 and right data accessed at time 2).”	Burton-Jones and Volkoff (2017)	G: The paper identifies affordances at various granularity levels (e.g., inputting data [technology use]; managerial decision-making [emerged from the relation between administrators and categorized populations]) T: Affordance network. “Affordances and outcomes depend on each other across time and organizational levels” (p. 470). C: N/A
IT spirit	“the incorporeal essence of an IT artifact”. A new conceptualization of DeSanctis and Pool’s IT spirit.	Cheikh-Ammar (2018)	G: The paper acknowledges that “affordances are inherently hierarchical, they exist at different levels of abstraction” (p. 285). T: N/A C: An affordance may be decomposed into sub-affordances (e.g., sending/receiving messages and replying/forwarding messages comprise the collaborating with others affordance).
G = granularity; T = trajectory; C = composability			

Trajectory. Inspired by Thapa and Sein’s (2018) *trajectory of affordances*, we used *trajectory* to name the dimension that considers longitudinal affordance dependency, since it conveys the idea that an affordance is “coming from” somewhere (i.e., has a trajectory of preceding events before its emergence). In their paper, Thapa and Sein show that the actualization of an affordance may lead to the emergence of other affordances. Both Strong et al. (2014) and Burton-Jones and Volkoff (2017) propose similar “affordance journeys” in their affordance dependency diagram (Strong et al., 2014) and affordance network (Burton-Jones & Volkoff, 2017). But this idea is not new. More than three decades ago, Gaver (1991) introduced the concept of sequential affordances “to refer to situations in which acting on a perceptible affordance leads to information indicating new affordances” (p. 82). With reference to Thapa and Sein, Hatakka et al. (2020) also acknowledge that “the actualisation of an affordance may also reveal new affordances that an individual can act upon” (p. 667). Markus and Silver (2008) do not specifically address the topic of affordance trajectories. However, their goal was to develop “a foundation for the study of IT effects” (p. 627). As other scholars have pointed out later, an effect of the actualization of an affordance may indeed be the emergence of other affordances. The remaining papers in Table 7 (Cheikh-Ammar, 2018; Karahanna et al., 2018; Mettler et al., 2017) do not address the topic of affordance trajectories.

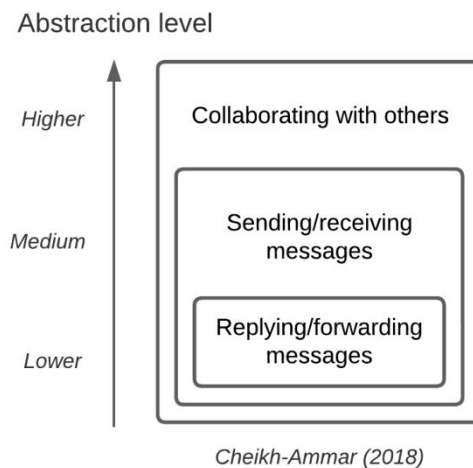


Figure 2. Cheikh-Ammar's (2018) Composite Affordances Span Multiple Levels of Abstraction

Composability. With composability, we refer to the idea that an affordance is considered a composite of other affordances. Cheikh-Ammar (2018) illustrates the notion of composability by showing how an affordance can be decomposed into sub-affordances (Figure 2). Markus and Silver (2008) touch upon the same issue, as they suggest that “the researcher may hypothesize that the system as a whole, rather than one or more component parts, provides an affordance” (p. 628) as a means to escape the repeating decomposition problem. While alluding to the composability of affordances, their statement also relates to the importance of choosing an appropriate level of granularity for an IS study. Thapa and Sein's (2018) notion of ensemble of affordances resembles that of Cheikh-Ammar's, as Thapa and Sein recognize that the volunteerability affordance that is clustered to from an ensemble with the virtual co-localisability affordance in reality is contingent on and is actualized for the first time at a later point in time than the volunteerability affordance (p. 813).

4 Affordance Analysis

In this section the findings from the affordance classification are presented and analyzed. The detailed coding of all identified affordances can be found in Table B1 in the Appendix.

4.1 Affordance Enactors and Beneficiaries

Although AT is being adopted to IS and studies in organizational contexts, it is hard to get away from the fact that organizational tasks and actions are performed by individuals within the organizations. As such, the findings reveal (or perhaps better, confirm) that 298 of the affordances are enacted by individuals or groups of individuals. However, for many affordances it is hard to decide undoubtedly whether they have a singular or plural enactor (e.g., locate the best sites for camera traps [Pan et al., 2020]). Only two affordances are coded with an organizational enactor (organizational memory affordance [Chatterjee et al., 2015, 2020]; harmonious IT affordance [Chatterjee et al., 2020]), while six are not assigned any enactor at all, because of the nature of the claimed affordance; that is, they are arguably not affordances that can be enacted (e.g., animation [Lankton et al., 2015]; Patient satisfaction [Li et al., 2020]) — yet, some of them do have beneficiaries (e.g., the wiki community will benefit from open boundaries [Arazy, Daxenberger, Lifshitz-Assaf, Nov, & Gurevych, 2016]).

After the affordance coding process was done, the coded categories were revisited to further analyze the findings. The three beneficiary categories community, third-party, and general were grouped together in an overarching category called third-party (Table 8). Note that for two of the identified affordances it was not possible to identify neither enactor nor beneficiary (patient satisfaction with teleconsultation; patient-perceived media richness [Li et al., 2020]).

Table 8. Distribution of Affordances

Enactor \ Beneficiary	Self	Organization	Third-party			N/A	Total
			Community	3 rd Party Individual	General		
Individual	152	19	3	3	2	-	179
Group (of individuals)	17	89	11	1	1	-	119
Organization	-	2	-	-	-	-	2
N/A	3	-	1	-	-	2	6
Total	172	110	15	4	3	2	306

Figure 3 and Figure 4 show how enactors and beneficiaries evolve over time. Notably, in the initial phase of IS-affordance literature, the enactors were groups of individuals that enacted affordances to benefit the organizations in which they work. 2014 marks a shift — from then on affordances that can be enacted by a single individual to benefit the individual him-/herself are dominant in IS affordance literature. Recently, there is also a growing number of affordances that benefit third parties (Figure 4). Without going into too much speculation, one might wonder if the failure to arrive at a consistent set of extensions to AT has led IS scholars to modify their expectations towards the analytical leverage of AT. This could explain the growing trend of applying AT to describe simple and isolated phenomena of individuals' interaction with IT artifacts for their own immediate benefit, rather than to explain action potentials in relation to a complex configuration of organizational enactors and beneficiaries.

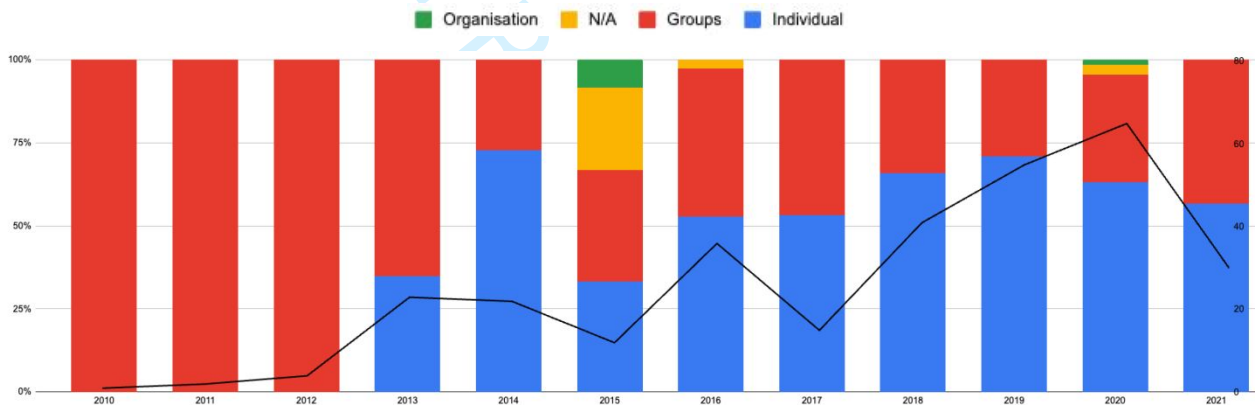


Figure 3. Affordance Enactors of the Affordances in the Review Set. The Bars Show Yearly Distribution in Terms of Percentage (Left Y Axis). The Line Shows the Total Number of Affordances (Right Y Axis).

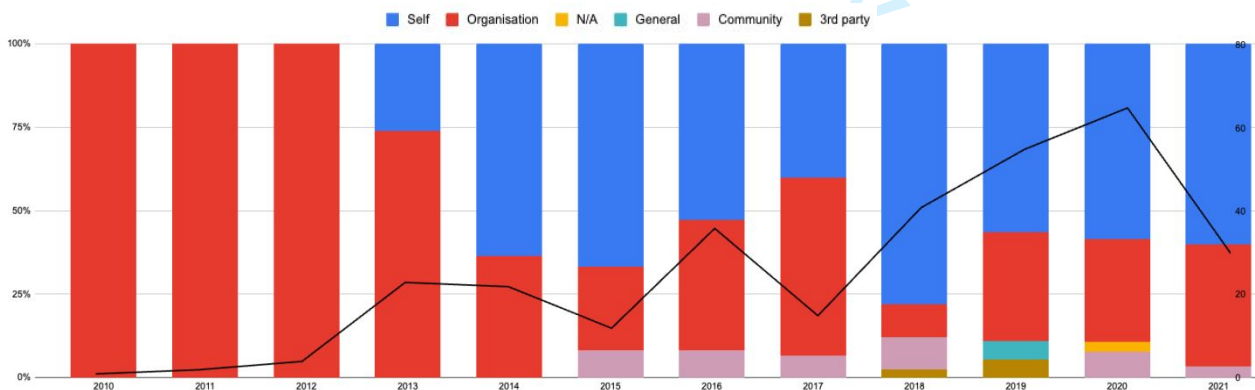


Figure 4. Affordance Beneficiaries of the Affordances in the Review Set. The Bars Show Yearly Distribution in Terms of Percentage (Left Y Axis). The Line Shows the Total Number of Affordances (Right Y Axis).

Although several IS-flavored affordance definitions (Table 6) highlight the possibility for groups of individuals to enact affordances, only 40% (n=121) of the identified affordances could be enacted by groups of individuals or organizations, while 58% (n=179) could be enacted by a single individual. In total, individuals and groups of individuals are the potential enactors of 97% (n=298) of the identified affordances.

4.2 Affordance Granularity Levels

Affordances are identified and enacted at different levels of granularity, and IS researchers are encouraged to focus on the appropriate level of granularity while doing affordance research (Volkoff & Strong, 2017). However, there is no clear consensus on how to refer to different granularity levels. IS scholars refer to lower and higher levels (e.g., Burton-Jones & Volkoff, 2017), first- and second order (Leidner et al., 2018), and individual- and organizational-level (Strong et al., 2014), and Cheikh-Ammar (2018) introduces medium-level affordances as a term when he articulates how an affordance can be decomposed into sub-affordances.

The granularity level of an affordance indicates the abstraction level of the affordance. During the coding process, three overarching granularity levels for affordances emerged. Instead of two levels, the findings support the introduction of a third granularity level for affordances, namely mid-level affordances. While Cheikh-Ammar (2018) mentions three levels of abstraction (lower, medium, high), he does not outline any fundamental difference between the lower-level affordances (replying and/or forwarding messages) and the medium-level affordances (sending and receiving messages). In the following analysis, each of the overarching granularity levels are explained, clearly distinguishing them from one another. Examples of affordances at each granularity level are given in Table 9.

4.2.1 Lower-Level Affordances

From the identified affordances in the review set, we observe that they relate to technology in various ways. Some describe the potential for very concrete and direct use of a technology or a technology feature, such as inputting data and sending emails. We refer to such potential for direct use of technology as lower-level affordances. As with Gibson's (1977, 1979) cutting affordance, these are affordances that are easily perceivable, since they often relate to specific technology features.

Technology features and their use. While a technology artefact is a technology construct with technology properties, it does also have features. The properties of the technology determine its features and indicate what an actor can do with the technology. For instance, an EHR system can have a data entry feature which allows the user to enter data. That is, technology features indicate which concrete actions can be performed with the technology. However, distinguishing between the technology features themselves and technology feature *use* might be a challenging exercise, since they in many cases would be the same. For instance, Lankton et al. (2015) explain how animation can be used to present information. In their case, animation is a feature of the technology, allowing the user to animate the information. However, as they elaborate on animation, they explain, referring to Johnson et al. (2006), that “[animation] can provide rich feedback and communication [Johnson et al., 2006], which provides action possibilities to the user such as deciding what to buy on a website or deciding the next step to take in an online learning environment” (p. 902). Although Lankton et al. themselves state that “social affordances are the possibilities for action that people offer one another” (p. 886), they present animation as an affordance rather than alluding to the actual action possibilities that animation provides.

Technology feature use as basic affordances. Burton-Jones and Volkoff's (2017) affordance network helps describe how interlinked affordances can lead to larger outcomes in organizations. These interlinked affordances range from basic affordances, such as inputting data, to more complex tasks, like decision making. For instance, decision making cannot be done without accessing data, which in turn requires inputting data. Although not specifically referring to a data entry feature, inputting data is undoubtedly a concrete and basic task consisting of inputting data using a technology artefact's data inputting feature.

Technology use. While technology feature use is the concrete use of a specific technology feature, technology use is still direct use of technology, but not of a specific technology feature. For instance, in their study of virtual reality and augmented reality technologies, Steffen et al. (2019) present an affordance they call *create aspects that do not exist in the physical world*. Although creating such aspects is undoubtedly done using technology, it is not possible to pin-point one single feature used to actualize this affordance. Technology use affordances thus reside on a slightly higher granularity level than technology feature use affordances, although still within the lower level.

4.2.2 Mid-Level Affordances

As opposed to lower-level affordances that relate to the potential for concrete use of a specific technology or a technology feature, we introduce a second granularity level — the mid-level — to categorize affordances that denote a more abstract use of technology. A good example of a mid-level affordance is Hatakka et al.'s

(2020) job information reachability affordance, which “[relates] to the use of ICT to find available jobs” (p. 680). It is clearly conveyed that technology is used to actualize the affordance, but the affordance does not relate to a specific technology or technology feature in the same way as lower-level affordances. Considering Leidner et al.’s (2018) train ride example, the commuter used the train (the technology) to work, sleep, mediate or converse with others. In this example, the commuting itself would be a lower-level affordance, while working, sleeping, meditating, and conversing would be considered mid-level affordances. In the same manner as these activities are “made possible by the train ride” (p. 120), mid-level affordances are affordances that emerge as a result of the actualization of lower-level affordances.

In most of the articles that identified one or more affordances (72%; 38 out of 54 articles), more than half of the affordances (56%; 148 out of 265 affordances in the 38 articles) were coded to be of a somewhat abstract nature, thus pertaining to the mid-level. Leidner et al. (2018) propose that affordances of such nature are the affordances that IS scholars should be concerned with. This is because they have more intriguing organizational implications.

4.2.3 Higher-Level Affordances

Higher-level affordances are even more abstract than mid-level affordances and emerge as a result of the actualization of mid-level affordances. Higher-level affordances are in a murky territory as they at first glance seem to deviate quite clearly from Gibson’s original ideas. They are abstract and often non-immediate action possibilities that emerge from technology appropriation and use. Higher-level affordances may also be hard to distinguish from mid-level affordances. For instance, Seidel et al.’s (2013) delocalization affordance serve as a good example of a higher-level affordance. They explain that “virtual collaboration systems providing file sharing and communication features” affords delocalization (p. 1285). While Hatakka et al.’s (2020) job information reachability affordance regards how people may find job information *through* technology use, “delocalization affordances enable work practices to become location-independent” (Seidel et al., 2013, p. 1282) *because of* technology use. In other words, while mid-level affordances are actualized by virtue of using technology, higher-level affordances are realizable because of previous technology use, often by multiple enactors. Both the mid-level information reachability affordance and the higher-level delocalization affordance are afforded by technology. That is, also higher-level affordances are afforded by technology.

A common interpretation is that an affordance denotes the action possibility offered by an object to an actor and that it relates to the concrete usage of the object. However, if we look at Gibson’s (1979) work, this interpretation may be disputed. Consider the following two points. First, Gibson explains that air affords “unimpeded locomotion” (p. 130). Note that there is a difference between how a human enacts a knife’s cutting affordance (p. 133) and the air’s locomotion affordance. While cutting is a concrete and direct use of the knife, locomotion is an indirect way of using the air. Although the animal does not make direct use of the air to locomote, the very existence of the air affords locomotion. Second, Gibson explains that not only objects but also places may have affordances (p. 136). The properties of a place determine what the place affords to the animal, for example hiding from a predatory animal. That is, the place has affordances. Like with the air example, the animal does not use the place for hiding in the same way as a human applies the knife for cutting. The place does nevertheless afford hiding. Similarly, higher-level affordances are afforded by technology, although it is a different kind of affordance than direct use of technology, such as Seidel et al.’s (2013) delocalization.

In the classification of the affordances in the review set for this study, we identified only seven higher-level affordances. This illustrates the lack of focus on this level of abstraction — perhaps because of the difficulty of identifying such higher-level affordances. At the same time, IS scholars have recently become more concerned with implications of technology use at the organizational field and societal level (Faik et al., 2020). The identification of higher-level affordances may give analytical leverage in such studies, while pushing AT to its analytical limits. Faik et al. employed a combination of affordances and institutional logics to illustrate how IT affordances gain scale through a set of mechanisms and “suggest that these scaled IT affordances can contribute to societal change when they become the basis of shifts in the prevailing configuration of institutional logics” (p. 1360). By combining these two lenses, they avoid extending the affordance notion to account for higher-level affordances.

4.3 Affordance Naming Conventions

Since affordances generally are considered action possibilities, it is no surprise that most of the affordances are named using verbs (n=216; 71%). The most common naming convention is the use of gerund (n=137; e.g., wearing; enabling face-to-face communication). Second, infinitive is also quite commonly used (n=49;

e.g., reduce resource cost; prioritize vulnerable children at school). One affordance is named using present tense (provides information about seminars and lectures). However, the nature of many of the claimed affordances in the review set are arguably mere technology features, properties, and artefacts, and, interestingly, 90 affordances (29%) are described using nouns (e.g., interaction; add-ons). One might ask, what happened to action possibilities in these instances? The last 29 affordances are named using what I have termed possibility (e.g., presentability; educability).

Table 9. Affordance Granularity Levels

Classification	Explanation	N	Examples
Definition-bending affordances (n=20; 7%)			
Technology artefact	A technology construct	2	Forums; listserv groups
Technology property	A property of the technology	16	Open access; responsiveness
Mislabeled	No clear enactor or beneficiary	2	Patient satisfaction with teleconsultation; patient-perceived media richness
Lower-level affordances (n=130; 42%)			
Technology feature	A built-in software feature	13	Animation; automatic release of changes
Technology feature use	The concrete usage of a specific technology feature	33	Editability; character movement
Technology use	Direct use of technology in general, but without reference to any specific feature	84	Connecting members; visualization
Mid-level affordances (n=140; 46%)			
Mid-level affordances	Describes something that is possible to do because of the technology. Distinguished from technology use in that it is not a direct use of the technology.	140	Pursuing hobbies; assess wildlife distribution; making decisions collectively
Higher-level affordances (n=7; 2%)			
Higher-level category	More abstract actions or mechanisms made possible because of technology use	7	Organizational memory affordance; reflective disclosure
Non-technology-related affordances (n=9; 3%)			
Non-tech-affordance	Not related to technology use (i.e., possible to actualize without relying on technology)	3	Wearing; practice improvability
Workplace environmental affordance	Non-technology related affordance in a workplace environment (category from Waizenegger et al., 2020)	6	Socializing; ad-hoc information exchange
Total		306	

5 Discussion and Recommendations

At the core of research lies the desire to understand and explain events that occur. Theory helps us do this, and knowledge is accumulated by building on prior work. Many researchers have used AT as a promising lens in their research and contributed to the appropriation of AT in IS. Yet, a concise body of knowledge on IS affordances, for others to build upon, is lacking. Some seminal papers have set the stage for further exploration, such as Leonardi's (2011) work on imbrication and Markus and Silver's (2008) and Volkoff and Strong's (2013) IS-flavored definitions of affordances (Table 6). Nevertheless, as our findings illustrate, IS scholars interpret and use the notion of affordances differently, and many new extensions are introduced in descriptive papers, without really being picked up and elaborated on by others. Thus, the IS version of AT remains fragmented, with several loose ends. It leaves us little doubt that the IS research community would benefit from stronger conceptual clarity. Given the common project of appropriating AT to our field, we should work towards a shared understanding of the concepts we employ. In the following, we provide a unified framework based on the key extensions to AT by IS research papers in the review set. The key dimensions of the framework are the three identified extensions to AT, namely granularity, trajectory, and composability.

5.1 Addressing IS Complexities in the Appropriation of Affordance Theory

While Gibson was studying how the environment afforded action possibilities to animals, IS researchers are concerned with how IT affords action possibilities to individuals and organizations in complex socio-technical contexts. In its original form, the affordance theory did not suffice for IS research, and it was indeed necessary to embark on an appropriation process.

5.1.1 Granularity

Leidner et al. (2018) claim that IS scholars' "views of affordance emphasize ... that it is a fundamentally different perspective than merely looking at technology use or technology feature use" (p. 3). Consistent with this, Volkoff and Strong (2017) do also point out that "feature use is not the same as an affordance actualization" (p. 242). However, in their fourth principle regarding affordance granularity, Volkoff and Strong refer to Gibson, who explains that the eating affordance is a nested affordance, depending on the actualization of the biting, chewing and swallowing affordances.⁴ Similarly, Volkoff and Strong argue that a monitoring affordance depends on the actualization of the data inputting affordance. But what exactly is *data inputting*, if not mere technology feature use (e.g., a data entry feature)?

Gibson himself did indeed refer to the usage of an item as an affordance, such as the cutting affordance afforded by the knife (Gibson, 1979, pp. 133&137). Thus, following Gibson's initial meaning, we cannot really argue that technology use is not an affordance. Both Leidner et al. (2018) and Volkoff and Strong (2017) seem to agree that research on technology feature use do not contribute with any revolutionary insight, as both are reluctant of muddling technology use with affordances and affordance actualization. However, as argued above, if we want to adhere to Gibson's initial meaning of the concept, technology use is indeed actualization of affordances.

Nevertheless, what is interesting to study is not the basic technology use, but what such use affords. Leidner et al. (2018) exemplify this with their train ride example. The interesting part is not that the train affords commuting to work, but what the commuter is afforded through taking the train ride (e.g., working, sleeping, meditating, conversing). In other words, the interesting affordances are the affordances at a higher level of granularity — the affordances that emerge through the actualization of the more basic affordances (i.e., technology use).

According to Volkoff and Strong's (2017) fourth principle, IS scholars should direct their attention to the appropriate level of granularity of affordances, which is subject to the question at hand. In many cases, the appropriate level of granularity would require researchers to look beyond mere technology use. Thus, the problem that IS researchers should cope with, is not whether or not technology use is considered an affordance, but which affordance granularity level is most interesting to study. In that regard, Leidner et al. (2018) make a valid point: IS researchers should not focus on mere technology use, but rather what technology use affords — that is, the affordances that emerge from technology use. This, however, indicates that there is a need to define a framework that helps IS scholars focus on the appropriate level of analysis in IS research.

Consider the affordances presented by Karahanna et al. (2018) as a means to explain why users with certain psychological needs turn to social media. For instance, instead of focusing on "content sharing" as an affordance, it would be more interesting to understand *why* the users shared content. What did the content sharing technology feature afford the users? What happens at the next level of granularity? The relationship formation affordance, on the other hand, emerges through the use of the technology feature joining groups. In the latter example we understand that the users join the groups in order to establish relationships.

Figure 5 illustrates the differences in granularity levels for some of the abovementioned affordances. Notably, there is a causal relationship between affordances on different granularity levels. We turn to this next.

⁴ It seems the real source for this example is Shaw and Bransford's (1977) preface (and not from Gibson himself) in the book where Gibson (1977) first introduced affordances: "Experiences of chewing, swallowing, etc., are constitutive of the act of eating." (Shaw & Bransford, 1977, p. 42; see also p. 37). However, Gibson (1966) himself alludes to the similar, although not with reference to an apple (as Volkoff and Strong [2017] wrote) but to food in general (p. 138).

5.1.2 Trajectory

While several IS scholars have coined various terms to address longitudinal dependency, Gaver (1991) introduced the concept of sequential affordances to indicate that “acting on a perceptible affordance leads to information indicating new affordances” (p. 82). Whoever claims to have coined the idea first is anyway preceded by Gibson (1966), as he states, “food-getting ... consists of a whole chain of activities — finding food, taking it, biting or chewing it, ... swallowing it» (p. 138). Whether we call it a chain of affordances, sequential affordances (Gaver, 1991), affordance dependencies (Strong et al., 2014), affordance network (Burton-Jones & Volkoff, 2017), or trajectory of affordances (Thapa & Sein, 2018), they all allude to the same core idea, namely that the actualization of one affordance may lead to the emergence of subsequent affordances. Figure 6 visualizes the interdependency of some affordances in the review set. As the figure indicates, the actualization of an affordance may trigger the emergence of an affordance at the same granularity level or at a higher level of granularity. The actualization of an affordance may also cause several other affordances to emerge, indicating a one-to-many relationship between affordances.

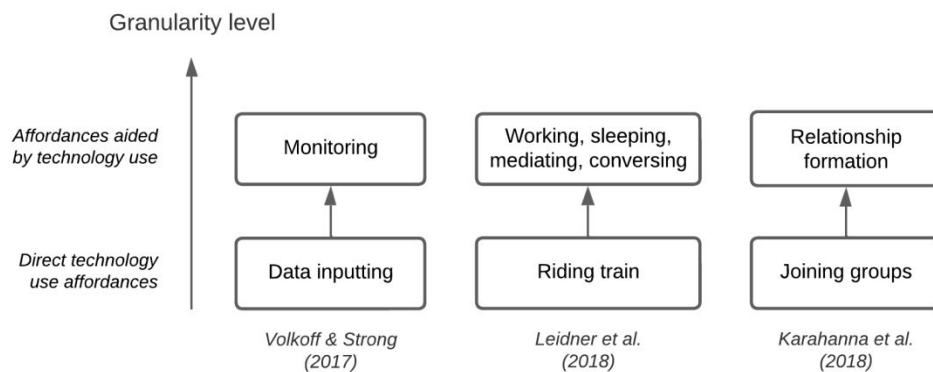


Figure 5. Causal Relationships Between Affordances at Different Granularity Levels

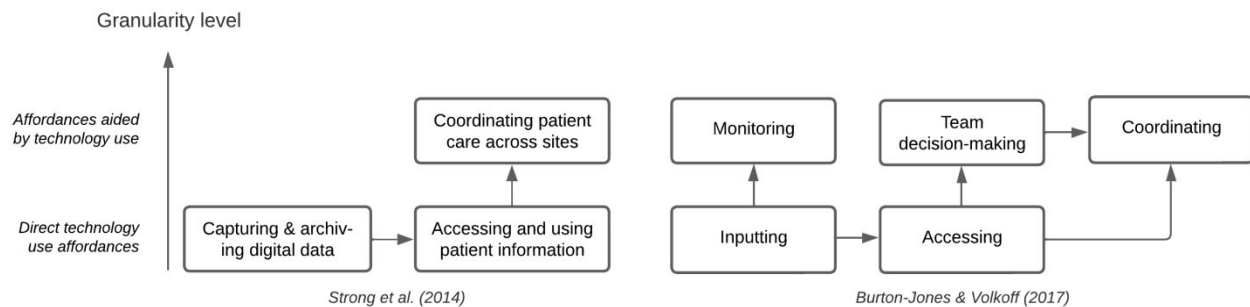


Figure 6. Examples of Affordance Interdependencies in the Review Set

5.1.3 Composability

More than three decades ago, Gaver (1991) coined the idea of *nested affordances* — that is, affordances that are grouped in space — and explained how pulling a door consisted of the sub-affordance pulling the door handle. Bernardi (2016) refers to the same idea as *composite affordances* and explains how the building a support network affordance is a composite of the self-presentation and narration affordances. The notion of composability originates nevertheless from Gibson (1966) himself, as he explains how finding, taking, biting, chewing, and swallowing food are components of the food-getting system (p. 138). Composite affordances are different from sequential affordances in that one or more affordances constitute another affordance. For example, Bernardi’s building a support network affordance is not a third affordance that can be actualized after the self-presentation and narration affordances but rather a composite of the two. It is actualized only by virtue of the actualization of the other two. A noteworthy observation is that a composite affordance can be at a higher granularity level than its sub-affordance(s). Cheikh-Amman’s (2018) *collaborating with others* affordance is a suitable example of this. Through sending and receiving messages, the user is collaborating with others. Thapa and Sein (2018) do also subscribe to the notion of composability

as they describe how affordances cluster together to form an ensemble of affordances. Clearly, IS researchers have been grappling with the same basic idea in appropriating the affordance lens, yet the terminology has been inconsistent and synergies between studies have been limited. Some examples of composite affordances are shown in Figure 7.

Notably, Gibson's (1966) food-getting affordance and Thapa and Sein's (2018) ensemble of affordances consist of sequential affordances, as illustrated in Figure 8. In other words, a composite affordance does not necessarily consist of independent sub-affordances but may as well consist of dependent, sequential affordances.

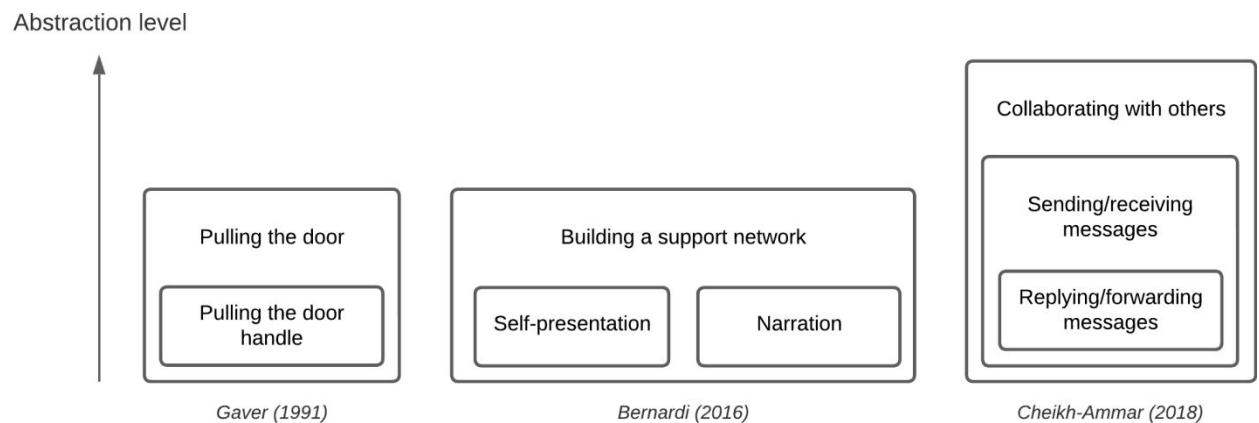


Figure 7. Examples of Composite Affordances

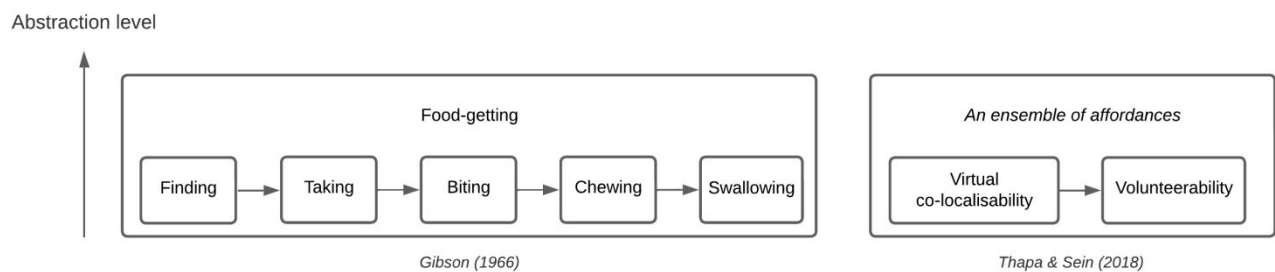


Figure 8. Example of Composite Affordances With Sequential Sub-Affordances

5.2 Key Elements for an IS-flavored Affordance Theory

In order to develop an AT suitable for the IS community, the aforementioned complexities should be further investigated. It seems unnecessary that our research community not yet seem to agree on how to address these important complexities. Do we need all these different frameworks about decomposed, interrelated, interdependent or networked affordances, or can they be united into a single framework addressing the affordance interdependency? Similarly, are there really any significant difference between nested, composite, and clustered affordances? To paint a clearer picture of the complexity of IS affordances, we propose a unified framework to cater for the three IS AT complexities. Our nested affordance process model is presented in the following and depicted in Figure 10.

5.2.1 The Nested Affordance Process Model

Based on the analysis of the AT extensions along the identified complexities, we derive our conceptual nested affordance process model. In the model, we cater for the various complexities and incorporate AT extensions suggested in extant IS research. The model is explained in the following.

Granularity. In our model, we use three granularity levels. Lower-level affordances denote a very concrete and direct use of technology. Mid-level affordances refer to action possibilities that are aided by technology. That is, actions that require the involvement of technology to a certain degree, but the action possibility itself

might not in an on itself convey technology use (e.g., job information reachability [Hatakka et al., 2020]; relationship formation [Karahanna et al., 2018]). Higher-level affordances are action possibilities that emerge from the actualization of mid-level affordances. Calling such action possibilities affordances may be disputed, since these action possibilities do not involve technology use. However, higher-level affordances are nevertheless made possible by technology use, and we have argued that technology in that regard affords these higher-level action possibilities.

Trajectory. Extant research shows that affordance dependencies may span granularity levels (e.g., Burton-Jones & Volkoff, 2017; Strong et al., 2014; Thapa & Sein, 2018). The actualization of one affordance may cause the emergence of another affordance at the same granularity level or at a higher granularity level. Furthermore, affordance actualization and emergence are seldom a one-to-one causality; the actualization of one affordance may trigger the emergence of one or several new affordances and similarly, an affordance may require the actualization of one or many preceding affordances (see Figure 6). Our model thus accounts for affordance dependency within and across granularity levels, conflating the several notions that relate to affordance dependency. We remain with the term trajectory, as proposed by Thapa and Sein (2018).

Composability. Drawing on Gibson (1966), Gaver (1991), Markus and Silver (2008), Bernardi (2016), Cheikh-Ammar (2018), and Thapa and Sein (2018), we contend that most affordances are composite affordances that may consist of one or many sub-affordances. The sub-affordances may be individual, composite or sequential affordances. The simplified “layered” illustration of affordances in Figure 10 conveys this.

Context. Affordances are actualized in a social context and not in a vacuum (Volkoff & Strong, 2017). The organizational context affects the goals and actions of the actors (Strong et al., 2014). Bygstad et al. (2016) call social mechanisms the context beyond affordances, serving as “enabling/constraining, stimulating or releasing conditions” (p. 92). Similarly, Thapa and Sein (2018) use the term facilitating conditions to refer to the conditions that serve as a prerequisite for an affordance to be actualized. In our model, we remain with the term facilitating conditions to denote motivating, stimulating, and facilitating factors supporting the affordance actualizations.

Feedback loops. Burton-Jones and Volkoff (2017) encourage researchers to “map out the network of affordances and the connections and feedback loops among the affordance-outcome units” (p. 482). Strong et al. (2014) explain how the outcome of actualized affordances “provide feedback for adjusting (as needed) those individual actions as well as adjusting the elements giving rise to the affordance” (p. 70). Furthermore, Tim et al. (2018) note that unintended consequences of technology use also “provide feedback for adjusting the actions of actors and thus the uses of technology” (p. 69).

Affordance loops. Volkoff and Strong (2013) consider enabling, stimulating, and releasing conditions to be the “presence and degree of actualization of other affordances” and explain how the actualization of an affordance may serve to enable, stimulate and release more advanced affordances (p. 828). They point out that “appropriately actualized basic affordances were the enabling conditions for exercising the remaining affordances” (p. 828). But would the basic affordances have been realized without the perception of a compelling outcome of a more-advanced, not-yet-existing, affordance? What would motivate, or stimulate, the actualization of the basic affordance “setting up models for automated analysis by the solver (Aff 1)” (p. 827)? Presumably, the perception of the more-advanced analysis affordances and their possible outcomes played a role as stimulating conditions. This presumption corresponds well with what Burton-Jones and Volkoff (2017) observed in their study of an EHR system, namely that “these affordances relate to outcomes that these users wish to attain and these affordance-outcome units can weave together across the organization to reflect how affordances and outcomes depend on each other across time and organizational levels” (p. 470). We thus propose that even the potential outcome of affordances that have not yet emerged may stimulate the actualization of preceding affordances. We incorporate this special case of feedback loops in our framework. To avoid muddling these kinds of feedback loops with “normal” feedback loops that follow a longitudinal trajectory, we call this special case feedback loops for *affordance loops*. The affordance loops are depicted in a simplified manner in Figure 9.

In Figure 10, we present the complete model, with all elements discussed. Note that the illustration (Figure 10) attempts to convey that an affordance can consist of an ensemble of sub-affordances (i.e., “nested in space” [Gaver, 1991]; cluster/ensemble of affordances [Thapa & Sein, 2018]) and as such, that there is not a one-to-one relation between the actualization of an affordance and the following emergence of an affordance at a higher level of granularity (Burton-Jones & Volkoff, 2017; Strong et al., 2014). For instance, the actualization of one lower-level affordance can result in the emergence of a multitude of mid-level

affordances. And the emergence of one mid-level affordance might require the actualization of a multitude of lower-level affordances. The trajectory along which an affordance travels (Thapa & Sein, 2018) is illustrated with the arrows, and the facilitating conditions serving as prerequisites for the emergence of the affordances are illustrated with the dotted arrows.

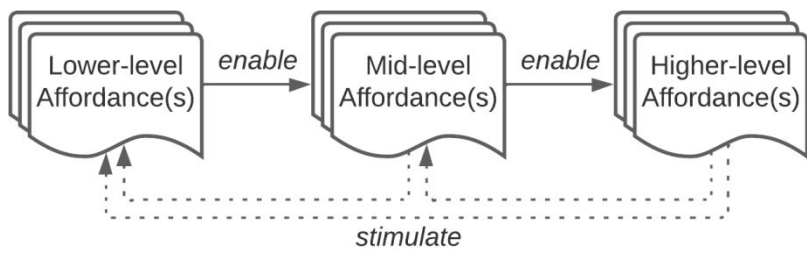


Figure 9. Affordance Loops

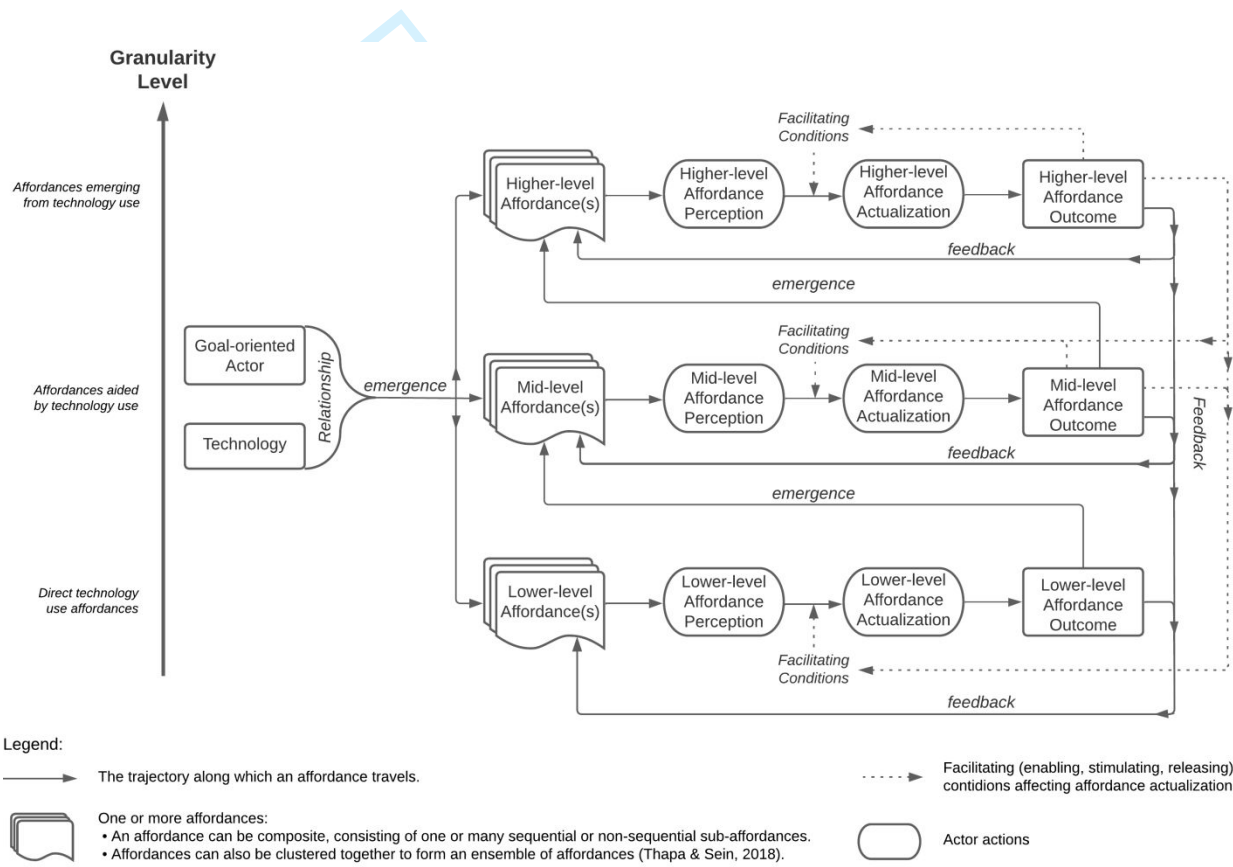


Figure 10. The Nested Affordance Process Model (NAP)

6 Conclusion

Based on a descriptive literature review of 69 articles in the top eight IS journals and the analysis of the 306 identified affordances in the reviewed literature, this paper has identified the divergent ways in which IS scholars have used the concept of affordances. Although there seems to be a baseline consensus on what an affordance is (action possibility), several researchers have labelled technology artefacts, properties, and features as affordances, even by using nouns to describe these action possibilities. The findings also reveal that the level of analysis in many affordance studies have pivoted towards an individual level, focusing on lower-level technology use affordances enacted by individuals, producing an outcome that benefits the enactors themselves. Does this indicate that IS scholars have lost momentum in their efforts to extend and appropriate AT to account for complex organizational phenomena?

We have identified three key dimensions along which IS scholars have extended AT. However, extensions along these dimensions use different notions and are partly overlapping without building clearly on each other. We synthesize these extensions to recognize that IS affordances form sequential trajectories over time, are interdependent, as they can be nested composites, and there are three major granularity levels (low, middle, and high).

To draw these key dimensions together, this paper contributes with a nested affordance process model, illustrating the interdependency of lower-, mid-, and higher-level affordances and the affordances' context dependency. The model can also be used as a tool to help identify affordances at an appropriate level of granularity. We suggest that IS researchers focus on the granularity level that lies beyond mere technology use — that is, mid- and higher-level affordances.

Our literature review, and the contributions informed by it, have two major limitations. First, a broader set of literature could have been reviewed to obtain more nuanced insights and more rigorous trends. Second, the initial part of the literature review was done single-handedly by the first author, which could introduce personal bias in the early categorizations of the literature. Nevertheless, given the relatively high number of analyzed papers in top journals and several review iterations, we believe the findings and analysis presented are plausible and that the proposed model provides a fruitful synthesis of the key adaptations of AT to IS research so far.

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Appendix A: Paper Classification

Table A1. Article List, Sorted by Journals and Authors, Showing the Web of Science Article Category, Number of Citations per Year and in Total, Along with the Research Method of the Articles and Number of Affordances found in each Article

Article	Article category	Citations per year	Citations in total	Research Method	Affordances found
EUROPEAN JOURNAL OF INFORMATION SYSTEMS (14 articles):					62
Abouzahra and Ghasemaghaei (2021)	Article	0	0	Case study	9
Benbunan-Fich (2019)	Article	2	4	Archival research	6
Cheikh-Ammar (2018)	Article	2	7	Literature review	3
Ciriello et al. (2019)	Article	2	4	Case study	7
Hacker et al. (2020)	Article	3	3	Case study	5
Henningsson et al. (2021)	Article	0	0	Case study	6
Mettler et al. (2017)	Article	4	16	Case study	0
Niemimaa and Niemimaa (2019)	Article	1	2	Case study	0
Pan et al. (2020)	Article	1	1	Action design research	6
Piccoli (2016)	Article	3	14	Archival research	1
Porter and van den Hooff (2020)	Article	0	0	Case study	3
Seidel et al. (2018)	Article	7	22	Design science research	4

Te'Eni (2016)	Editorial	1	7	Excluded (editorial)	- (Ed.)
Waizenegger et al. (2020)	Article	10	10	Case study	12
INFORMATION SYSTEMS RESEARCH (4 articles):					25
Alam and Campbell (2017)	Article	3	12	Case study	4
Arazy et al. (2016)	Article	3	17	Case study	5
Burton-Jones and Volkoff (2017)	Article	11	45	Case study	9
Leonardi et al. (2019)	Article	3	6	Case study	7
INFORMATION SYSTEMS JOURNAL (11 articles):					57
Chatterjee et al. (2021)	Article	0	1	Survey	3
Hanelt et al. (2017)	Article	3	10	Case study	2
Hatakka et al. (2020)	Article	4	4	Case study	10
Jung & Lyytinen (2014)	Article	3	21	Case study	4
Lee et al. (2021)	Article	0	1	Survey	3
Mckenna (2020)	Article	5	5	Case study	8
Mettler and Wulf (2019)	Article	9	17	Case study	4
Sæbø et al. (2020)	Article	5	5	Case study	9
Thapa and Sein (2018)	Article	6	17	Case study	3
Tim et al. (2018)	Article	8	24	Case study	3
Zheng and Yu (2016)	Article	10	48	Case study	8
JOURNAL OF INFORMATION TECHNOLOGY (3 articles):					21
Argyris and Ransbotham (2016)	Article	2	8	Case study	5
Bygstad et al. (2016)	Article	13	64	Case study	8
Van Osch and Steinfield (2016)	Article	2	12	Case study	8
JOURNAL OF MANAGEMENT INFORMATION SYSTEMS (7 articles):					38
Arazy and Gellatly (2012)	Article	5	46	Survey	4
Burgoon et al. (1999)	Article	5	109	Case study (simulated)	0
Chan et al. (2019)	Article	4	8	Survey	4
Chatterjee et al. (2015)	Article	5	27	Survey	3
Krancher et al. (2018)	Article	3	8	Case study	4
Lehrer et al. (2018)	Article	12	36	Case study	0
Steffen et al. (2019)	Article	3	5	Case study	23
JOURNAL OF STRATEGIC INFORMATION SYSTEMS (6 articles):					23
Aversa et al. (2018)	Article	4	13	Case study	0
Chatterjee et al. (2020)	Article	6	6	Survey	4
Du et al. (2019)	Article	14	27	Case study	3

Leidner et al. (2018)	Article	11	32	Case study	15
Nandhakumar et al. (2005)	Article	3	49	Case study	0 ⁵
Von Krogh and Haefliger (2010)	Article	1	12	Literature Review	1
JOURNAL OF THE ASSOCIATION FOR INFORMATION SYSTEMS (13 articles):					39
Chua and Yeow (2010)	Article	1	16	Case study	0
Davern et al. (2012)	Article	3	30	Historical analysis	0
Demetis and Kietzmann (2021)	Article	0	0	Case study	12
Deng and Joshi (2016)	Article	6	29	Revealed causal mapping	7
Grgecic et al. (2015)	Article	4	21	Survey	5
Lang et al. (2015)	Article	2	13	Experimental economics	0
Lankton et al. (2015)	Article	9	52	Survey	4
Li et al. (2020)	Article	0	0	Survey	3
Markus and Silver (2008)	Article	20	259	Literature review	0
Mittleman (2009)	Article	0	1	Design science	0
Robey et al. (2013)	Article	5	43	Literature review	0
Rossi et al. (2019)	Editorial	5	10	Excluded (editorial)	- (Ed.)
Strong et al. (2014)	Article	16	111	Case study	8
MIS QUARTERLY (13 articles):					62
Bernardi et al. (2019)	Article	1	2	Case study	5
Faik et al. (2020)	Review	1	1	Literature review	5
Gaskin et al. (2014))	Article	6	45	Case study	6
Jiang and Cameron (2020)	Review	3	3	Literature review	4
Karahanna et al. (2018)	Article	9	28	Literature review	12
Leonardi (2011)	Article	53	533	Case study	2
Leonardi (2013)	Article	15	117	Case study	0
Leong et al. (2016)	Article	15	73	Case study	0
Majchrzak, Wagner, et al. (2013) *	Article	13	107	Case study	1
Nan and Lu (2014)	Article	4	29	Archival research	4
Seidel et al. (2013)	Article	15	121	Case study	4
Vaast et al. (2017)	Article	10	39	Case study	0
Volkoff and Strong (2013)	Article	17	133	Literature review	19

⁵ Nandhakumar et al. (2005) list seven affordances in their Table 2 (p. 236), but from the way they are presented, it is not possible to understand just what the claimed affordances are (e.g., one of their affordances is "could not proceed with the global 'unifying model' as systems in many national organizations were not year 2000 compliant" [p. 236]).

*) *Note:* This is not the same article as the heavily-cited article Majchrzak, Faraj, et al. (2013). Majchrzak, Faraj, et al. (2013) is left out of the trend analysis and systematic literature review, because the article was published in the Journal of Computer-Mediated Communication, which is not in the Basket of 8.

Appendix B: Affordance Categorization

Table B1. Affordance Classification

Authors	Year	Affordance	Enactor	Beneficiary	Naming Convention	Granularity
Abouzahra, M; Ghasemaghaei, M	2021	[Ability to] alert seniors to engage in a planned activity	Individual	Self	Infinitive	Technology feature
Abouzahra, M; Ghasemaghaei, M	2021	[Ability to] provide a comparative analysis to seniors	Individual	Self	Infinitive	Technology feature
Abouzahra, M; Ghasemaghaei, M	2021	[Capability to] reward seniors for their activity improvement by providing accomplishment medals or trophies	Individual	Self	Infinitive	Technology feature
Abouzahra, M; Ghasemaghaei, M	2021	[Enable seniors to] share their activities and trophies with others	Individual	Self	Infinitive	Technology feature use
Abouzahra, M; Ghasemaghaei, M	2021	Creating a strategy for exercising or engaging in activities	Individual	Self	Gerund	Technology feature
Abouzahra, M; Ghasemaghaei, M	2021	Data display and arrangement	Individual	Self	Noun	Technology feature use
Abouzahra, M; Ghasemaghaei, M	2021	Data recording	Individual	Self	Gerund	Technology feature use
Abouzahra, M; Ghasemaghaei, M	2021	improve seniors' activity	Individual	Self	Infinitive	Mid-level affordance
Abouzahra, M; Ghasemaghaei, M	2021	Providing recommendations for activity level	Individual	Self	Gerund	Technology feature
Alam, SL; Campbell, J	2017	Commenting	Individual	Self	Gerund	Technology feature use
Alam, SL; Campbell, J	2017	Forums	Individual	Self	Noun	Technology artefact
Alam, SL; Campbell, J	2017	Listserv groups	Individual	Self	Noun	Technology artefact
Alam, SL; Campbell, J	2017	Tagging	Individual	Self	Gerund	Technology feature use
Arazy, O; Daxenberger, J; Lifshitz-Assaf, H; Nov, O; Gurevych, I	2016	Choice of anonymity	Individual	Self	Noun	Mid-level affordance
Arazy, O; Daxenberger, J; Lifshitz-Assaf, H; Nov, O; Gurevych, I	2016	Open boundaries	N/A	Community	Noun	Technology property

Arazy, O; Daxenberger, J; Lifshitz-Assaf, H; Nov, O; Gurevych, I	2016	Task decomposability	Individual	Self	Possibility	Mid-level affordance
Arazy, O; Daxenberger, J; Lifshitz-Assaf, H; Nov, O; Gurevych, I	2016	Unconstrained workflow	Mid-level affordance	Self	Noun	Mid-level affordance
Arazy, O; Daxenberger, J; Lifshitz-Assaf, H; Nov, O; Gurevych, I	2016	Work process visibility	Individual	Community	Noun	Technology property
Arazy, O; Gellatly, IR	2012	Automatic release of changes	Mid-level affordance	Organisation	Noun	Technology feature
Arazy, O; Gellatly, IR	2012	Open access	Mid-level affordance	Organisation	Noun	Technology property
Arazy, O; Gellatly, IR	2012	Peer-based governance	Mid-level affordance	Organisation	Noun	Technology property
Arazy, O; Gellatly, IR	2012	Transparency	Mid-level affordance	Organisation	Noun	Technology property
Argyris, Y; Ransbotham, S	2016	Editability	Individual	Self	Possibility	Technology feature use
Argyris, Y; Ransbotham, S	2016	Experimentation	Individual	Self	Noun	Mid-level affordance
Argyris, Y; Ransbotham, S	2016	Persistence	Individual	Self	Noun	Technology property
Argyris, Y; Ransbotham, S	2016	Visibility	Individual	Organisation	Possibility	Technology use
Benbunan-Fich, R	2019	Aggregation	Individual	Self	Noun	Technology use
Benbunan-Fich, R	2019	Interaction	Individual	Self	Noun	Technology use
Benbunan-Fich, R	2019	Learning	Individual	Self	Gerund	Mid-level affordance
Benbunan-Fich, R	2019	Maintenance	Individual	Self	Noun	Real world affordance
Benbunan-Fich, R	2019	Self-effector	Individual	Self	Noun	Mid-level affordance
Benbunan-Fich, R	2019	Wearing	Individual	Self	Gerund	Real world affordance
Bernardi, R; Sarker, S; Sahay, S	2019	Accessing data anywhere, anytime	Individual	Self	Gerund	Technology use
Bernardi, R; Sarker, S; Sahay, S	2019	Collecting and compiling data reports	Individual	Organisation	Gerund	Technology feature use
Bernardi, R; Sarker, S; Sahay, S	2019	Performing complex analysis	Individual	Organisation	Gerund	Technology use
Bernardi, R; Sarker, S; Sahay, S	2019	Reporting data through a single channel	Individual	Organisation	Gerund	Technology use

Bernardi, R; Sarker, S; Sahay, S	2019	Retrieving and compiling data	Individual	Organisation	Gerund	Technology feature use
Burton-Jones, A; Volkoff, O	2017	Accessing data	Individual	Self	Gerund	Technology feature use
Burton-Jones, A; Volkoff, O	2017	Clinical decision making (complex case)	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Burton-Jones, A; Volkoff, O	2017	Clinical decision making (simple case)	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Burton-Jones, A; Volkoff, O	2017	Inputting data	Individual	Organisation	Gerund	Technology feature use
Burton-Jones, A; Volkoff, O	2017	Managerial decision making	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Burton-Jones, A; Volkoff, O	2017	Monitoring operations	Individual	Self	Gerund	Technology use
Burton-Jones, A; Volkoff, O	2017	Reporting on operations	Individual	Organisation	Gerund	Technology use
Burton-Jones, A; Volkoff, O	2017	Team decision making	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Booking	Individual	Self	Gerund	Technology feature use
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Developing a service	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Developing concepts	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Integrating new services	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Linking new business partner	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Prototyping	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Registering	Individual	Self	Gerund	Technology feature use
Bygstad, B; Munkvold, BE; Volkoff, O	2016	Searching	Individual	Self	Gerund	Technology feature use
Chan, TKH; Cheung, CMK; Wong, RYM	2019	Accesibility	Individual	Self	Possibility	Technology use
Chan, TKH; Cheung, CMK; Wong, RYM	2019	Information retrieval	Individual	Self	Noun	Technology use
Chatterjee, S; Moody, G; Lowry, PB; Chakraborty, S; Hardin, A	2015	Collaborative IT affordance	Mid-level affordance	Organisation	Noun	Higher-level category
Chatterjee, S; Moody, G; Lowry,	2015	Organizational memory affordance	Organisati on	Organisation	Noun	Higher-level category

PB; Chakraborty, S; Hardin, A						
Chatterjee, S; Moody, G; Lowry, PB; Chakraborty, S; Hardin, A	2015	Process management affordance	Mid-level affordance	Organisation	Noun	Higher-level category
Chatterjee, S; Moody, G; Lowry, PB; Chakraborty, S; Hardin, A	2020	Harmonious IT affordance [HITA]	Organisation	Organisation	Noun	Higher-level category
Cheikh-Ammar, M	2018	Replying and/or forwarding messages	Individual	Self	Gerund	Technology feature use
Cheikh-Ammar, M	2018	Sending and receiving messages	Individual	Self	Gerund	Technology feature use
Ciriello, RF; Richter, A; Schwabe, G	2019	Animatability	Individual	Self	Possibility	Technology feature use
Ciriello, RF; Richter, A; Schwabe, G	2019	Digitality	Individual	Self	Possibility	Technology property
Ciriello, RF; Richter, A; Schwabe, G	2019	Integrability	Individual	Self	Possibility	Technology property
Ciriello, RF; Richter, A; Schwabe, G	2019	Malleability	Individual	Self	Possibility	Technology use
Ciriello, RF; Richter, A; Schwabe, G	2019	Modularity	Individual	Self	Possibility	Technology use
Ciriello, RF; Richter, A; Schwabe, G	2019	Presentability	Individual	Self	Possibility	Technology feature use
Ciriello, RF; Richter, A; Schwabe, G	2019	Sequentiality	Individual	Self	Possibility	Technology feature use
Demetis, DS; Kietzmann, J	2021	Access social media accounts by bypassing age restrictions	Individual	Self	Infinitive	Technology use
Demetis, DS; Kietzmann, J	2021	Bypass encryption on confiscated devices	Mid-level affordance	Organisation	Infinitive	Technology use
Demetis, DS; Kietzmann, J	2021	Combine intelligence from different sources and build up offender profiles	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Demetis, DS; Kietzmann, J	2021	Conduct time-sensitive scan on imagery and risk-score contact sex offenders	Mid-level affordance	Organisation	Infinitive	Technology use
Demetis, DS; Kietzmann, J	2021	Contact initiation and communication through proxy identities	Individual	Self	Noun	Technology use
Demetis, DS; Kietzmann, J	2021	Engage in online extortion and receive first-generation imagery	Individual	Self	Infinitive	Technology use
Demetis, DS; Kietzmann, J	2021	Identify second-generation imagery and differentiate it from first-generation imagery	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Demetis, DS; Kietzmann, J	2021	Monitor online conversations for suspicious keywords	Mid-level affordance	Organisation	Infinitive	Technology use

Demetis, DS; Kietzmann, J	2021	Posting children's photographs online	Individual	Self	Gerund	Technology feature use
Demetis, DS; Kietzmann, J	2021	Prioritize vulnerable children at school	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Demetis, DS; Kietzmann, J	2021	Traffic child imagery, encrypt imagery and explore elite networking or monetization/gamification	Mid-level affordance	Community	Infinitive	Technology use
Demetis, DS; Kietzmann, J	2021	Trust development through digital imagery	Individual	Self	Infinitive	Mid-level affordance
Deng, XF; Joshi, KD	2016	Affordability of work equipment	Individual	Self	Possibility	Technology property
Deng, XF; Joshi, KD	2016	Automation	Mid-level affordance	Self	Noun	Technology feature
Deng, XF; Joshi, KD	2016	Internet ubiquity	Individual	Self	Noun	Technology property
Deng, XF; Joshi, KD	2016	Modularity of micro tasks	Individual	Self	Possibility	Technology property
Deng, XF; Joshi, KD	2016	Portability of work	Individual	Self	Possibility	Technology property
Deng, XF; Joshi, KD	2016	Simplicity of work equipment	Individual	Self	Possibility	Technology property
Deng, XF; Joshi, KD	2016	Virtualization of work processes	Individual	Self	Noun	Technology feature
Du, WY; Pan, SL; Leidner, DE; Ying, WC	2019	Small suppliers can secure loans from financial institutions	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Du, WY; Pan, SL; Leidner, DE; Ying, WC	2019	Subsidiaries and suppliers can settle payment directly	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Du, WY; Pan, SL; Leidner, DE; Ying, WC	2019	Transaction participants can automate transactions	Mid-level affordance	Organisation	Infinitive	Technology use
Faik, I; Barrett, M; Oborn, E	2020	Broadening Accessibility and Traceability	Mid-level affordance	Community	Gerund	Mid-level affordance
Faik, I; Barrett, M; Oborn, E	2020	Connecting Members and Opening Governance	Mid-level affordance	Community	Gerund	Mid-level affordance
Faik, I; Barrett, M; Oborn, E	2020	Enhancing Knowledgeability and Autonomy	Mid-level affordance	Self	Gerund	Mid-level affordance
Faik, I; Barrett, M; Oborn, E	2020	Standardizing and Controlling Operations	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Faik, I; Barrett, M; Oborn, E	2020	Stimulating and Coordinating Transactions	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Gaskin, J; Berente, N; Lyytinen, K; Yoo, Y	2014	Analysis	Individual	Self	Noun	Technology use
Gaskin, J; Berente, N; Lyytinen, K; Yoo, Y	2014	Control	Individual	Self	Noun	Mid-level affordance
Gaskin, J; Berente, N; Lyytinen, K; Yoo, Y	2014	Cooperation	Individual	Self	Noun	Technology use

Gaskin, J; Berente, N; Lyytinen, K; Yoo, Y	2014	Representation	Individual	Self	Noun	Technology use
Gaskin, J; Berente, N; Lyytinen, K; Yoo, Y	2014	Storage	Individual	Self	Noun	Technology use
Gaskin, J; Berente, N; Lyytinen, K; Yoo, Y	2014	Transformation	Individual	Self	Noun	Technology use
Grgecic, D; Holten, R; Rosenkranz, C	2015	[Possibility to] download course materials	Individual	Self	Infinitive	Technology feature use
Grgecic, D; Holten, R; Rosenkranz, C	2015	[Possibility to] exchange opinions with other students	Individual	Self	Infinitive	Technology use
Grgecic, D; Holten, R; Rosenkranz, C	2015	[Possibility to] learn about the offered courses	Individual	Self	Infinitive	Mid-level affordance
Grgecic, D; Holten, R; Rosenkranz, C	2015	[Possibility to] use a forum	Individual	Self	Infinitive	Technology feature use
Grgecic, D; Holten, R; Rosenkranz, C	2015	Provides information about seminars and lectures	Mid-level affordance	Community	Present	Technology feature
Hacker, J; vom Brocke, J; Handali, J; Otto, M; Schneider, J	2020	Attending events	Individual	Self	Gerund	Technology use
Hacker, J; vom Brocke, J; Handali, J; Otto, M; Schneider, J	2020	Communicating with social groups	Individual	Self	Gerund	Technology use
Hacker, J; vom Brocke, J; Handali, J; Otto, M; Schneider, J	2020	Consuming non-recreational services	Individual	Self	Gerund	Technology use
Hacker, J; vom Brocke, J; Handali, J; Otto, M; Schneider, J	2020	Engaging in shared social activities with family and friends	Individual	Self	Gerund	Technology use
Hacker, J; vom Brocke, J; Handali, J; Otto, M; Schneider, J	2020	Pursuing hobbies	Individual	Self	Gerund	Mid-level affordance
Hanelt, A; Busse, S; Kolbe, LM	2017	Digital eco-innovation	Mid-level affordance	Organisation	Noun	Mid-level affordance
Hanelt, A; Busse, S; Kolbe, LM	2017	Technological flexibility	Mid-level affordance	Organisation	Noun	Mid-level affordance
Hatakka, M; Thapa, D; Saebo, O	2020	[Job information] reachability	Individual	Self	Possibility	Mid-level affordance
Hatakka, M; Thapa, D; Saebo, O	2020	Customer intractability	Individual	Self	Possibility	Technology use

Hatakka, M; Thapa, D; Saebo, O	2020	Digital production information accessibility	Individual	Self	Possibility	Mid-level affordance
Hatakka, M; Thapa, D; Saebo, O	2020	Digital service reachability	Mid-level affordance	Community	Possibility	Mid-level affordance
Hatakka, M; Thapa, D; Saebo, O	2020	Educability [study circles]	Individual	Self	Possibility	Mid-level affordance
Hatakka, M; Thapa, D; Saebo, O	2020	Information disseminability	Individual	Self	Possibility	Technology use
Hatakka, M; Thapa, D; Saebo, O	2020	Practice improvability	Individual	Self	Possibility	Real world affordance
Hatakka, M; Thapa, D; Saebo, O	2020	Product/business marketability	Individual	Self	Possibility	Mid-level affordance
Hatakka, M; Thapa, D; Saebo, O	2020	Technology and information accessibility	Mid-level affordance	Community	Possibility	Mid-level affordance
Hatakka, M; Thapa, D; Saebo, O	2020	Training possibility	Mid-level affordance	Community	Gerund	Mid-level affordance
Henningsson, S; Ketinger, WJ; Zhang, C; Vaidyanathan, N	2021	"Last mile" telecommuting device readiness	Mid-level affordance	Organisation	Noun	Mid-level affordance
Henningsson, S; Ketinger, WJ; Zhang, C; Vaidyanathan, N	2021	Integrated branch-central operating model	Mid-level affordance	Organisation	Noun	Mid-level affordance
Henningsson, S; Ketinger, WJ; Zhang, C; Vaidyanathan, N	2021	Organisation-wide remote work	Mid-level affordance	Organisation	Noun	Mid-level affordance
Henningsson, S; Ketinger, WJ; Zhang, C; Vaidyanathan, N	2021	Strategic IT engagement	Mid-level affordance	Organisation	Noun	Mid-level affordance
Henningsson, S; Ketinger, WJ; Zhang, C; Vaidyanathan, N	2021	Telecommuting skill readiness	Mid-level affordance	Self	Noun	Mid-level affordance
Henningsson, S; Ketinger, WJ; Zhang, C; Vaidyanathan, N	2021	Virtualised branch services	Mid-level affordance	Organisation	Noun	Mid-level affordance
Jiang, JL; Cameron, AF	2020	Data collection	Individual	Self	Noun	Technology use
Jiang, JL; Cameron, AF	2020	Preparation	Individual	Self	Noun	Mid-level affordance
Jiang, JL; Cameron, AF	2020	Social connection	Individual	Self	Noun	Mid-level affordance
Jiang, JL; Cameron, AF	2020	User reflection and action	Individual	Self	Noun	Mid-level affordance

Jung, YS; Lyytinen, K	2014	[Possibility for] parallel communication	Individual	Self	Noun	Technology use
Jung, YS; Lyytinen, K	2014	[Possibility for] reprocessible communication	Individual	Self	Noun	Technology use
Jung, YS; Lyytinen, K	2014	[Possibility for] secure and timely communication	Individual	Self	Noun	Technology use
Jung, YS; Lyytinen, K	2014	[Possibility for] successful online survey with high response rate	Individual	Self	Noun	Technology use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Browsing Others' Content	Individual	Self	Gerund	Technology feature use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Collaboration	Mid-level affordance	Self	Noun	Mid-level affordance
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Communication	Individual	Self	Noun	Technology feature use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Competition	Individual	Self	Noun	Mid-level affordance
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Content Sharing	Individual	Self	Gerund	Technology feature use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Group Management	Mid-level affordance	Self	Noun	Technology use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Interactivity	Individual	Self	Noun	Technology use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Presence Signaling	Individual	Self	Gerund	Technology feature use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Relationship Formation	Individual	Self	Noun	Mid-level affordance
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Self-presentation	Individual	Self	Noun	Technology use
Karahanna, E; Xu, SX; Xu, Y; Zhang, N	2018	Sourcing	Individual	Self	Gerund	Mid-level affordance
Krancher, O; Luther, P; Jost, M	2018	Reusing software services	Mid-level affordance	Organisation	Gerund	Technology use
Krancher, O; Luther, P; Jost, M	2018	Self-organizing	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Krancher, O; Luther, P; Jost, M	2018	Shaping environments	Mid-level affordance	Organisation	Gerund	Technology use

Krancher, O; Luther, P; Jost, M	2018	Triggering continuous feedback	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Lankton, NK; McKnight, DH; Tripp, J	2015	Animation	N/A	Self	Noun	Technology feature
Lankton, NK; McKnight, DH; Tripp, J	2015	Dynamism	N/A	Self	Noun	Technology property
Lankton, NK; McKnight, DH; Tripp, J	2015	Interpersonal communication	Mid-level affordance	Self	Noun	Technology feature use
Lankton, NK; McKnight, DH; Tripp, J	2015	Responsiveness	N/A	Self	Noun	Technology property
Lee, ZWY; Cheung, CMK; Chan, TKH	2021	Achievement affordance	Individual	Self	Noun	Mid-level affordance
Lee, ZWY; Cheung, CMK; Chan, TKH	2021	Immersion affordance	Individual	Self	Noun	Mid-level affordance
Lee, ZWY; Cheung, CMK; Chan, TKH	2021	Social affordance	Individual	Self	Noun	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Acquiring insight on new processes, products and services for management	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Acquiring Insights on New Products/ Services	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Acquiring New Job Skills	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Acquiring new technology skills	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Broadening perspective	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Building Relationships with Peers	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Building Relationships with Superiors	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Demonstrating Leadership	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Finding Resources	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Helping Peers	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Interacting with Peers	Individual	Self	Gerund	Mid-level affordance

Leidner, DE; Gonzalez, E; Koch, H	2018	Interacting with Superiors	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Participating in OnBoard Events	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Socializing	Individual	Self	Gerund	Mid-level affordance
Leidner, DE; Gonzalez, E; Koch, H	2018	Taking a Break	Individual	Self	Gerund	Mid-level affordance
Leonardi, PM	2011	[Allows engineers to] coordinate analyses of models	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Leonardi, PM	2011	[Provides capability to] automate standards	Mid-level affordance	Organisation	Infinitive	Technology use
Leonardi, PM; Bailey, DE; Pierce, CS	2019	Asynchronicity and electronic transfer	Mid-level affordance	Organisation	Noun	Technology use
Leonardi, PM; Bailey, DE; Pierce, CS	2019	Choice delineation	Mid-level affordance	Organisation	Noun	Mid-level affordance
Leonardi, PM; Bailey, DE; Pierce, CS	2019	Exemplification	Mid-level affordance	Organisation	Noun	Technology use
Leonardi, PM; Bailey, DE; Pierce, CS	2019	Explanation	Mid-level affordance	Organisation	Noun	Technology use
Leonardi, PM; Bailey, DE; Pierce, CS	2019	Identification and location	Mid-level affordance	Organisation	Noun	Technology use
Leonardi, PM; Bailey, DE; Pierce, CS	2019	Indexicality	Mid-level affordance	Organisation	Possibility	Technology use
Leonardi, PM; Bailey, DE; Pierce, CS	2019	Visualization	Mid-level affordance	Organisation	Noun	Technology use
Li, XX; Rai, A; Ganapathy, K	2020	Patient satisfaction with teleconsultation	N/A	N/A	Noun	Mislabelled
Li, XX; Rai, A; Ganapathy, K	2020	Patient-perceived media richness	N/A	N/A	Noun	Mislabelled
Li, XX; Rai, A; Ganapathy, K	2020	Physician-patient communication	Mid-level affordance	Self	Noun	Technology use
Majchrzak, A; Wagner, C; Yates, D	2017	Shaping	Mid-level affordance	Community	Gerund	Technology use
McKenna, B	2020	Add-ons	Individual	Self	Noun	Technology feature
McKenna, B	2020	Allowing members to leave a guild	Individual	Self	Gerund	Technology feature use
McKenna, B	2020	Character movement	Individual	Self	Noun	Technology feature use
McKenna, B	2020	Guilds	Individual	Self	Noun	Technology feature

McKenna, B	2020	Membership	Individual	Self	Noun	Technology feature
McKenna, B	2020	Questioning affordance	Individual	Self	Gerund	Technology feature use
McKenna, B	2020	The affordance of a virtual space	Individual	Self	Noun	Technology feature use
Mettler, T; Wulf, J	2019	[Action potential to] better adapt to the work environment	Mid-level affordance	Self	Infinitive	Mid-level affordance
Mettler, T; Wulf, J	2019	[Action potential to] improve awareness and cognition	Individual	Self	Infinitive	Mid-level affordance
Mettler, T; Wulf, J	2019	[Action potential to] improve workplace security	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Mettler, T; Wulf, J	2019	[Action potential to] signal adherence to group norms and values	Individual	Self	Infinitive	Mid-level affordance
Nan, N; Lu, Y	2014	Assembling	Individual	Self	Gerund	Technology use
Nan, N; Lu, Y	2014	Associating	Individual	Self	Gerund	Technology use
Nan, N; Lu, Y	2014	Metavoicing	Individual	Self	Gerund	Technology use
Nan, N; Lu, Y	2014	Verifying	Individual	Self	Gerund	Technology use
Pan, SL; Li, MW; Pee, LG; Sandeep, MS	2020	Assess wildlife distribution	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Pan, SL; Li, MW; Pee, LG; Sandeep, MS	2020	Assess wildlife population size	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Pan, SL; Li, MW; Pee, LG; Sandeep, MS	2020	Identify threats of human-wildlife conflict on wildlife	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Pan, SL; Li, MW; Pee, LG; Sandeep, MS	2020	Identify threats of poaching on wildlife	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Pan, SL; Li, MW; Pee, LG; Sandeep, MS	2020	Locate the best sites for camera traps	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Pan, SL; Li, MW; Pee, LG; Sandeep, MS	2020	Optimise the patrol routes	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Piccoli, G	2016	Triggered essential reviewing	Individual	Community	Gerund	Technology use
Porter, AJ; van den Hooff, B	2020	Auditable performance information	Individual	Organisation	Noun	Mid-level affordance
Porter, AJ; van den Hooff, B	2020	Automation of sales information	Individual	Organisation	Noun	Technology use
Porter, AJ; van den Hooff, B	2020	Real-time access/visibility of sales information	Individual	Organisation	Noun	Technology use
Saebo, O; Federici, T; Braccini, AM	2020	(De)structuring the community	Mid-level affordance	Organisation	Gerund	Mid-level affordance

Saebo, O; Federici, T; Braccini, AM	2020	Adapting rules and processes	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Saebo, O; Federici, T; Braccini, AM	2020	Circulating information	Individual	Organisation	Gerund	Technology use
Saebo, O; Federici, T; Braccini, AM	2020	Connecting members	Individual	Self	Gerund	Technology use
Saebo, O; Federici, T; Braccini, AM	2020	Crossing boundaries	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Saebo, O; Federici, T; Braccini, AM	2020	Delimiting actions	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Saebo, O; Federici, T; Braccini, AM	2020	Making decisions collectively	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Saebo, O; Federici, T; Braccini, AM	2020	Triggering actions	Individual	Organisation	Gerund	Mid-level affordance
Saebo, O; Federici, T; Braccini, AM	2020	Ubiquitous acting	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Seidel, S; Kruse, LC; Szekely, N; Gau, M; Stieger, D	2018	Noticing and bracketing labelling and categorising	Mid-level affordance	Self	Gerund	Mid-level affordance
Seidel, S; Kruse, LC; Szekely, N; Gau, M; Stieger, D	2018	Open and inclusive communication	Mid-level affordance	Self	Noun	Technology use
Seidel, S; Kruse, LC; Szekely, N; Gau, M; Stieger, D	2018	Presumptive disclosure and action planning	Mid-level affordance	Self	Noun	Mid-level affordance
Seidel, S; Kruse, LC; Szekely, N; Gau, M; Stieger, D	2018	Triggering disruptive ambiguity and surprise	Mid-level affordance	Self	Gerund	Mid-level affordance
Seidel, S; Recker, J; vom Brocke, J	2013	Delocalization	Mid-level affordance	Self	Noun	Higher-level category
Seidel, S; Recker, J; vom Brocke, J	2013	Information democratization [for organizations]	Mid-level affordance	Organisation	Noun	Mid-level affordance
Seidel, S; Recker, J; vom Brocke, J	2013	Output management	Mid-level affordance	Organisation	Noun	Higher-level category
Seidel, S; Recker, J; vom Brocke, J	2013	Reflective disclosure	Mid-level affordance	Self	Noun	Higher-level category
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Amplify Reality	Individual	Self	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO;	2019	Coordination	Mid-level affordance	Organisation	Noun	Mid-level affordance

Jenkins, JL; Wolman, I						
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Create aspects that do not exist in the physical world	Mid-level affordance	General	Infinitive	Technology use
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Depict the Nonexistent	Individual	General	Infinitive	Technology use
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Diminish negative aspects of physical world	Individual	Self	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Enable Physically Incapable Participants	Individual	Self	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Enhance positive aspects of the physical world	Individual	Self	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Enhanced Computing	Individual	Self	Gerund	Technology use
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Facilitate Additional Information	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Filter Information	Individual	Self	Infinitive	Technology use
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Increase Empathy	Individual	3rd party	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Mobile Computing	Individual	Self	Gerund	Technology use
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Overcome Space-time Linearity	Individual	General	Infinitive	Mid-level affordance

Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Physical Interaction with Digital Objects	Individual	Self	Noun	Technology use
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Recreate existing aspects of the physical world	Individual	Self	Infinitive	Technology use
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Reduce Emotional/Mental Risk	Individual	Self	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Reduce Physical Risk	Individual	Self	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Reduce Resource Cost	Mid-level affordance	Organisation	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Training	Individual	3rd party	Gerund	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Understand Proximal Positioning	Individual	3rd party	Infinitive	Mid-level affordance
Steffen, JH; Gaskin, JE; Meservy, TO; Jenkins, JL; Wolman, I	2019	Video-logging	Individual	Self	Gerund	Technology use
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I; Trudel, J; Garber, L	2014	Accessing and using patient information anytime from anywhere	Individual	Organisation	Gerund	Technology use
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I; Trudel, J; Garber, L	2014	Capturing and archiving digital data about patients	Individual	Organisation	Gerund	Technology feature use
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I;	2014	Coordinating care	Mid-level affordance	Organisation	Gerund	Mid-level affordance

Trudel, J; Garber, L						
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I; Trudel, J; Garber, L	2014	Incorporating rich information into clinical decision making	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I; Trudel, J; Garber, L	2014	Monitoring organizational operations	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I; Trudel, J; Garber, L	2014	Shifting work across roles	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I; Trudel, J; Garber, L	2014	Standardizing data, processes, and roles	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Strong, DM; Volkoff, O; Johnson, SA; Pelletier, LR; Tulu, B; Bar-On, I; Trudel, J; Garber, L	2014	Substituting healthcare professionals for each other	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Thapa, D; Sein, MK	2018	Educability [tele-education]	Mid-level affordance	3rd party	Possibility	Mid-level affordance
Thapa, D; Sein, MK	2018	Virtual co-localisability	Mid-level affordance	Community	Possibility	Technology use
Thapa, D; Sein, MK	2018	Volunteerability	Individual	Community	Possibility	Mid-level affordance
Tim, Y; Pan, SL; Bahri, S; Fauzi, A	2018	Emergent organizing	Mid-level affordance	Community	Gerund	Mid-level affordance
Tim, Y; Pan, SL; Bahri, S; Fauzi, A	2018	Information democratization [for communities]	Mid-level affordance	Community	Noun	Mid-level affordance
Van Osch, W; Steinfield, CW	2016	Generative Role-Taking	Individual	Self	Gerund	Technology use
Van Osch, W; Steinfield, CW	2016	Network-informed associating	Mid-level affordance	Self	Gerund	Mid-level affordance
Van Osch, W; Steinfield, CW	2016	Triggered attending	Individual	Self	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Accessing cross-functional, global, and historical information in real-time	Mid-level affordance	Self	Gerund	Technology use

Volkoff, O; Strong, DM	2013	Analyzing and evaluating solver outputs to improve design approaches	Individual	Organisation	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Communicating with engineering clients	Individual	Self	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Comparing multiple iterations of model tests	Individual	Organisation	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Consulting more easily with other engineers	Individual	Self	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Controlling which individuals can perform each transaction	Mid-level affordance	Organisation	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Exercising real-time control over processes and outcomes using real-time data about organizational operations	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Generating output reports from the solver output	Individual	Organisation	Gerund	Technology feature use
Volkoff, O; Strong, DM	2013	Guiding and constraining how work is done	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Integrating processes and data	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Making decisions using cross-functional, global information	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Monitoring organizational operations across boundaries	Individual	Organisation	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Performing "all" work through a single system	Mid-level affordance	Organisation	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Recording data associated with performing transactions	Individual	Self	Gerund	Technology feature use
Volkoff, O; Strong, DM	2013	Setting up models for automated analysis by the solver	Mid-level affordance	Organisation	Gerund	Technology use
Volkoff, O; Strong, DM	2013	Sharing work	Individual	Organisation	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Standardizing model setup routines	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Standardizing output of post-processors	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Volkoff, O; Strong, DM	2013	Standardizing processes and data	Mid-level affordance	Organisation	Gerund	Mid-level affordance
von Krogh, G; Haefliger, S	2010	Adaptability	Mid-level affordance	Organisation	Possibility	Technology property
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Ad-hoc information exchange	Individual	Self	Noun	Workplace environmental affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Ad-hoc problem solving	Individual	Self	Gerund	Workplace environmental affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Enabling face-to-face communication	Individual	Self	Gerund	Workplace environmental affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Enabling online conversations	Individual	Self	Gerund	Technology use

Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Enabling technology- mediated communication	Individual	Self	Gerund	Technology use
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Explaining problems faced	Individual	Self	Gerund	Mid-level affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Problem solving	Individual	Self	Gerund	Mid-level affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Reaching out virtually	Individual	Self	Gerund	Technology use
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Sharing and consuming food and drinks	Individual	Self	Gerund	Workplace environmental affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Sharing knowledge artefact	Individual	Self	Gerund	Mid-level affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Socialising [Workplace environmental affordance]	Individual	Self	Gerund	Workplace environmental affordance
Waizenegger, L; McKenna, B; Cai, WJ; Bendz, T	2020	Viewing knowledge artefact	Individual	Self	Gerund	Workplace environmental affordance
Zheng, YQ; Yu, A	2016	Agenda setting	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Zheng, YQ; Yu, A	2016	Distributed collaboration	Mid-level affordance	Organisation	Noun	Mid-level affordance
Zheng, YQ; Yu, A	2016	Enacting public scrutiny	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Zheng, YQ; Yu, A	2016	Enforcing transparency	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Zheng, YQ; Yu, A	2016	Enhancing accountability	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Zheng, YQ; Yu, A	2016	Enrolling participant	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Zheng, YQ; Yu, A	2016	Framing	Mid-level affordance	Organisation	Gerund	Mid-level affordance
Zheng, YQ; Yu, A	2016	Mobilising resources	Mid-level affordance	Organisation	Gerund	Mid-level affordance

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Investigating Mid-level IT Affordances as Drivers for Societal Change: Addressing the Education Data Challenge in The Gambia

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Abstract. Affordance perspectives have gained traction among information systems (IS) scholars and have seen recent adoption in ICT4D research. Although scholars recognize the need to differentiate between mere technology use and higher-level organizational and societal IT affordances, no clear terminology for the representation of affordance granularity exists. This paper introduces “mid-level IT affordances”, which, we argue, emerge from technology use and serve as prerequisites for the actualization of higher-level affordances. To illustrate, we draw on a case study of education management information systems in The Gambia. International development agendas encourage public sector actors to produce increasingly granular data. Yet, the capacity to utilize the data is not strengthened correspondingly. This introduces a disconnect between policy and practice, whereby investments in technology use affordances fail to translate into IT affordances for monitoring progress towards complex policy goals. A mid-level IT affordance perspective allows for the identification and potential mitigation of such gaps.

Keywords: Mid-level IT affordances · Education management · SDGs

1 Introduction

A theoretical challenge identified by information systems (IS) scholars pertains to the level of granularity of affordances. DeSanctis and Poole [1] introduce the term “repeating decomposition problem”, pointing at the fact that “there are features within features (e.g., options within software options) and contingencies within contingencies (e.g., tasks within tasks)” and raise the question, “how far must the analysis go to bring consistent, meaningful results?” (p. 124). To date, there is no clear consensus on how best to conceptualize the aggregation of affordances from “simple” (e.g., tagging [2]; inputting data [3]; searching [4]) to more complex composite affordances at the organizational and societal level (e.g., clinical decision-making [3]; developing concepts [4]; organizational memory affordance [5]; Enhancing Knowledgeability and Autonomy [6]). Accounting for the intricate relationship between technology use and its implications for social

development is at the heart of the ICT4D research agenda. Further development of an affordance perspective is promising in this regard.

Technology is not a panacea for development [7, p. 12]. Yet, the development landscape is fraught with ICT interventions to improve the lives of the world's poor (e.g., [8]). Faik et al. [6] point out that there is limited attention to “how [societal consequences] emerge from the development, deployment, or use of IT” (p. 1361). To this end, the authors attempt to develop an analysis that ties IT use affordances directly to societal changes. Inspired by this recent work, we argue that the recognition of “mid-level IT affordances” allows us to trace and account for the action possibilities that emerge from basic technology use (lower-level affordances). In turn, we argue, “mid-level IT affordances” are constitutive of higher-level affordances that are associated with social development, such as improved health and wellbeing of populations or equitable access to quality education.

This study reports from the Gambian education sector, where the Ministry of Basic and Secondary Education (MoBSE) has engaged in an “Education Management Information Systems shift”, a stepwise digitization initiative, that entails the transition from reliance on surveys and aggregate statistics to individual learner records. Until recently, the EMIS was an aggregated and paper-based data system, managed at the national level and characterized by fragmented data [9, p. 129]. The existing information system could not explain why learning outcomes in the country remained low while the proportion of qualified teachers increased. More recently, it could not respond to information needs regarding the effect of school closures during the Covid-19 pandemic, nor guide interventions to alleviate the situation for out of school learners.

MoBSE, like many other ministries of education, were unable to produce data to monitor progress towards some of the key Sustainable Development Goals (SDGs), which aim to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” [10]. This includes ensuring “equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations”. Consequently, “data needs to be disaggregated by gender, location, wealth quintile and other factors” [11, p. 9]. This necessitates processing of individual learner data. MoBSE experienced a policy-practice gap, whereby national and international policies called for increasingly granular data, while the education system's capacity to record, interpret and utilize the data for local action remained scarce.

This paper draws on and extends an affordance perspective [12], to explore the action possibilities the “EMIS Shift” affords education management in The Gambia. Our main contribution is the introduction of “mid-level IT affordances” to IT affordance research. An affordance perspective allows us to study action possibilities associated with IT adoption, implementation and use at an organizational “mid-level” (e.g., [13–17]). In ICT4D research, affordance perspectives are hitherto underutilized, although there are recent promising examples (e.g., [18–20]). A widely adopted definition of affordances in IS research, is that an affordance is “the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an artifact and a goal-oriented actor or actors” [16, p. 69, 17, p. 823].

In this paper, we map the interdependence between “simple”, or lower-level, technology feature use affordances (e.g., inputting data) to mid-level affordances (i.e., organizational IT capabilities) such as *decentralizing data access*. Finally, we relate these mid-level affordances to higher-level affordances, which afford the education sector in The Gambia the ability to *monitor progress* towards the SDGs and national policy goals (i.e., societal changes [6]). The structure of the paper is as follows. In the next section, we provide an overview of relevant IT affordance literature. Next, we present our method. In Sect. 4 we present our empirical case and discuss the case findings before we in Sect. 5 consider how the Gambian EMIS case underscores the importance of understanding the composite, interdependent, and delicate nature of IT affordance realization in public sector organizations in the Global South.

2 IT Affordances at Different Levels of Granularity

Gibson [21, 22] first introduced the concept of affordances to the field of evolutionary psychology while arguing that animals do not perceive the objects’ physical properties, but rather what objects can provide: “The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill” [22, p. 127]. A shelter affords sheltering to animals, and a knife affords cutting to people. Since different actors have different capabilities, affordances are not the same for all actors. For instance, stairs afford climbing to most people, but not to infants or people with certain disabilities. While affordances can be easy to perceive and actualize for “simple” objects (e.g., a knife), the application of AT to the IS field has proven difficult. In an organizational context, a complex information system affords a plethora of different action possibilities to an array of different actors.

Markus and Silver [23] warn that repeating decomposition of IT feature usage might pose analytical challenges and suggest to “hypothesize that the system as a whole, rather than one or more component parts, provides an affordance” (p. 628). Nonetheless, a complex information system in an organization setting affords a number of desirable action possibilities that somehow needs to be perceived and realized by organizational actors. Gutek et al. [24] notes that most computer systems are really “sets of loosely bundled capabilities and can be implemented in many different ways” (p. 234, as cited in DeSanctis & Poole [1, p. 126]). Leidner et al. [14] urge researchers to look beyond mere technology use, while Volkoff and Strong [25] highlight that researchers should study affordances at an appropriate level of granularity. To date, there is no clear guidance on how to identify and label such different granularity levels of IT affordances. This is needed, we hold, to study the relationship between changing IT use affordances and societal development and to generate a coherent body of knowledge.

2.1 Towards an Ensemble View of IT Affordances

The decomposability of affordances has given rise to several theoretical constructs in IS research. Strong et al. [16] illustrate affordances’ interdependency through the *affordance dependency diagram*. Similarly, Burton-Jones and Volkoff’s [3] *affordance network* explains how affordances are interrelated. Both these concepts allude to how the

actualization of an affordance can lead to the emergence of another affordance. Thapa and Sein [19] extend this line of reasoning and introduce the *trajectory of affordances*, that is, the trajectory along which affordances travel, “specifying the process and conditions through which affordances are perceived leading to actualisation of affordances” (p. 811). They also argue that affordances form *ensembles*. Interestingly, these notions all resemble ideas introduced by Gaver [26] more than two decades earlier: “Complex actions can be understood in terms of groups of affordances that are *sequential in time* [emphasis added] or *nested in space* [emphasis added]” (p. 79).

As an illustration of sequential affordances, Gaver [26] explains how a door handle affords turning *after* the grasping affordance (i.e., grasping the door handle) has been actualized. He distinguishes sequential affordance (in time) from nested affordances (in space), as he explains how the *door opening* affordance consists of the affordances *pulling the door handle* and *pulling the door*. Drawing on Gaver, Bernardi [27] refers to nested affordances as *composite affordances* and provides an example of how the *building a support network* affordance is a composite of the *self-presentation* and *narration* affordances. We have visualized Gaver’s ideas in Fig. 1, and in Fig. 2 we have replaced Gaver’s affordances with generic terms. This simple framework served as a starting point for our study of affordances in the Gambian EMIS Shift implementation.

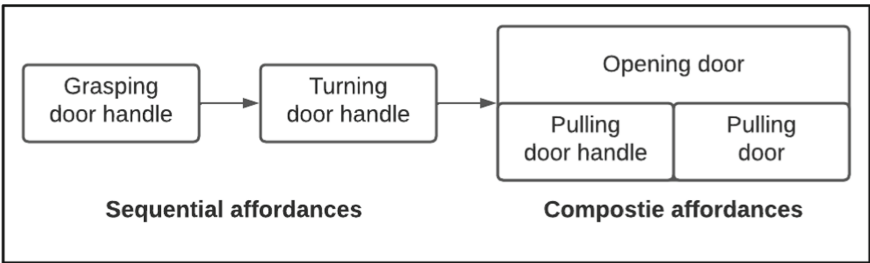


Fig. 1. Conceptual framework derived from Gaver [26], using Gaver’s affordances

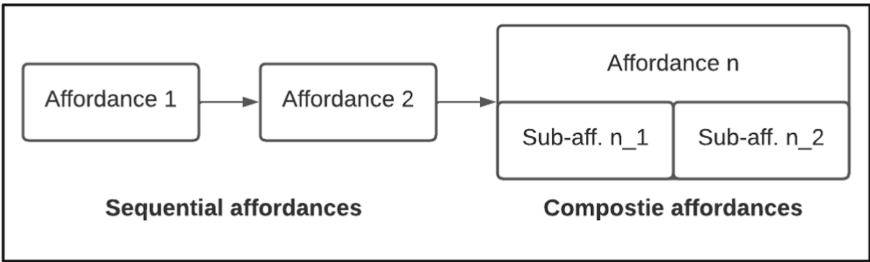


Fig. 2. Conceptual framework derived from Gaver [26], using generic terms

2.2 Gaps

Although IS scholars have shown that there is interdependency between affordances and that the IT affordances of most interest reside on a higher level of abstraction, there

is a gap in the literature on how to identify and characterize these affordances. Extant literature mentions lower and higher level (e.g., [3]), first- and second-order [14], and individual- and organizational-level [16] affordances. In this paper we introduce “mid-level IT affordances” to signify affordances that emerge as a consequence of technology use and are constitutive to the higher-level affordances.

In the following methods section, we describe the case context, and in the subsequent section we argue how IS scholars may investigate affordance interdependencies, by recognizing their *composite* and *sequential* nature, across three different levels of granularity (low, mid, and high).

3 Method

3.1 Case Background

This study reports from an ongoing research endeavor in The Gambia, coordinated by the Health Information Systems Programme (HISP) center at the University of Oslo. The Gambia, like many other ministries of health in low- and middle-income countries, has been using the open-source District Health Information Software 2 (DHIS2¹) as a nation-wide health management information system (HMIS) since 2010 [28] and is now expanding the usage of DHIS2 into the educational domain, implementing it as their national education management information system (EMIS). To meet the demand of individual data reporting, put forth by the SDG4 and national goals of improved learning outcomes across social stratifications, the need for an information system which could disaggregate data to individual level was identified. The positive experience from the health domain and the establishment of relevant in-country technical capacity resulted in the selection of DHIS2 as a backbone for the nationwide EMIS implementation. Despite its historical association with the public health sector, DHIS2 offers a set of generic data models and customizable modules that are deliberately domain agnostic. The on-going appropriation of DHIS2 to the education sector is driven by countries that already have developed a strong national capacity to utilize DHIS2 for health and wish to capitalize on this also in education.

As part of the digitalization initiative MoBSE has implemented DHIS2 as the backbone of its national EMIS. DHIS2 is a modular and complex digital platform system, consisting of a software core onto which new contents, applications or services can be developed. The development and implementation of such compliments are facilitated by DHIS2’s software development kits, design systems, documentation and open application programming interfaces (APIs). To utilize the flexibility of DHIS2, MoBSE in The Gambia needs to obtain local capacity to configure and customize existing DHIS2 modules and develop and maintain complimentary applications when necessary.

3.2 Data Collection and Analysis

Through field trips, interviews, and recurrent biweekly online meetings with representatives from MoBSE, the authors have continuously engaged with the Gambian implementation of DHIS2-EMIS over a period of 16 months. We reviewed relevant official

¹ <https://dhis2.org/>.

Table 1. Data sources

Data source	Type
Education Sector Strategic Plan 2016-2030 [9]	Official Gambian government publication
The shift from aggregate to individual-level data system in the case of The Gambia EMIS (Internal project document)	PhD Proposal to the University of Oslo by a MoBSE employee
Meeting the global learning crisis with data: a research agenda on digital platforms for education management [29]	Research opinion article (manuscript in preparation)
Information system centralization and decentralization: The introduction of digital learner records in The Gambia [30]	Conference article (manuscript in preparation)
17 Bi-weekly EMIS status and update meeting Participants: • The EMIS project manager (HISP center) • 3 scientific staff (HISP center, including second author) • 1 PhD Research fellow (first author) • Representatives from national EMIS implementations ◦ The Gambia (2) ◦ Uganda (4) ◦ Mozambique (1) ◦ Sri Lanka (1) ◦ Togo (2)	Recurrent meeting with local stakeholders for EMIS implementations in The Gambia, Uganda, Mozambique, Sri Lanka, and Togo
20 Bi-weekly EMIS project coordination meeting Participants: • The EMIS project management team ◦ The EMIS project manager ◦ 1 Professor ◦ 1 Associate professor (second author) ◦ 1 Senior engineer • 1 PhD Research fellow (first author)	Recurrent meeting for HISP's EMIS project management team at the HISP center (UiO)
18 Bi-weekly research meeting. Participants: • 3 scientific employees at the HISP center ◦ 1 Professor ◦ 2 Associate professors (including second author) • 3 PhD research fellows ◦ 1 MoBSE employee currently doing a PhD at UiO studying the Gambian <i>EMIS shift</i> towards individual data collection and reporting. ◦ 1 HISP Uganda employee involved in the expansion of DHIS2 from the health sector to the education sector. Doing a PhD studying disaggregation of decision-making in the Ugandan education sector. ◦ 1 PhD research fellow at the HISP center, studying the implementation of DHIS2-EMIS in The Gambia and Uganda (first author).	Recurrent meeting among PhD research fellows studying EMIS implementations in The Gambia and Uganda
6 interviews of employees at different levels of the educational system in The Gambia. The average interview duration was approximately 30 minutes.	Semi-structured interviews. Snowballing used to identify interviewees.

documents to further contextualize the case study. Table 1 gives an overview of the data sources. We identified a set of affordances related to the ongoing DHIS2-EMIS implementation and organized these into themes, with the help of the conceptual framework we derived from Gaver's [26] work (Fig. 2). This allowed us to engage with the clustered and sequential nature of the identified affordances and explore the interdependencies between lower- and higher-level affordances. Our analyses revealed the need for a terminology that can describe affordances that are neither basic lower-level affordances nor very abstract higher-level affordances. Hence, we introduce the notion of "mid-level affordances" to bridge this gap.

4 Case Description

4.1 Configuring DHIS2 for Education Management

DHIS2 is an open-source management information software platform, used by 73 ministries of health [31] and six ministries of education [32]. DHIS2 development is coordinated by the HISP center at the University of Oslo. HISP is a research and implementation network, with 15 recognized HISP groups around the world and numerous other contributors. Recently, DHIS2 has been adopted in several new domains, such as agriculture, road safety, logistics management, and education management [33]. For more than a decade, The Gambia has been using DHIS2 as an HMIS. The Ministry of Basic and Secondary Education (MoBSE) have since 2019 adopted DHIS2 as a backbone for its EMIS. DHIS2 can be used for both individual records keeping and aggregate data collection and analysis. MoBSE wishes to leverage DHIS2 to meet EMIS requirements put forth by the SDG4 and national goals of improved learning outcomes across social stratifications.

DHIS2 is a rather complex piece of software, with a platform architecture. This grants local design flexibility, for those who have the necessary capacity to configure DHIS2's "bundled applications" or develop platform extensions themselves. A freshly installed instance of DHIS2 requires configuration in terms of setting up organizational hierarchies and creating data elements and indicators which data collectors will report against and analysts will monitor. By taking advantage of DHIS2's software development kits, APIs, design tools and documentation it is possible to create software extensions or applications that can be loosely integrated with the platform core. These apps can also be uploaded to the DHIS2 App Hub, which makes them available for other user organizations to download and install on their DHIS2 instances.

Since DHIS2 is open source, the entire source code can be modified by anyone with the right skill sets. However, as the DHIS2 core is maintained and governed by HISP at the University of Oslo (HISP UiO), actors with core software requirements engage with the HISP UiO development team to have their requirements recognized in the DHIS2 roadmap. Through two decades of north-south-south university collaborations, a large network of experts has emerged to cater for public sector DHIS2 implementation needs. Implementations are often organized as participatory co-creation projects involving HISP UiO, a local regional or national HISP group and a ministerial department as partners. In addition to knowledge sharing through projects, there are formalized training structures referred to as DHIS2 Academies as well as a vibrant online community of practice, where local problem owners can find advice and support from experienced members of the community.

4.2 Gambian DHIS2-EMIS Configurations

Data Visibility at All Levels. DHIS2 affords education sector administrators the possibility of creating custom analytics dashboards and analysis tools using for example pivot tables, graphs, or maps. Nine members of the MoBSE national level team received training from HISP West and Central Africa (HISP WCA) on how to configure relevant thematic dashboards and analysis tools. The national team can now design their own

thematic dashboards and share these with users at sub-levels. Ideally, given sufficient organizational capacity, each organizational level could be trained to develop custom dashboards for the level below themselves in the hierarchy. Hence, the national level would make dashboards for the regions and the regional offices would make dashboards for schools in their regions. Furthermore, each level can make their own dashboards or adjust the dashboards received from a higher level to account for local priorities and circumstances. Given sufficient training in software configuration and data analysis, each school can visualize its own data and inspect relevant indicators for their own planning and management (e.g., teacher and student attendance, dropout, and completion rates by relevant group disaggregations, etc.). Similarly, cluster monitors – school inspectors responsible for following up a cluster of schools within a region – have access to a different dashboard and analysis setup and can inspect school performance and reporting rates. At national level, MoBSE has access to all data in the system and has yet another dashboard and data visualization setup to be able to monitor broad trends and evaluate national education sector programs. Figure 3 provides an example of a DHIS2-EMIS dashboard.

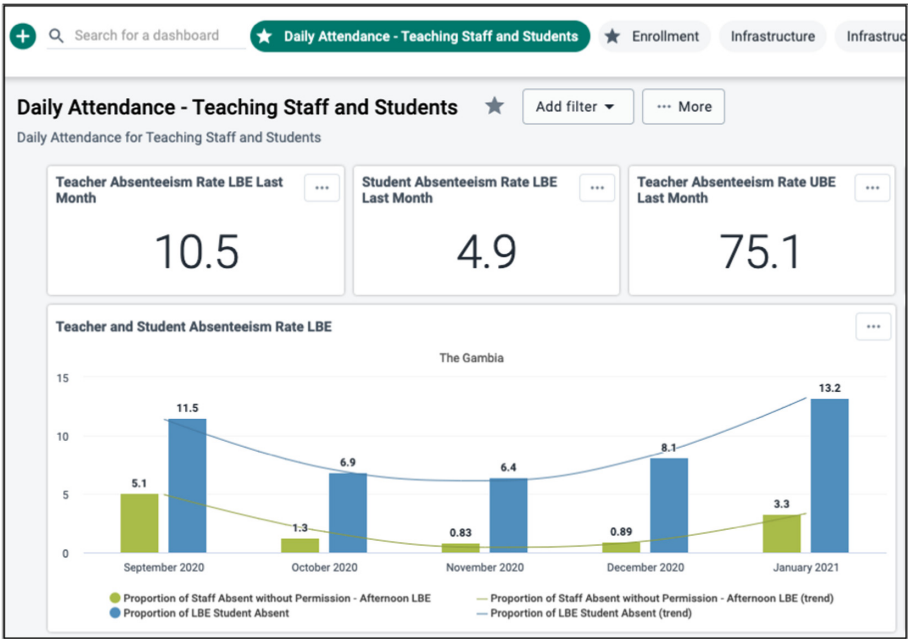


Fig. 3. DHIS2-EMIS dashboard showing daily attendance trend in lower basic education (LBE) units in The Gambia. Demo data may not correlate with actual figures.

Data Disaggregation. MoBSE in The Gambia decided to redesign its EMIS, which was essentially based on Microsoft Excel, Access databases and paper-based data collection tools, in order to cater for the novel socio-economic disaggregation requirements of education data. Internally, this process has been called the “EMIS shift”, as it entails

a shift from handling purely aggregated data (statistics) to also maintaining individual learner records.

MoBSE perceived the possibility of using DHIS2's Tracker module - a generic module for capturing data over time about any type of tracked entity - to capture and store educational data on individuals. The Tracker module is used in public health implementations of DHIS2 to store medical information on patients from their recurring visits to a clinic or to record data about trajectories of blood samples or health commodities. The module supports storing (constant) information about the tracked entity as well as data that varies over time. Thus, MoBSE decided to use the Tracker module to collect and store socio-economic data, attendance history, and continuous assessment data about learners.

Exploiting the design flexibility of DHIS2, MoBSE, in collaboration with HISP WCA, configured individual learner modules to be able to follow-up individual students. The modules were designed through participatory methods where HISP WCA first engaged in capacity building workshops in order to inform MoBSE about the different design possibilities. In the configured modules, MoBSE captures the learners' socio-economic data, attendance history, continuous assessment, and disciplinary record. During 2020, MoBSE implemented individual learner admission and registration by employing a combination of DHIS2, mobile data traffic, and Chromebooks in 200 schools. The technical resources from the initial phase were further leveraged to collect and register students throughout public schools in the entire country. Beyond individual record keeping, the individual data can be anonymized and aggregated to provide useful information for secondary administrative use.

Digitized School Report Card. The Gambian school report card (SRC) is a school-level information product intended to promote community participation and increase accountability and transparency. The tool highlights priority areas for the coming year and informs the preparation of school improvement plans. In 2008, the first version of the SRC was created. Although there have been challenges using the SRC, it has been widely recognized and embedded in the country's EMIS practice. A limitation of the initial version was that sub-national levels could not access the data directly and had to wait for distributed printouts from the central level. This hindered broad engagement from regional officers, head teachers, parents, and community representatives in a timely manner. Furthermore, despite the focus on simplicity and visual guidance in designing the SRC, evaluations revealed challenges associated with interpretation of results.

By taking advantage of DHIS2's API, MoBSE, in collaboration with HISP WCA, and three informatics master students from UiO, developed a new web-application of the SRC - a DHIS2 addon - which could be integrated into the Gambian DHIS2-EMIS instance. Consequently, SRC data access can be granted to DHIS2-EMIS users and has allowed for decentralized access and improved availability and use. To support local use of the SRC, the web-application features a printer friendly version that can be printed at schools or nearby printing facilities. Figure 4 shows the remodeled SRC in DHIS2-EMIS.

5 Discussion

5.1 Granularity Levels

Volkoff and Strong [25, p. 241] argue the importance of selecting “an appropriate level(s) of granularity for the affordances”. They point out that Strong et al.’s [16] widely accepted definition of IT affordances does not say anything about which granularity level is appropriate. Affordances can be decomposed to lower-level affordances and aggregated to higher-level affordances. To examine how DHIS2-EMIS affords informed decision-making that puts the Gambian education system on track to improve learning outcomes and social inclusion, it follows that the most relevant granularity level is at the level of the organization.

A problem with studying affordances at the organizational level (mid- or higher-level affordance), however, is the difficulty of distinguishing the affordance itself from its outcome, when the affordance is actualized. Volkoff and Strong give an example of *visibility*, which several researchers have identified as an affordance (e.g., [34–37]). Visibility, in itself, is not an affordance but “a state, and masks the associated actions – and even the actor” [25, p. 242]. In the following we address this concern and argue that an organizational affordance, or action possibility, emerges from the actualization of an array of lower-level affordances. This view is consistent with IS researchers’ prior arguments regarding the decomposability of affordances (e.g., [23, 25]).

5.2 DHIS2-EMIS Affordances

The DHIS2 platform, implemented in The Gambia as an EMIS backbone, affords action possibilities to education sector stakeholders. The most “hands-on” affordances, such as *configuring* the readily installed instance, *developing* and *integrating* an addon application, or *rewriting* the source code are readily perceived. However, in the following

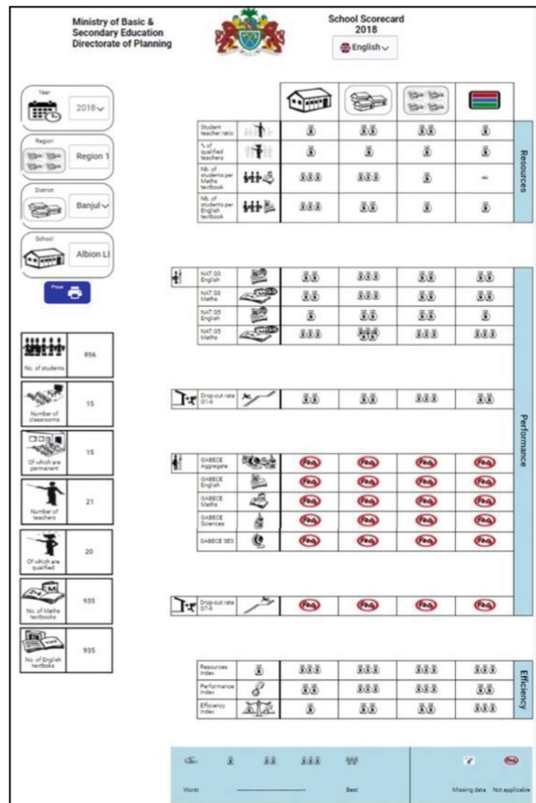


Fig. 4. The digitized school report card in the Gambian DHIS2-EMIS instance

subsections we argue that, at a higher level of granularity, *decentralizing data access*, *educational decision-making*, and *ensuring equal access to quality education* are three affordances that emerge in the relation between DHIS2 and goal-oriented education sector stakeholders in The Gambia. The following subsections relate to the case descriptions in Subsect. 4.2.

Educational Decision-Making. Extant IS literature points out how affordances are interdependent and that the actualization of one affordance can cause other affordances to emerge (e.g., [3, 16, 19]). Data-driven decision-making depends on the actualization of lower- and mid-level affordances. DHIS2 affords the possibility of *configuring dashboards and analysis tools*. A user can thus have a personalized dashboard layout presenting the data, indicators, and analysis of most interest and relevance. The configured dashboards and analysis tools afford the user the possibility of *visualizing and inspecting educational data* from the user's own level and related sublevels. The user can – usually in collaboration with others – *take informed decisions* regarding a school, a school cluster, a region, or the entire country. Figure 5 illustrates how the actualization of the lower-level affordance *configuring dashboards and analysis tools* leads to the emergence of the subsequent mid-level affordance *visualizing and inspecting education data* and the higher-level, more abstract, affordance *informed decision-making*. The arrows in the figure indicate causal-temporal dependencies. For instance, it is a prerequisite for the *informed decision-making* affordance that the two preceding affordances have been actualized.

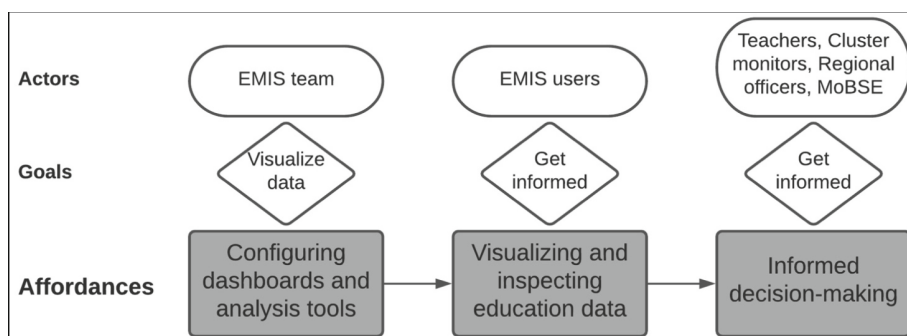


Fig. 5. Decision-making affordances

Decomposing Goals. Use of the DHIS2 Tracker module affords the possibility of *recording data on individuals*. When the EMIS contains individual data, teachers are afforded the possibility of *intervening in individual learner trajectories*. By following up the learners individually they enhance the possibility of *ensuring equal access to quality education*. Figure 6 illustrates how the actualization of the lower-level *recording data on individuals* affordance enables the mid-level affordance *intervening in individual trajectories* and the higher-level affordance *ensuring equal access to quality education*.

The *ensuring equal access to quality education* affordance can also be considered an ensemble affordance, as it both is dependent on and consists of the two preceding

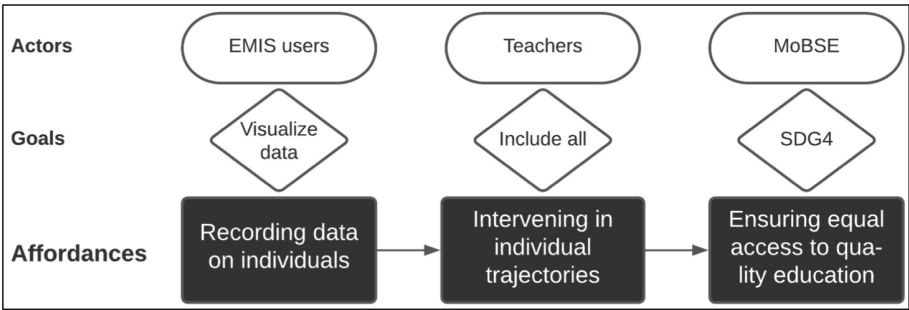


Fig. 6. Data disaggregation affordances

affordances of *recording data on individuals* and *intervening in individual trajectories* (Fig. 7). The affordance *ensuring equal access to quality education* cannot be actualized unless the two preceding affordances *recording data on individuals* and *intervening in individual trajectories* have been actualized. At the same time, *ensuring equal access to quality education* consists of the composite of the preceding affordances, as illustrated in Fig. 7.

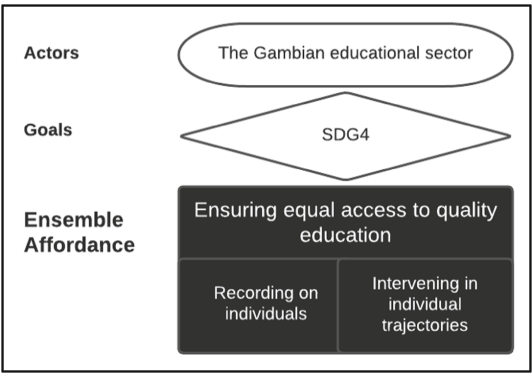


Fig. 7. Higher-level disaggregation affordance

Decentralizing Data Access – a Goal or an Affordance? Thapa and Sein [19] explain how multiple affordances can form an ensemble of affordances which together can be actualized in order to reach the ultimate goal. However, as pointed out by Volkoff and Strong [25], it can be difficult to distinguish an abstract affordance from the desired outcome (i.e., the goal). But does the goal necessarily have to be different from the affordance? Consider the digitized Gambian SRC. Figure 8 illustrates how the actualization of the *developing addon* affordance is a prerequisite for the *integrating addon* affordance. And once integrated, trained users can start *accessing the data* provided through the SRC app. There are of course other affordances at play, such as *quality data collecting* and *timely data inputting*, which are also necessary for the *accessing data* affordance to

emerge. The underlying affordances that constitute a higher-level affordance may need to be identified and examined whenever there is a breakdown or failure to realize the higher-level IT affordance. This is for example the case when stakeholders at the school level provide feedback that the available data is erroneous or misrepresents local reality. In this case, it is necessary to consider the *collecting data* affordance.

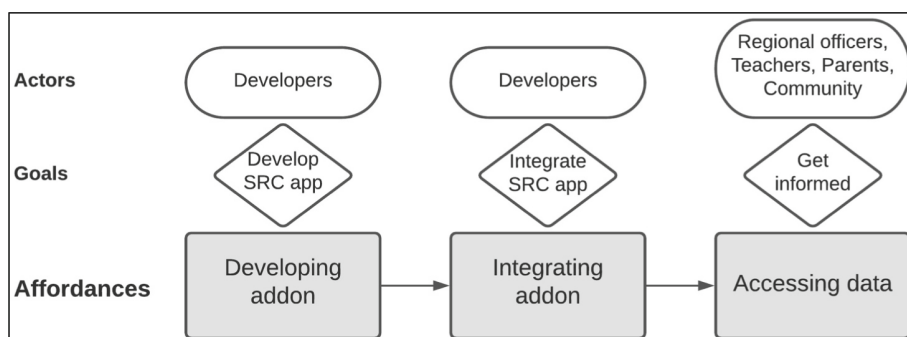


Fig. 8. SRC lower-level affordances

The three singular affordances illustrated in Fig. 8 form the composite affordance of *decentralizing data access* (Fig. 9). Just as Shaw and Bransford's [38, p. 42] example of the *eating* affordance being an ensemble of the biting, chewing and swallowing affordances, the *decentralizing data access* affordance is composed from the *developing addon*, *integrating addon* and *accessing data* affordances. While the singular affordances are lower-level technology use-affordances, the ensemble affordance is a mid-level affordance, which requires action from several actors to be actualized.

Through actualizing the three lower-level affordances, the *decentralizing data access* affordance is also actualized, and the "immediate concrete outcome" [16, p. 69] is decentralized data access, allowing local stakeholders to access data previously unavailable to them. In this case, the goal and outcome are somewhat indistinguishable from the affordance itself.

Extending the Conceptual Framework. In the framework derived from Gaver's [26] affordances, as illustrated in Fig. 2, sub-affordance n_1 and sub-affordance n_2 are actualized simultaneously (e.g., in Gaver's example, the human pulls the door while pulling the door handle). However, this is not necessarily the case. The findings in the preceding subsections show that a composite affordance can also consist of sequential sub-affordances, as indicated by Shaw and Bransford's eating affordance [38, p. 42]. For instance, the *ensuring equal access to quality education* affordance is a composite of the sequential affordances *recording on individuals* and *intervening in individual trajectories* (see Fig. 7). Thus, we have extended the conceptual framework we derived from Gaver's affordances to include sequential affordances in a composite affordance. In Fig. 10 the affordance m consists of three other affordances, one of which is also a composite affordance (n).

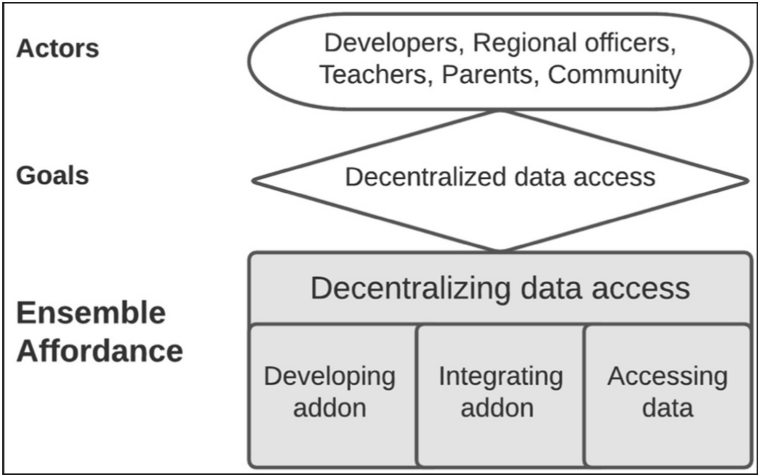


Fig. 9. SRC higher-level ensemble affordance

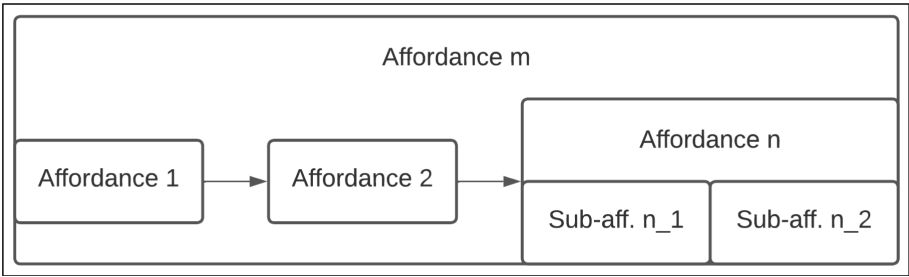


Fig. 10. Our extended conceptual framework

5.3 Choosing the Appropriate Level of Granularity

As seen from the Gambian examples, the design and use flexibility of the DHIS2 platform, matched with local capacity strengthening in both software configuration and data analysis, opens an array of action possibilities. However, it is not the direct technology use, exemplified by the lower-level affordances in this paper (e.g., developing and integrating addons, accessing data, recording data on individuals), that are the key affordances to understand. These lower-level affordances resemble the technology functionalities themselves and might appear indistinguishable from the functionalities. However, just as a knife affords humans the very basic cutting affordance [22, pp. 133, 137], developing addon, integrating addon, and accessing data should also be considered affordances. What we should be concerned with, is what use of technology in context affords, that is, what mid- and higher-level affordances emerge from the actualization of lower-level affordances to address real world problems. The mid- and higher-level

affordances identified in our case are *decentralizing data access, intervening in individual trajectories, ensuring equal access to quality education, visualizing and inspecting education data, and informed decision-making.*

5.4 Defining Granularity Levels

While technology certainly offers an opportunity for development, it is not a panacea for development [7, p. 12]. Our intention is not to say that technology drives development outcomes at a societal level, such as equitable access to education. Rather, our analysis highlights how mid- and higher-level affordances are composed from lower-level affordances. Hence, an understanding of affordances as action possibilities that are interdependent both temporally (sequence of affordances) and spatially (composite affordances) [3, 16, 19, 26] is necessary to understand when, in what way and for whom higher-level affordances become actualized, or not. Scholars studying IT affordances tend to distinguish between lower-level affordances (typically basic technology use) and abstract higher-level affordances emerging from lower-level affordances. However, in many cases, such as in the cases presented here, it is more revealing to identify and study the actualization of *mid-level* affordances.

5.5 Mid-level Affordances

Mid-level affordances are affordances on a granularity level between lower-level technology use affordances and abstract higher-level affordances. Similar to higher-level affordances, mid-level affordances do not denote direct technology use. However, we argue that they are more directly related to organizations’ technology use than the abstract

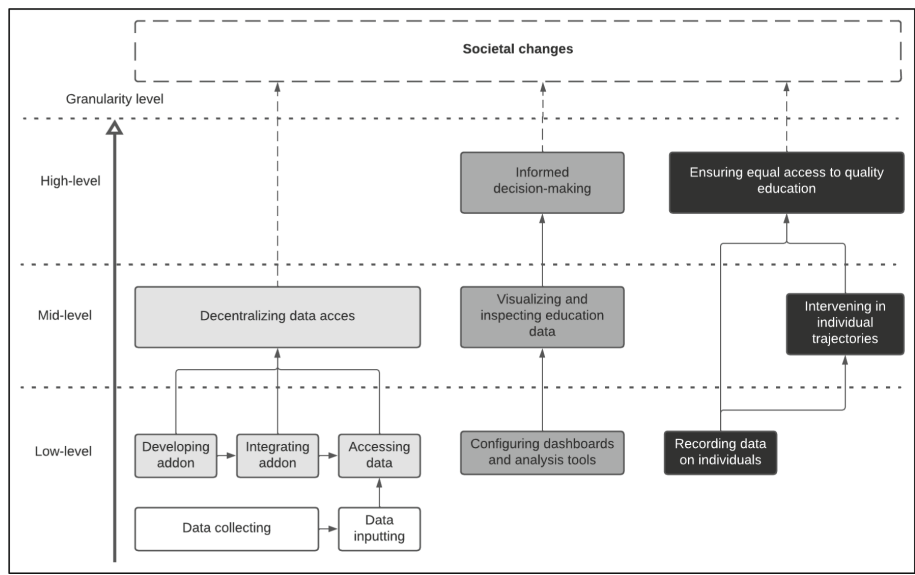


Fig. 11. Lower-, mid-, and higher-level DHIS2-EMIS affordances

higher-level affordances. Mid-level affordances emerge directly as a result of actualization of lower-level affordances in organizational contexts. Figure 11 illustrates how the affordances identified through the Gambian DHIS2-EMIS case study relate to the three granularity levels we have outlined. Mid-level IT affordances can be thought of as the perceived and realized action possibilities of what is often associated with organizational “IT capabilities” (e.g., [39, 40]) and in many studies are left as a black box.

6 Conclusion

EMIS stakeholders strive to identify and scale (desirable) action possibilities that may be actualized to produce value in local context. The actualization of the action possibilities in any local setting relies on a conducive interplay between technology, the capability of the enacting actor, and goal-oriented action. Both the affordance and the actor can be composites, in the sense that an affordance can emerge from an ensemble of lower-level affordances (e.g., the affordances *developing addon*, *integrating addon*, and *accessing data* constitute the *decentralizing data access* affordance), while enacting actors can be an individual, a group of individuals, an organization or a social movement with a shared aspiration. For practitioners, this means that higher-level shared goals (outcomes), such as the SDG4, needs to be aligned with contextual conditions as well as affordances that can be actualized in those contexts. When desirable affordances are not actualized, we can start to unpack the ensemble affordance to identify constitutive affordances that need to be actualized.

We believe a composite affordance perspective, which recognizes temporal and spatial interdependencies of IT affordances, is useful in bridging what we perceive to be a growing policy-practice divide in the education sector in low-income countries. International agendas, such as the SDGs put pressure on public sector services to produce an increasing amount of granular data, while the underlying structures that should produce and act on the data are not strengthened proportionately. Often, top-down and technology deterministic policy goals tend to inform too much emphasis on the lower-level affordances of technology use, such as enabling data collection and international reporting. These lower-level affordances are then expected to enable strides towards the actualization of lofty higher-level IT affordances such as ensuring equitable education, which in turn lie the foundation for societal development. However, this introduces the risk of underestimating the complexity and interdependency of mid-level organizational IT affordances. These affordances, often black-boxed in literature as organizational IT capabilities, are realized from a combination of lower-level affordances and are prerequisite to the actualization of higher-level affordances. Mid-level IT affordances, such as the ones identified in our case study, must be actualized across heterogenous socio-technical and political context to produce significant strides towards development outcomes at a societal level.

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RESEARCH ARTICLE

WILEY

Informing sustainable development in education: Identification and actualization of layered IS affordances

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Abstract

This paper reports from a qualitative case study in the Gambian education sector. The study applies an affordance perspective to the ongoing strengthening of the national education management information system. Our analysis distinguishes between micro-level technology-use affordances (e.g., civil servants using IT for data capture and reporting), meso-level information system (IS) affordances (e.g., data-driven decision making at the organizational level), and macro-level affordances, which include policy interventions to ensure the attainment of education sector goals. The contribution of the paper is twofold. First, the paper introduces a stepwise framework for IS affordance identification in terms of granularity levels (micro, meso and macro). Second, the paper outlines how use of IT at the micro-level allows for the actualization of meso-level IS affordances, which in turn serve as a foundation for the articulation of higher-level interventions. Far too often, ICT for development (ICT4D) projects focus on putting technology in the hands of users with the assumption that “better data” will drive development. The significant work involved in identifying and actualizing meso-level IS affordances is often not explicated and recognized in related plans and budgets. By highlighting meso-level IS affordance actualizations, the paper explicates the link between public sector IT adoption and use and intended societal-level impact, which remains a key policy and research concern.

KEYWORDS

affordance theory, education management information systems, meso-level IS affordances

1 | INTRODUCTION

This paper reports from a qualitative case study in the Gambian education sector. It applies an affordance perspective to highlight the role of information and communication technology (ICT) use in informing education sector interventions and monitoring progress toward national development goals, which include the Sustainable Development Goal 4 (SDG 4). The Gambian Ministry of Basic and Secondary Education (MoBSE) has launched an education management information system (EMIS) strengthening initiative, leveraging DHIS2¹ as its digitalization backbone. Developed and maintained by the ISP Center at the University of Oslo, DHIS2 has, since its inception in the early 90s, emerged as a digital global public good

A manuscript presenting the preliminary findings in this study has been published in a research-in-progress paper in the GlobDev Pre-ICIS 2022 Workshop proceedings (Valbø, 2022).

¹<https://dhis2.org/>

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software platform and is currently used as a foundational health management information system (HMIS) in more than 70 countries. The Gambia has used DHIS2 in the health sector since 2010. Motivated by success stories from the health sector in terms of health data availability and use, MoBSE, in 2019, embarked on a DHIS2-based EMIS implementation. A pertinent question, then, is what action possibilities does this proven digital platform from the health sector afford the education sector?

Affordance perspectives have grown in popularity in the information systems (IS) community. In IS research, affordances are considered action possibilities that arise in/from the relationship between an actor (or group of actors) and ICT (e.g., Volkoff & Strong, 2013). In addition to relying on the actor and the ICT, the actualization of an affordance also depends on the context in which the actor and the ICT are embedded, sometimes recognized in terms of facilitating conditions.

Information systems scholars have previously argued that affordances can be identified at different levels of granularity (Leidner et al., 2018; Strong et al., 2014; Volkoff & Strong, 2017). Furthermore, scholars hold that it is advisable to differentiate between lower-level and higher-level affordances. Lower-level affordances are related to direct technology use and can be readily observed and perceived. Higher-level affordances emerge as a result of the actualization of lower-level affordances. Affordances on a higher granularity level are arguably of greater interest to the study of information systems and organizational change, while lower-level affordances have been the key interest of human-computer interaction (HCI) scholars. Hence, Leidner et al. (2018) urge IS researchers to focus on affordances on a granularity level higher than mere technology-use. Along the same vein, Volkoff and Strong (2017) encourage IS researchers to identify and study affordances on an appropriate level of granularity. Yet, they offer no clear guidance to IS researchers on how to do so.

To account for affordances that emerge from organizational actors' interaction with organizational IT capabilities, rather than an individual's specific interactions with a particular technology feature, we introduce the notion of meso-level affordances as an affordance granularity level situated between low- and high-level affordances, which we here refer to as micro- and macro-level affordances. We hold that the establishment of an affordance perspective that recognizes three levels of abstraction adds clarity to the study of affordances associated with complex and situated information systems. We contend that meso-level affordances emerge from the actualization of one or more micro-level affordances and constitute a prerequisite for the emergence and actualization of macro-level affordances. Macro-level affordances are in turn potentials for action that are instrumental in the attainment of goals at the level of an organizational field or society. However, macro-level affordances would typically not be traceable to direct interaction between a human agent and ICT.

The unclear causal relation between ICT and development, or societal change, has informed extensive debate concerning the "4" in ICT4D. An affordance perspective offers no simple pathway to explaining the causality between ICTs and development. Yet, it offers a consistent terminology that highlights the inherently relational and emergent nature of ICT enabled action possibilities. To date, there is no unified framework for how to identify and distinguish micro-level affordances from meso- and macro-level affordances. This paper introduces a framework for affordance identification in terms of granularity levels.

The key contribution of the paper is a novel articulation of IS affordances at different levels of granularity. We demonstrate how this layered affordance view can be operationalized to carefully assess and question the relationship between IT appropriation and envisioned development outcomes. The practical motivation for our study is the need to better articulate the relationship between IT and action possibilities at different levels of granularity. From the analysis of empirical data, we find that meso-level IS affordances, which are often not explicitly recognized or problematized, play a critical role in the attainment of higher-level societal goals. In our case these goals are represented by The Gambia national education sector goals and SDG 4 on equitable quality education. The paper thus addresses Essén and Värlander's (2019) call for research on "micro-level processes through which technology can transform not only organizational but also larger-scale social structures" (p. 1174). Our research also answers Strong et al.'s (2014) call for further research on "the emergence of organizational level actualization from individual level actualization journeys" (p. 80). The following research question motivated the research reported on in this paper:

How can the identification of IS affordances at three distinct levels improve our understanding of the relationship between IT adoption and use and the attainment of envisioned development goals?

The paper proceeds as follows. In the next section, we provide a brief narrative literature review on EMIS strengthening in LMICs. A description of relevant affordance theory development in the IS field follows. Thereafter we describe the qualitative case study methodology employed for this study. Subsequently the findings and discussions are presented before we offer some final concluding remarks.

2 | STRENGTHENING EDUCATION MANAGEMENT INFORMATION SYSTEMS IN LOW- AND MIDDLE-INCOME COUNTRIES

Prior research has highlighted how ICT projects in LMICs are notoriously prone to failure and fraught with sustainability issues (Ali & Bailur, 2007; Best & Kumar, 2008; Kleine & Unwin, 2009; Marais, 2015; Sanner, 2017; Sanner & Sæbø, 2014). This has been problematized in terms of design-reality gaps (Heeks, 2002), failure to build sufficient local capacity to maintain and nurture technology interventions (Sanner et al., 2014), lack of

institutionalization (Sahay et al., 2010), problematic incentive structures (Sanner & Sæbø, 2014) and weak information culture, to mention a few. There is often a naïve technology determinism attached to many externally supported ICT initiatives in LMICs, in that much emphasis is placed on the procurement and distribution of technology and training of end users in the use of basic IT features, such as data capture, while the establishment of arenas and procedures for organization-wide utilization of the rich digital data, such as revision of organizational procedures, workflow reengineering, articulation of new data management roles and mandates, or data-driven policy development, is often an afterthought, rather than a core implementation focus. IT appropriation and use is often assumed to have long-term impact on development of public sector interventions, without much consideration of how data-driven decision-making should be nurtured and actualized at the organizational level. The general trends outlined above are also reflected in the past 20 years of EMIS strengthening initiatives in LMICs (Abdul-Hamid et al., 2015; Cassidy, 2006; UNICEF East Asia & Pacific, 2020).

Although EMISs have been around for decades, they are surprisingly understudied in IS research. Perhaps have their development trajectory been too mundane and too stagnant to attract much interest, although their potential role in shaping the education sector in LMICs cannot be overstated. There is a significant amount of gray literature on EMIS and EMIS strengthening (e.g., Cassidy, 2006; Wako, 2003). From an IS research perspective, an EMIS is not only the computerized system used to collect, manage and analyze data, but constitutes the entire national education data ecosystem (UNESCO, 2020). Developing an effective EMIS is both complex and expensive, and during the process “it is important to consider the needs of all the groups that will rely on the information, including central ministry planners, officials of other national ministries (for example, ministries of finance), regional and district education officials, donors, and NGOs” (UNESCO-IIEP, 2010, p. 156).

As noted by Cassidy (2006), “there is no universally-accepted definition of EMIS. The acronym, EMIS, means different things to different people” (p. 2). Hence, Cassidy provides a somewhat wordy definition of EMIS, explaining the key inputs, functions, and outputs of an EMIS:

“An EMIS is a system for the collection, integration, processing, maintenance and dissemination of data and information to support decision making, policy-analysis and formulation, planning, monitoring, and management at all levels of an education system. It is a system of people, technology, models, methods, processes, procedures, rules and regulations that function together to provide education leaders, decision makers and managers at all levels with a comprehensive, integrated set of relevant, reliable, unambiguous, and timely data and information to support them in completion of their responsibilities.”

(Cassidy, 2006, p. 27)

Cassidy's (2006) definition has been widely adopted (e.g., Abdul-Hamid, 2014; Bhatti & Adnan, 2010; UNESCO, 2007) and is the definition supporting our understanding of EMIS in this paper.

Education data is key, as it can be used to monitor progress at individual schools, as well as the entire education system (Bhatti & Adnan, 2010; Hua & Herstein, 2003; Wako, 2003). EMIS data is useful for allocation of education staff, school supply and other resources (Chapman, 1991; Hua & Herstein, 2003; Wako, 2003), management strengthening (Chapman, 1991), and policy planning and formulation (Hua & Herstein, 2003; Wako, 2003). Yet, despite these insights documented over the past decades, EMISs in many LMICs remain static and unresponsive, largely geared toward generation of statistics for historical analysis. Successes in establishing digitized EMISs that co-evolve with changing organizational priorities and decision maker needs are scarce. It is difficult to monitor progress toward national and global development goals (SDGs), when the EMIS backbone itself is unsustainable and systematic data use is lacking above the school level.

In the following section we describe the recent uptake and development of affordance theory in IS research and suggest a direction for its application in the analysis of IS strengthening efforts in the education sector and beyond.

3 | THEORY: AFFORDANCES IN IS

The affordance lens has gained traction in IS research (Fromm et al., 2020; Valbø, 2021), serving as a useful tool to understand ICT-related organizational change. The notion of affordances was first introduced by Gibson (1977, 1979) to the field of evolutionary psychology:

“The *affordances* of the environment are what it *offers* the animal, what it *provides* or *furnishes*, either for good or ill. The verb to *afford* is found in the dictionary, but the noun *affordance* is not. I have made it up. I mean by it something that refers to both the environment and the animal in a way that no existing term does. It implies the complementarity of the animal and the environment.”

(Gibson, 1979, p. 127)

The concept was picked up in the HCI field (e.g., Gaver, 1991; Norman, 1988) and later found its way to the IS community. However, because the concept was adopted by IS (and HCI) researchers before it was fully developed in the original field (Fromm et al., 2020), there is a divergent use of the affordance lens among IS scholars (Leidner et al., 2018; Valbø, 2021; Volkoff & Strong, 2017). A frequently used affordance definition is that of Volkoff and Strong (2013), being “the potential for behaviors associated with achieving an immediate concrete outcome and arising from the relation between an object (e.g., an IT artifact) and a goal-oriented actor or actors” (p. 823). However, Du et al. (2019) dispute the need to include

immediate and *concrete* in the definition, since “it is difficult to separate concrete from non-concrete outcomes” and “not all affordances will have outcomes occurring instantly at the point in time of affordance actualization” (p. 53). There are also psychology scholars who argue that “Gibson’s affordance theory still needs to be brought beyond ‘the axiom of immediacy’” (Pedersen & Bang, 2016, p. 731). While it makes sense in the HCI field to talk about immediate and concrete outcome of actions (e.g., clicking a button, scrolling with the mouse), limiting affordance outcomes to something “immediate [and] concrete” (Volkoff & Strong, 2013, p. 823) makes little sense when studying organizational change. “Organizations are complex and change is incremental and evolutionary” (Keen, 1981, p. 24). Hence, a study of how technology affects organizations and contributes to organizational change should be more concerned about longitudinal processes and their effects rather than simple technology use actions with immediate observable outcomes. Although Leidner et al. (2018) go a long way in distancing themselves from Gibson’s initial definition of an affordance, they raise a valid concern around how IS scholars have applied the affordance lens – namely that we should not be too concerned about the technology use itself, but rather what the technology use affords to the organization. It is in this debate we position our contribution, providing a theoretical framework nudging IS researchers toward studying affordances at an appropriate level of granularity suitable for the study of how technology use affects organizations. Thus, the affordance definition motivating this case study, is that of Volkoff and Strong but without the need for an immediate concrete outcome. Furthermore, affordances are not actualized in a vacuum (Volkoff & Strong, 2017), but require facilitating conditions (Thapa & Sein, 2018) in the context where they emerge (Bygstad et al., 2016; Strong et al., 2014). The actualization of affordances are supported by enabling, stimulating, and releasing conditions (Bygstad et al., 2016). In Strong et al. (2014), some of the enabling conditions are the previously actualized lower-level affordances. In their affordance dependency diagram, they show how higher-level affordances depend on lower-level affordances. Their affordances are sequential in time and have stronger and weaker dependencies on lower-level affordances. In our analysis, we discovered similar dependencies. Using Bygstad et al. (2016) terminology, we refer to enabling, stimulating, and releasing conditions when describing the multi-layered affordance dependencies we discovered.

To avoid too much focus on mere technology-use, Volkoff and Strong (2017) recommend that IS researchers study affordances at an appropriate level granularity. Leidner et al. (2018) also subscribe to this idea, urging IS researchers to avoid focusing on lower-level technology-use affordances. Valbø and Sanner (2023) propose a nested affordance process model as a tool to nudge IS scholars toward the appropriate level of analysis in case studies using the affordance lens. In the present study we develop a framework for the identification of micro-, meso-, and macro-level affordances. First, micro-level affordances are technology-use affordances. That is, affordances that describe direct use of technology (e.g., data entering, data visualization). Meso-level affordances are affordances that emerge as a result from the actualization of lower-level affordances and reside at the organizational level of abstraction. They are not direct technology-use but still tightly coupled to technology-use since they emerge as a consequence of technology-use. They can best be understood as related to the overall IT capabilities of an organization. Third, macro-level affordances are affordances that emerge as a result of the actualization of meso-level affordances. These might be hard to perceive and trace back to technology-use. However, they can be identified by looking at the outcomes of the actualizations of meso-level affordances and would typically constitute organization, organizational field or society level interventions and changes afforded by ICTs.

Technology is not a panacea for development (Von Braun, 2010, p. 12). Still, IT interventions can be seen “everywhere” in the development landscape, seeking to improve the lives of the marginalized and the poor (e.g., De’ Pal et al., 2018). Faik et al. (2020) recently noted that there is limited attention to “how [societal consequences] emerge from the development, deployment, or use of IT” (p. 1361). They provide a rare analysis where they tie IT-use affordances to societal changes. Along the same vein, Essén and Värlander (2019) conclude that “the introduction and evolution of a technological artifact in an institutional setting” can contribute to changes at the field level (p. 1173). It is in response to these inspirational calls that we establish a framework for the identification of IS affordances and their interdependencies, at three levels of granularity in the discussion part of this paper. We recognize that associating affordances to micro, meso, and macro levels may be a point of contention in IS research. Our stance is that identifying affordances at these three levels of granularity allows us to reveal and question assumptions about the role of technology in shaping human endeavors while being mindful of the appropriate level of abstraction.

4 | METHOD

4.1 | Data collection

The aim of this case study is to explore the layered IS affordances that emerge from users’ interaction with ICT and the DHIS2-EMIS instance in the Gambia. During 2022, the authors had three visits to The Gambia, for a total of 6 weeks. The first author conducted 19 semi-structured interviews with a total of 17 interviewees from several levels of the educational sector (Table 1). Cluster monitors are employed at the district level and have an advisory role for a cluster of schools. Many of them have previously worked as teachers, and in their daily work they interact with several teachers. Interviewing cluster monitors was thus considered more effective than interviewing many teachers. The two teacher interviews that were conducted also did not reveal any new information that was not previously given by the cluster monitors. Three of the interviews were follow-up interviews. In total, more than 8 h of interviews were conducted, with an average duration of approximately 30 min. The interview guide was approved by the Norwegian center for research data (NSD), and the interviewees were informed about the research and

TABLE 1 Interview overview.

Interviewee	No. of interviews
EMIS ^a Head	2 interviews
Technical advisor, EMIS unit	2 interviews
2 ICT officers, EMIS unit	2 interviews (both together in both interviews)
ICT officer, EMIS unit	1 interview
Regional director	1 interview
2 Planning focal points ^b	1 interview each
Assistant cluster monitor ^c focal point ^d	1 interview
3 Cluster monitors	1 interview each
Ex-cluster monitor	1 interview
2 Head teachers	1 interview each
ICT teacher	1 interview
Teacher	1 interview

^aEducation management information system.

^bThe planning focal point is the regional contact person for the planning unit in the ministry of education.

^cA cluster monitor has an advisory role for a cluster of schools.

^dA cluster monitor focal point is the person responsible for coordinating the region's cluster monitors' work.

their right to withdraw information at any time. An informed consent was given by all participants, and the quotes in this paper are published with explicit approval by all informants. The 19 interviews were transcribed verbatim to facilitate the coding process and identification of affordances. Whenever a person was identified in the interviews, a code was used in the transcribed files to avoid revealing the identity. A total of 138 pages of transcribed interviews laid the foundation for the data analysis.

Further, both authors participated in roundtable meetings at six different Gambian schools. In addition to a HISP team from the University of Oslo, directors, head teachers, teachers, parents, and cluster monitors also participated in these roundtable meetings. The authors also attended the week-long academy for DHIS2 for education, which was organized in the country. The roundtable meetings and the participation in the academy served as good sources for a broader understanding of the Gambian educational sector. The second author has been involved in the long-term strengthening of the Gambian EMIS since January 2019. Through participation in strategic planning meetings, stakeholder mobilization meetings and capacity building initiatives, the second author has reviewed EMIS strategy documents, EMIS peer reviews, data policy briefs, school management manuals and software training materials as well as actual tools for education data collection, analysis, and presentation at all organizational levels.

4.2 | Data analysis

The transcribed notes were analyzed to identify affordances (i.e., action possibilities) emerging from the DHIS2-EMIS use in the educational sector in The Gambia. To identify these affordances, we followed an inductive coding process, similar to that of Treem and Leonardi (2012, p. 148). We identified 235 action possibilities, distributed between actions that were already realized as well as latent action possibilities perceived by the informants. We then sorted similar actions and action possibilities into first-order groups and then sorted the first-order groups into second-order groups. Finally, we abstracted the four overarching affordances from the second-order groups.

Table 2 shows examples from our data set, illustrating the coding process. Similar to Majchrzak et al.'s (2013) *metavoicing* affordance, the four remaining affordances can take many forms. For instance, our processability affordance can be in terms of availing data, interacting with data, analyzing data, or reporting data. Subsequently, the four affordances were coded according to granularity levels (micro, meso, macro) using the affordance identification framework we developed in this study. The process outlined here resembles Bygstad et al.'s (2016) fifth step for analysis of a set of affordances (p. 92).

4.2.1 | The affordance identification framework

The present study introduces the affordance identification framework (AIF). The framework extends the nested affordance process model (see Appendix A) and addresses the persistent lack of clarity regarding the “appropriate” level of granularity of affordance identification in

TABLE 2 Examples from the coding process of the capturability and processability affordances.

Identified affordances	First-order grouping	Second-order grouping	Overarching affordances
Collect data on time ^a	Collect data		Capturability
Collect enrolment data			
Collecting teacher attendance			
Enter annual census data	Data entry	Register data	
Enter daily attendance			
Enter data			
Store individual information about disability, health, family	Store data		
Enroll students	Student registration		
Register students			
Fill the form on [credentials]	Self-registration		
Upload documents			
Upload their credentials			
See enrolment	See data/information	Gather information	Processability
See information			
See the data			
See the input			
Easily request/get data	Retrieve data		
Extract data			
Get some facts			
Get some reports			
Send data	Send/sync data	Share data	
Send enrolment			
Sync daily attendance			
Facilitate information flow through the structure	Share data across levels		
Forward things			
Share data			
Analyze data on time	Analyze data	Analyze data	
Analyze thematic areas			
Transform/refine data into information			
Look at trends	Identify trends		
See what is critical of evolvment			
Compare indicators	Compare data		
Look at comparisons here and there			

^aThe identified affordances in column 1 are named according to the informants' own words/terms used in the interviews.

IS research (Volkoff & Strong, 2017). The process outlined in Table 3 was used to categorize the identified affordances in this study and presents the steps of the framework.

5 | CASE DESCRIPTION

DHIS2 is a free and open-source web-based software platform. The HISP Center at the University of Oslo coordinates the developed and implementation of DHIS2. Through 30 years in operation, a global network of local HISP groups – the HISP network – has emerged to facilitate south-south innovation, experience, and knowledge sharing. The Gambian EMIS team with MoBSE was initially trained on DHIS2 customization and use by HISP West and Central Africa. Key outputs were locally relevant thematic dashboards and analysis tools in the software. One of the key strengths of DHIS2, is the HISP ecosystem – the increasing human capacity of the global HISP network. DHIS2 thus affords stakeholders in both the health and the educational domain in The Gambia the possibility of collecting, reporting, analyzing, and acting on timely data. The initial phases of the DHIS2-EMIS pilot in The Gambia involved using the individual student and registration component in DHIS2 at 200 schools.

TABLE 3 The affordance identification framework (AIF).

Step	Explanation	Case examples
1. Identify actualized affordances	Affordances are action possibilities. An actualized affordance is thus a performed action and can be identified by looking for, or asking the interviewees about, realized activities.	“We are entering the attendance of these children.” (Head teacher 1) “[Within] 15 days we were able to report all the data.” (EMIS ^a head)
2. Identify latent affordances	Affordances that are not yet enacted can be identified by looking for, or asking the interviewees about, potential use scenarios	“It is going to be very flexible now to take the paper to the ministry.” (ICT teacher) “You can do some data mining and see this kind of students is performing this way when you compare this type of background.” (EMIS technical advisor)
3. Categorize micro-level affordances	Micro-level affordances relate to individuals' basic use of a technology, such as direct use of a specific technology feature.	Data entry; data syncing; accessing data; data reporting
4. Categorize meso-level affordances	Meso-level affordances are not pure technology use, but the technology has a facilitating role, serving as a tool to solve the actions at hand. Facilitated by the actualization of micro-level affordances, meso-level affordances entail more-advanced technology use.	Information processing; analyzing data; informing parents; avoiding time-consuming tasks
5. Categorize macro-level affordances	Macro-level affordances are action possibilities made possible by the virtue of the preceding actualization of micro- and meso-level affordances. The technology does not play a vital role in the enactment of macro-level affordances, and identifying technology-facilitated macro-level affordances directly can thus be challenging.	Reducing resources; decentralizing the work; improving performance; improving quality in education

^aEducation management information system.

5.1 | Aspirations of the Gambian education sector

MoBSE is determined to make progress toward SDG 4. These aspirations are embedded in national education policies and have been a key motivation for IT adoption not only for EMIS but in the area of education technology broadly, including piloting of educational apps in schools. This raises the questions: What can all this frequently generated digital education data be used for? How can it support decision-making and guide education sector planning and programmatic interventions? Whereas IT can be “rolled out” relatively quickly using a web-based server–client structure, the capacity to configure and use IT for something more than data collection takes time and is a prerequisite for the actualization of what we refer to as meso-level IS affordances. In the following we zoom in on two key SDG 4 targets that MoBSE has highlighted in its recent education policies and that the education sector aspires to attain through data-driven decision-making with DHIS2 as an EMIS backbone, namely SDG targets 4.1 and 4.5. Historical failure to monitor progress across all SDG 4 targets has been a key grievance for MoBSE managers for years. Many countries on the African continent experience the same data struggle.

5.2 | SDG 4

By measuring progress toward 10 targets, SDG 4 aims to “ensure inclusive and equitable quality education and promote lifelong learning opportunities for all” (United Nations, [n.d.](#)). Each target can be monitored with reference to suggested indicators. In the following, we present the SDG targets 4.1 and 4.5.

5.2.1 | SDG 4.1 – Ensuring free, equitable, and quality education

The aim of the SDG 4.1 target is to, “by 2030, ensure that all girls and boys complete free, equitable and quality primary and secondary education leading to relevant and effective learning outcomes” (United Nations, [n.d.](#)). The two suggested indicators to measure the attainment of this target, are the following:

4.1.1 Proportion of children and young people (a) in grades 2/3; (b) at the end of primary; and (c) at the end of lower secondary achieving at least a minimum proficiency level in (i) reading and (ii) mathematics, by sex

4.1.2 Completion rate

(primary education, lower secondary education, upper secondary education)

The sustainable development goals and targets are just that – goals and targets. They do not provide any means or suggestions as to how to achieve those goals. The suggested indicators for measuring progress toward achieving the SDG 4 sub-targets may however indicate actions that need to be taken. For instance, in order to know the education completion rate (indicator 4.1.2), one would need to know the number of students completing the education as well as the population data for the corresponding age group. To do these calculations, an EMIS ICT officer at MoBSE explains that they have perceived the possibility of feeding the population data into DHIS2-EMIS in order to visualize the completion rate. The visualizations can be broken down to look at each school, or aggregated to district, regional and national level. A head teacher welcomes these plans, as in their school, they enroll many children that later drop out from the school. Without a proper tool to track the dropouts, it is hard to follow up. The head teacher explains.

“If [MoBSE] are able to track that [children] are not going to school, they should have informed us that child X with admission number X is no longer coming to school. ... So that, at least, at our level, we can do something, because, sometimes, we call parents and convince them, [and] they bring back their children to school.”

(Head teacher 1)

5.2.2 | SDG 4.5 – Eliminating gender disparities in education

The aim of the SDG 4.5 target is to, “by 2030, eliminate gender disparities in education and ensure equal access to all levels of education and vocational training for the vulnerable, including persons with disabilities, indigenous peoples and children in vulnerable situations” (United Nations, n.d.). The suggested indicator to measure the attainment of this target, is the following:

4.5.1 Parity indices (female/male, rural/urban, bottom/top wealth quintile, and others, such as disability status, indigenous peoples and conflict-affected, as data become available) for all education indicators on this list that can be disaggregated

Data for the calculation of gender parity indicators is currently collected through the DHIS2-EMIS instance. As one of the EMIS ICT officers said, “you can just go in the system and have the enrolment of the gender at school”. Additionally, the possibilities of using DHIS2-EMIS captured data to overcome other disparities were also perceived. A regional director gives a hypothetical example for a disabled boy: “If the variables that are related to equity and equality are there, obviously, when you do your analysis ... you [will] know... what can we do, so that he has equal opportunities like everybody”.

6 | FINDINGS AND DISCUSSION: DHIS2-EMIS AFFORDANCES

We identify four distinct overarching affordances for DHIS2-EMIS affecting Gambian educational stakeholders in their quest for attaining the SDG 4: configurability, data registration, processability, and actionability. This section proceeds as follows. First, we define the four DHIS2-EMIS affordances and their corresponding levels of granularity. Second, we highlight the enabling, stimulating, and releasing conditions for the affordances and explain how affordances can serve both as enabling and stimulating conditions for other affordances, causing affordance loops to emerge. Lastly, we conclude this section by emphasizing the role of meso-level affordances in the attainment of higher-level aspirations, such as the attainment of SDG 4 in the education sector in The Gambia.

6.1 | Micro-, meso- and macro-level affordances

Strong et al. (2014) explain how the actualization of *basic affordances* (individual-level technology-use affordances) cause the emergence of *more-advanced affordances*. However, Leidner et al. (2018) suggest to use the terms *first-order* and *second-order* to indicate the order of actualization as well as to refrain from conveying the impression that basic affordances are easier to actualize than more-advanced affordances. Generally, IS scholars thus divide affordances into two layers, namely lower-level affordances and higher-level affordances. Lower-level (basic; first-order) affordances are often related to technology use, while higher-level (more-advanced; second-order) affordances just indicate affordances that

TABLE 4 DHIS2-EMIS affordances.

Affordances	Explanations	Case examples ^a
<i>Micro-level affordances (basic technology use)</i>		
Configurability	Entails both initial and continuous customization of DHIS2-EMIS ^b . Stakeholders can customize DHIS2 and prepare it for use.	• Set up the organization unit tree • Develop and install apps onto the DHIS2 software core • Design data entry forms and data visualization tools, such as charts, reports, maps, and dashboards
Capturability	Stakeholders can register students and teachers as well as data associated with these. Once the data is registered, it is immediately accessible to stakeholders at superior levels.	• Enroll students • Enter attendance • Enter annual census data • Collect individual student data • Collect annual school statistical data
<i>Meso-level IS affordances (emerging from technology use, i.e., micro-level affordances)</i>		
Processability	Stakeholders can access and interact with the data in the system. The interaction involves technology to access and extract data. But in order to make sense of the data, human capacity plays an important role.	• Access information from my home • Bring out the data in the system • Verify data • Analyze data on time • Analyze thematic areas • Compare indicators • Discuss about data
<i>Macro-level affordances (emerging from meso-level affordances)</i>		
Actionability	Due to timely reported, processed, and analyzed data, stakeholders can engage in planned activities and interventions with the aim of improving various aspects of the educational sector.	• Expedite decision-making • Enable/plan for targeted interventions • React to a situation • Rectify issues • Prepare students to become conductive citizens of the society

^aCitations from the informants.

^bThe Gambia's instance of DHIS2 serving as the backbone for their education management information system (EMIS).

emerge at a later stage and may or may not pertain to the organizational level. We therefore choose to use the terms micro, meso, and macro to help convey the societal level to which they pertain as well as the order of actualization.

Detailed descriptions of the affordances are given in Table 4. In the following, we explain how the multi-layered affordances depend on and influence each other through affordance loops.

6.2 | Affordance loops: Affordances as both enabling and stimulating conditions

Different stakeholders at different levels of the Gambian education system interact with DHIS2-EMIS. As such, the context in which DHIS2-EMIS is embedded, is complex, with a broad variation in stakeholders and operational sites, ranging from teachers in rural schools to ministry employees in the capital. In Table 5, we present the overarching DHIS2-EMIS affordances, the actors, the enabling, stimulating, and releasing conditions, and the outcome of the affordances. We observe that for micro- and meso-level affordances, the outcome is both immediate and concrete, coherent with Volkoff and Strong's (2013) affordance definition. However, considering the macro-level affordance *actionability*, the outcome is neither immediate nor concrete, which undergirds the challenge of explicitly linking IT adoption and use to concrete development outcomes, such as actions that inform progress toward the SDG 4 targets.

Strong et al. (2014) explain how the immediate concrete outcome of the actualization of an affordance provide feedback for adjusting the actions and the elements that give rise to the affordance (p. 70), while Bygstad et al. (2016) found that generative mechanisms could serve as stimulating conditions for affordances (p. 94). In our case, the findings suggest that future (not yet actualized) affordances may serve as stimulating conditions, even without having provided any outcome yet. The perception of a possible outcome of a future affordance was enough to stimulate the actualization of current affordances. For instance, actors' perceptions about the possible actionability affordance were found to stimulate the initiation of the DHIS2-EMIS implementation and thus motivate the actualization of the configurability affordance:

TABLE 5 DHIS2-EMIS Affordances; enabling, stimulating, and releasing conditions; and affordance actualization outcomes.

Affordances	Actors	Enabling (E), stimulating (S), and releasing (R) conditions	Case outcome examples
Configurability	EMIS ^a staff and HISP implementers (with EMIS knowledge and technical capacity)	E: Access to HISP network capacity S: Actionability R: HISP West and Central Africa support	• DHIS2 prepared for data registration, reporting and analysis • Same data definitions across the entire sector • A uniform dashboard for attendance
Capturability	(Trained) school staff	E: Configurability S: Desire to see own data R: Instructions from MoBSE	• Enrolled students • Statistical data
Processability	Education stakeholders at all levels (with EMIS knowledge and skills to interpret data)	E: Capturability S: Actionability R: Desire to understand development	• Reports • Annual yearbooks • Know if a catchment area needs development
Actionability	Education stakeholders at all levels	E: Processability S: SDG attainability R: Desire to improve	• Intervention plans • Improved education • Equitable access to education

^aEducation management information system.

“The goal is to get something that ... eventually like Facebook. *Everybody* uses it, whenever they want. Nobody controls it. So data is just used.”

(The EMIS head)

Similarly, the actionability affordance also motivated the actualization of the capturability affordance:

“Possible, if we can get [the reported information] very early, maybe in a shorter period, it is fine. Like, where you need to adjust yourself, you can know it very quickly. And then you act on that.”

(Head teacher 2)

At a later stage, the actionability affordance was also perceived to motivate the actualization of the processability affordance:

“If the system is such that it's very effective and people that are working on it have the capacity to do so. I'm pretty sure that it will bring a lot of benefits to the sector ... [and] help in our processes, not only decision making, but even action taking. It can do a world!”

(A regional director)

Affordances are not actualized in a vacuum (Volkoff & Strong, 2017) but in an organizational context. A vital part of an organizational context is knowledge production and knowledge sharing. For a future affordance to serve as a stimulating condition for a preceding affordance, actors must have the capability and knowledge needed to perceive the future affordance. While training stakeholders in *how* to use DHIS2-EMIS is important, our findings also stress the importance of teaching the stakeholders *why* they should use DHIS2-EMIS. Understanding the potential consequences of their technology use may motivate them to use it as instructed by MoBSE. In other words: perceiving future meso- and macro-level affordances serve as stimulating conditions for the actualization of micro-level affordances. In Figure 1, we demonstrate this interplay between micro-, meso- and macro-level affordances, as we illustrate how the DHIS2-EMIS affordances enable the emergence of subsequent affordances while the affordances also feed back by stimulating the actualization of the preceding affordances. It is this interplay between the multi-layered affordances we refer to as affordance loops.

Some might argue that the introduction of granularity levels and macro-level affordances without any immediate and concrete outcome is watering out the original idea of affordances. It is arguably quite some distance and difference between a basic cutting affordance (Gibson, 1977) and a higher-level actionability affordance (paper 4). But nevertheless, in an IS setting, affordances are what the technology “*provides or furnishes*” (Gibson, 1979, p. 127). And just like the knife provides a chef the possibility of cutting a cucumber, DHIS2-EMIS furnish the Gambian stakeholders with the knowledge they need to take actions. Hence, the actionability affordance does indeed “[imply] the complementarity of” (Gibson, 1979, p. 127) the Gambian stakeholders and DHIS2-EMIS. Thus, we contend that higher-level action possibilities that emerge as a result of the actualization of micro- and meso-level affordances involving a specific technology should indeed be considered affordances of that technology, even though the macro-level affordances themselves do not involve direct use of the technology. As long as they are provided or furnished by (the interaction between) the technology (and its users), they are indeed affordances of that technology.

The meso-level processability affordance plays a key role in the Gambian DHIS2-EMIS, stimulating the preceding capturability affordance and enabling the subsequent actionability affordance. We discuss the role of the meso-level affordances in the following sub-section.

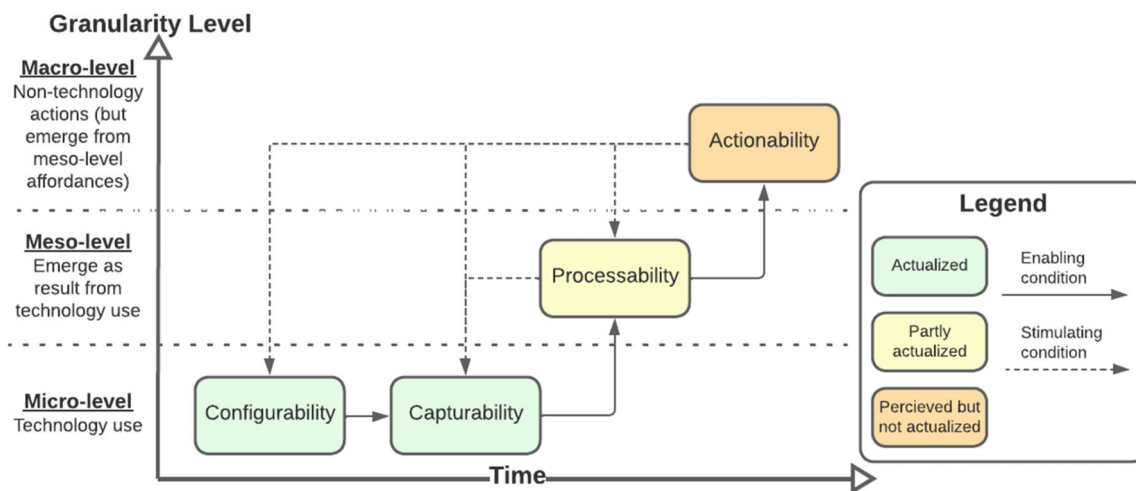


FIGURE 1 Affordance loops: The DHIS2-EMIS affordances and their interdependency in terms of enabling and stimulating conditions.

6.3 | Enacting sustainable development through meso-level affordances

The informants that are currently using DHIS2-EMIS, have all received training in how to use the technology. That is, they have learned how to enter and avail data (e.g., through visualizing data with dashboards). But available data alone is not sufficient to inform action. Data must be timely, of good quality, it must be interpreted correctly, and it must be presented in an understandable way to someone with the mandate and organizational flexibility to act. Qualified personnel must take decisions and assign the appropriate resources to see the necessary actions through. In other words, in order to use data to enact significant changes, it takes more than knowing how to use certain technology features. Considerable emphasis needs to be placed on the meso-level processability affordance in order to ensure significant utilization of education data in decision-making and subsequently acting on it. Drawing on close to 30 years of experience from “information for action” (Walsham, 2020), the HISP network assist with relevant capacity-building in the Gambian DHIS2-EMIS case.

Extensive capacity-building at the national and subnational level is necessary in an education sector that has historically relied on yearly census and survey data and is now shifting toward digital individual learner and teacher records. In the education sector in LMICs, novel ICTs are expected to contribute to a wealth of data that can inform interventions and facilitate progress toward SDG 4 attainment. Yet, few education data strategy and policy documents outline how organizational capacity to actualize these affordances will be harnessed. In particular, our study highlights the need for policy formulation that explicates the link between technology adoption and use and higher-level development goals and targets. Identification and scrutiny of meso-level IS affordances and how to realize them to pave the way for development outcomes is critical, and, as our empirical study indicates, should start by identifying the roles, resources, capacities, and facilitating conditions that enable and motivate the actualization of data processing and data use affordances at the sub-national level in LMICs.

7 | CONCLUSION

In this paper, we have introduced and applied the affordance identification framework (AIF). The identified DHIS2-EMIS affordances were categorized using the framework and abstracted to four overarching DHIS2-EMIS affordances: configurability, capturability, processability, and actionability. The paper shows how the four multi-layered DHIS2-EMIS affordances are interrelated through affordance loops and emphasizes the importance of the meso-level IS affordances. The meso-level processability affordance plays a vital role in the quest for attaining the SDG 4, since it connects micro-level technology-use affordances with macro-level affordances with societal-level impact. IT is not a panacea for development, and the actualization of the processability affordance requires the preceding actualization of a complex series of micro-level affordances along with enabling, stimulating, and releasing conditions, including sufficient human capacity to both configure data systems, structure, and analyze data in meaningful ways and prepare data for utilization in decision-making processes. Too often information systems strengthening initiatives in LMICs are seen as IT projects, with too much emphasis put on the affordances associated with direct and immediate technology use (micro-level affordances), while the realization of intended outcomes, such as SDG 4 attainment is assumed to flow from technology use. We would argue that an affordance perspective on IS strengthening can help identify and question technology determinisms and highlight the intricate interdependencies, including affordance loops, between the actualization of different micro-, meso- and macro-level affordances.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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