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The Nested Affordance Process Model: Bridging Technology Use and Societal-Level Impact

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Paper Category: Research-in-progress

ABSTRACT

This paper reports on an ongoing research endeavor in The Gambia. The study develops a nested affordance process model to make sense of the strengthening of the national education management information system. Distinguishing lower-level technology use affordances from mid- and higher-level affordances, the three-layered nested affordance process model guides the research and contributes to illuminating findings, explaining the implementation of the Gambian education management information system. The contribution of the paper is twofold. The paper contributes with the elaboration of a stepwise framework for affordance categorization in terms of granularity levels. Second, the paper illustrates how the actualization of mid-level affordances play a key role in an organization's quest for societal-level changes, thus bridging the gap between technology use and societal-level impact.

Keywords: Affordance theory, education management information system, EMIS, nested affordance process model, NAP.

INTRODUCTION

This paper reports on an ongoing research endeavor in The Gambia and explores how affordance theory can contribute to increased understanding of the processes from the introduction of information and communication technology (ICT) in a low- and middle-income country setting towards the expectations of societal-level impact.

The Gambian Ministry of Basic and Secondary Education (MoBSE) has launched an education management information system (EMIS) pilot using District Health Information System 2

(DHIS2¹) as the backbone for their EMIS implementation. Developed and maintained by the Health Information Systems Programme (HISP) Centre at the University of Oslo, DHIS2 has, since its inception in the early 90s grown to be a digital global public good software platform and is currently being used as the foundational computer system for health management information system (HMIS) implementations in more than 70 countries worldwide. The Gambia has used DHIS2 as the backbone system for their national HMIS since 2010 and in 2019, MoBSE embarked on a DHIS2-based EMIS pilot.

Affordance theory has become an increasingly popular theory 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. In addition to relying on the actor and the ICT, an affordance also depends on the context in which the actor and the ICT are embedded. For example, the affordances that emerge in two organizations using the same computerized system may differ, since they depend both on the actors, including their skillsets, and the organizational contexts.

In IS research, there is a consensus that affordances exist on different levels of granularity. That is, there are differences between lower-level and higher-level affordances. Lower-level affordances are often related to technology use and can be easily perceived, while higher-level affordances are affordances that emerge as a result of the actualization of lower-level affordances. Affordances on a higher granularity level are often more interesting when studying organizational change. Hence, Leidner et al. (2018) urge IS researchers to focus on affordances on a granularity level higher than technology-use. Along the same vein, Volkoff and Strong (2017) encourage IS researchers to study affordances on an appropriate level of granularity. To nudge IS researchers towards the identification of affordances on a higher granularity level than technology use, Valbø and Sanner (2022) introduce the notion of mid-level affordances as a third granularity level of affordances, being affordances that emerge from direct technology use, serving as a prerequisite for the emergence of higher-level affordances. Valbø and Sanner argue that mid-level affordances play a vital role for the emergence of higher-level affordances and societal-level changes. It does however not yet exist a framework on how to identify and separate

¹ <https://dhis2.org/>

lower-level affordances from mid- and higher-level affordances. To fill this gap, this paper contributes with a stepwise framework for affordance categorization in terms of granularity levels.

The analysis of the empirical data from this study suggests that mid-level IS affordances, which are not frequently recognized or problematized in ICT4D initiatives, play a crucial role in achieving societal-level goals. In the case of this study, the societal-level changes relate to equitable quality education. The paper thus partly 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). Studying MoBSE's DHIS2-EMIS implementation pilot in The Gambia, the following research questions motivate this paper:

RQ1: What are the mid-level affordances of the Gambian DHIS2-EMIS implementation?

RQ2: How can mid-level affordances contribute to societal change?

The paper proceeds as follows. In the next section, a narrative literature review on EMIS and affordance theory is presented. Thereafter I explain the methodology used for this study. Subsequently the findings are presented, before I conclude with a discussion and final remarks.

BACKGROUND

Education Management Information Systems

Although EMISs have been around for decades, they are surprisingly understudied in IS research. There does however exist a substantial amount of grey literature on EMIS (e.g., Cassidy, 2006; Wako, 2003). An EMIS is not only the computerized system used to collect, manage and analyze data, but includes also the entire 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" (Cassidy, 2006, p. 2). Hence, Cassidy provides

a somewhat wordy definition of EMIS, explaining the key inputs, functions, and outputs of an EMIS:

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)

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

Education data is key in an EMIS, 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).

Affordances

The affordance lens is gaining traction in IS research (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 human-computer interaction (HCI) field (e.g., Gaver, 1991; Norman, 1988) and later found its way to the IS community. However, because the concept was adopted by the IS (and HCI) field 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, 2018; Valbø, 2021; Volkoff & Strong, 2017). The affordance definition guiding the analyses in this case study, is that of Volkoff and Strong (2013), being “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” (p. 823).

To avoid too much focus on 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 in our studies. Valbø (2022) proposes a nested affordance process model (Figure 1) as a tool to nudge IS scholars towards the appropriate level of analysis in case studies using the affordance lens. The framework separates affordances into three layers. First, micro-level affordances are technology-use affordances. That is, affordances that describe direct use of technology (e.g., data entering, data visualisation). Mid-level affordances are affordances that emerge as a result from the actualization of lower-level affordances. In organizational contexts they often reside at the organisational level of abstraction and can best be understood as related to the IT capabilities of an organisation. Mid-level affordances are not direct technology-use but still tightly coupled to technology-use since they emerge as a consequence of technology-use (e.g., analyzing, information processing). Third, higher-level affordances are affordances that emerge as a result of the actualization of mid-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 mid-level affordances and would typically constitute organisation or society level interventions and changes afforded by ICTs in a social context (e.g., data-informed intervening).

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). Figure 1 depicts the nested affordance process model and indicate the importance of the facilitating conditions for the actualization of lower-, mid-, and higher-level affordances.

Connecting Affordances with Societal-Level Changes

Technology is not a panacea for development (Von Braun, 2010, p. 12). Still, ICTs interventions can be seen “everywhere” in the development landscape, seeking to improve the lives of the poor (e.g., De’ et al., 2018). IS scholars have traditionally been concerned with ICT-related

organizational change, and most IS studies using the affordance lens focus on lower-level technology-use affordances (Valbø, 2022). 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 they provide an 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).

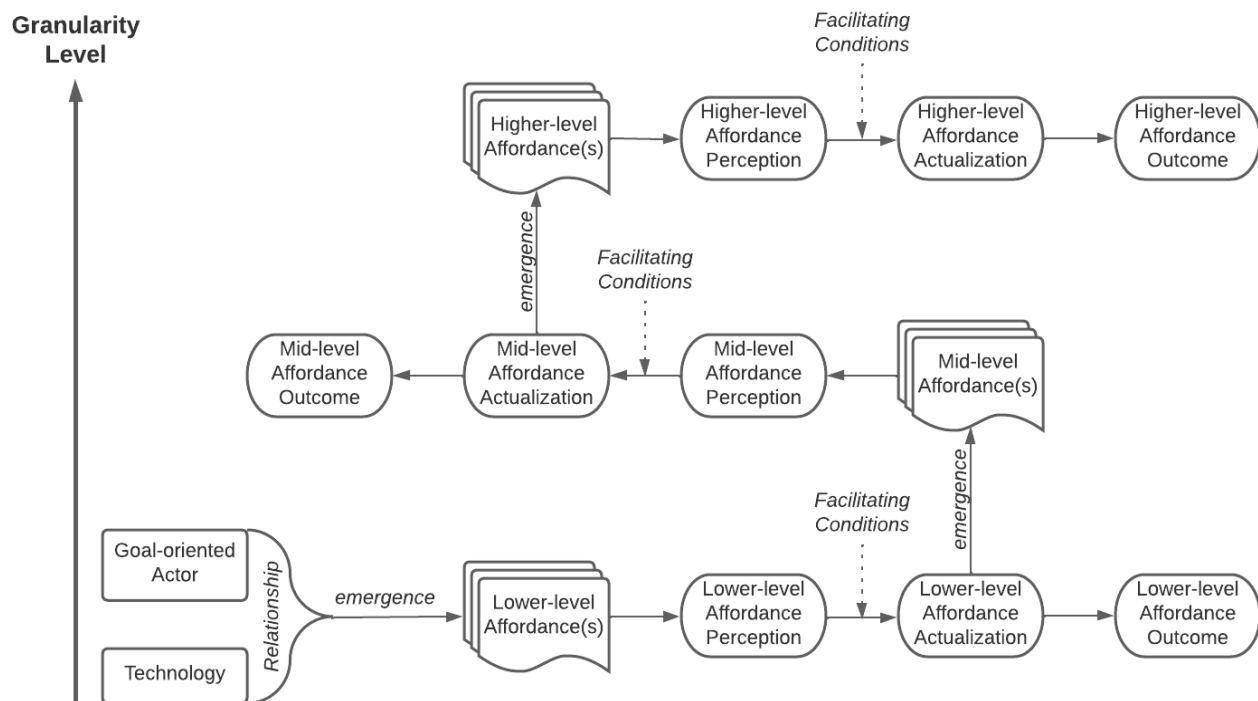


Figure 1. The Nested Affordance Process Model (Valbø, 2022).

METHOD

Data Collection

The aim of this case study is to explore the mid-level affordances available for the users of the Gambian DHIS2-EMIS instance and how these contribute to societal change. As such, a field study was warranted. The author spent three weeks in The Gambia in February 2022, participating in six roundtable meetings at schools and conducting six interviews of seven employees at different levels of the educational system in The Gambia. Five interviews were done by the author alone, and the sixth interview was carried out together with a HISP Centre

Senior Executive Officer. The average duration of the interviews were 30 minutes. The roundtable meetings were held together with the HISP team². Later, the author participated in the DHIS2 for Education Academy, which was held in The Gambia in April 2022, and a third field visit were carried out in September 2022. However, the content of the interviews from the third field visit are not yet transcribed and analyzed and is thus left out from the data sources from this research-in-progress paper. The data sources supporting this paper are presented in Table 1.

The interview guide was approved by the Norwegian center for research data, and the interviewees were informed about the research and their possibilities of withdrawing any information given at any time. An informed consent was given by all participants, and the quotes used in this paper have been presented to the participants for approval. The six 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. The 13 interviews from the second visit have not yet been transcribed and analyzed.

Data Analysis

The transcribed files were analyzed to identify affordances (i.e., action possibilities) emerging from the DHIS2-EMIS use in the educational sector in The Gambia. Each affordance was coded according to whether it has been actualized or not. That is, whether the action has already been done (or is being done currently) or if it is a perceived possibility that has not yet been done (e.g., a possibility for the future). Several of the interviewees perceived similar action possibilities, and the interviewees also described similar actions several times during the same interview (i.e., repeating him-/herself or describing similar actions). Hence, the affordances were thematically grouped together according to the action they described, and each group was assigned a thematic name. For instance, “collect data from schools and teachers” and “collect student information” were both sorted under the thematic affordance called “data collecting”. A complete overview of the identified affordances is given in Table A1 in the Appendix.

² The HISP team consisted of seven people: an assistant professor from the HISP Centre at the University of Oslo, the HISP Centre EMIS Project Manager, a HISP Centre Senior Executive Officer, a HISP Centre Master Student, the HISP West and Central Africa Implementation Manager, a MoBSE EMIS employee, and the author, a HISP Centre PhD Research Fellow.

Roundtable meetings	Participants (in addition to the HISP team)
Upper Basic school	Director Head teacher
Lower Basic School	Head teacher Teacher
Lower Basic School	Parent-teacher meeting: Parents Teachers
Upper Basic School	2 vice principals 1 cluster monitor 1 ICT teacher (responsible for inputting new enrollments) 1 teacher (responsible for entering and summarizing teacher attendance)
Upper Basic School & Upper Senior Secondary School	Head teacher
Lower Basic School	Head teacher
Interviews	
An EMIS leader	
A technical consultant in the EMIS team	
Two ICT officers in the EMIS team	
A cluster monitor	
A head teacher at a lower basic school	
An ICT teacher	

Table 1. Data Sources

After organizing the affordances thematically into groups, the groups were further revised until five overarching affordances remained. Finally, the overarching affordances were coded according to granularity level (low, middle, high), and a model was created (Figure 4), demonstrating how affordances at different levels of granularity can be actualized over time and their dependency on each other. The process outlined here resembles Bygstad et al.'s (2016) fifth step for analysis of a set of affordances (p. 92).

Steps	Explanations	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” (a head teacher) “[Within] 15 days we were able to report all the data” (an EMIS leader)
2. Identify latent affordances	Affordances that are not yet enacted can be identified by looking for, or asking the interviewees about, potential use scenarios and/or dreams for the future.	“It’s going to be very flexible now to take the paper to the ministry” (an ICT teacher) “You can perform some data mining, looking at students’ background, characteristics and performances to know which kind of students are performing better or less.” (an EMIS consultant)
3. Categorize lower-level affordances	Lower-level affordances relate to direct use of technology. Key question (see Figure 2): “Is this a direct use of a technology or a specific technology feature?”	Create dashboards; enter data; sync data; access data

4. Categorize mid-level affordances	Mid-level affordances are not direct technology use but still tightly coupled to technology use since they emerge from the actualization of lower-level affordances (i.e., as a consequence of technology use).	Process information; analyze data; monitor a cluster; track students
5. Categorize higher-level affordances	Identifying technology-facilitated higher-level affordances directly can be challenging since they are detached from technology use and may require several preceding affordance actualizations.	Inform parents; take action to mitigate low attendance; distribute children according to languages

Table 2. Stepwise Framework for Affordance Categorization

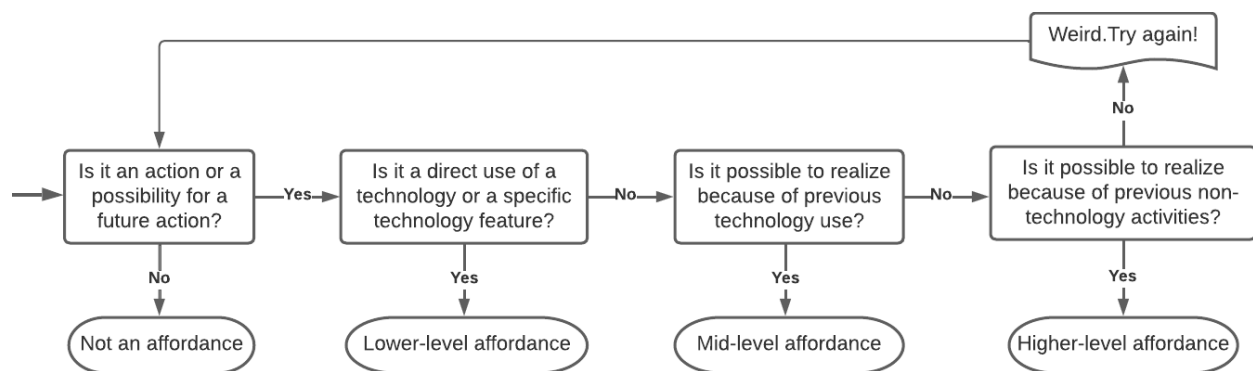


Figure 2. Key Questions in the Stepwise Process for Affordance Categorization

A Stepwise Framework for Affordance Categorization

The findings from this paper lay the foundation for the initial development of a stepwise framework for affordance categorization, in terms of granularity levels. Affordance categorization is useful in order to nudge IS researchers towards focusing on the appropriate level of granularity in our studies (Volkoff & Strong, 2017). Table 2 presents the steps of the framework, and Figure 2 depicts the key questions in the affordance categorization process.

CASE DESCRIPTION

For the past 20 years, DHIS2 has afforded health managers the possibility of collecting, reporting, analyzing, and acting on timely health data. The Gambia, along with more than 70 other countries worldwide³, has been using DHIS2 as their national HMIS since 2010 (Valbø, 2010). The Gambia are now expanding the usage of DHIS2 and have implemented it as a backbone for their nation-wide EMIS (Valbø & Sanner, 2022). MoBSE performed a partial pilot of DHIS2 in 2020, using the individual student and registration component in DHIS2 at 200 schools.

DHIS2 is a free and open-source software platform, developed and maintained by the HISP Centre at the University of Oslo. Throughout the years a global network of local HISP nodes has emerged, and it is invested a lot of resources on capacity-building in the network to facilitate south-south collaboration. The Gambian EMIS team was trained on DHIS2 by HISP West and Central Africa, who helped them configure thematic dashboards and analysis tools in the software. One of the strengths of DHIS2, compared with other similar systems, is the HISP ecosystem – the increasing human capacity of the global HISP network.

Perspectives of the DHIS2-EMIS Implementation Process

To shed further light on the DHIS2-EMIS implementation process and the status in The Gambia, a few viewpoints from some of the interviewees are presented in the following. To better explain the educational sector of The Gambia and the informants' positions therein, Figure 3 shows the organigram of the educational sector in The Gambia. The figure was elaborated in cooperation with the EMIS team.

An EMIS Leader: Why They Migrated to DHIS2

With reference to a previous system that MoBSE had used as a backbone for their EMIS, an EMIS leader notes, “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 ... website”. Before they

³ <https://dhis2.org/about/>

decided to migrate to DHIS2, their plan was to stick with this previous system. However, the EMIS leader explains that the EMIS team felt that

we had a tool ... only Gambia was using. And as people are changing roles, ... 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, "I 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.

Benefitting from the HISP community, avoiding having only a few key persons that knows the system, the EMIS leader explains enthusiastically that "the goal is to get something ... like Facebook. *Everybody* uses it, whenever they want. Nobody controls it. So, data is just used."

An EMIS Consultant: The Configuration of DHIS2

A technical consultant for the EMIS implementation explains that before they embarked on the DHIS2-EMIS implementation, they looked at the internal functionality needs for a national EMIS and tried to see how best they could incorporate these needs into a DHIS2-EMIS implementation. The main role of an EMIS is to guide the ministry so that they understand the situation and can intervene and address gaps that are made visible through the data in the EMIS. To do so, the backbone system for an EMIS needs to be very flexible. The ministry can come with new needs and requirements, and "the EMIS is here to listen to all those needs and try as much as possible to incorporate them in the process" (the EMIS consultant). Some needs and functionalities were easy to incorporate, while others were not: "There are some adjustments that need to be incorporated within the DHIS2 system in order to respond better to EMIS functionalities and needs."

A Cluster Monitor: The Current Information Reporting Flow

A cluster monitor is responsible for following up a group of schools within an educational region in The Gambia. An interviewed cluster monitor explains the information reporting flow in his/her region in the following. The schools have time books for all teachers. Every day data is

collected, and the cluster monitor collects the data termly, one week after the term ends. The data reported include attendance, earning, delivery and assessment. The data collected are called Performance Management System (PMS) summary sheet, and the cluster monitor inputs name, employment number, and the details into the PMS software on the computer. “After doing that for the *whole* cluster ..., [I] put the data in my flash drive, go to the office, [to the] principal education officer there, and I will submit this data to them” (the cluster monitor). And then they will compile the data for the entire region. In this region there are 17 cluster monitors.

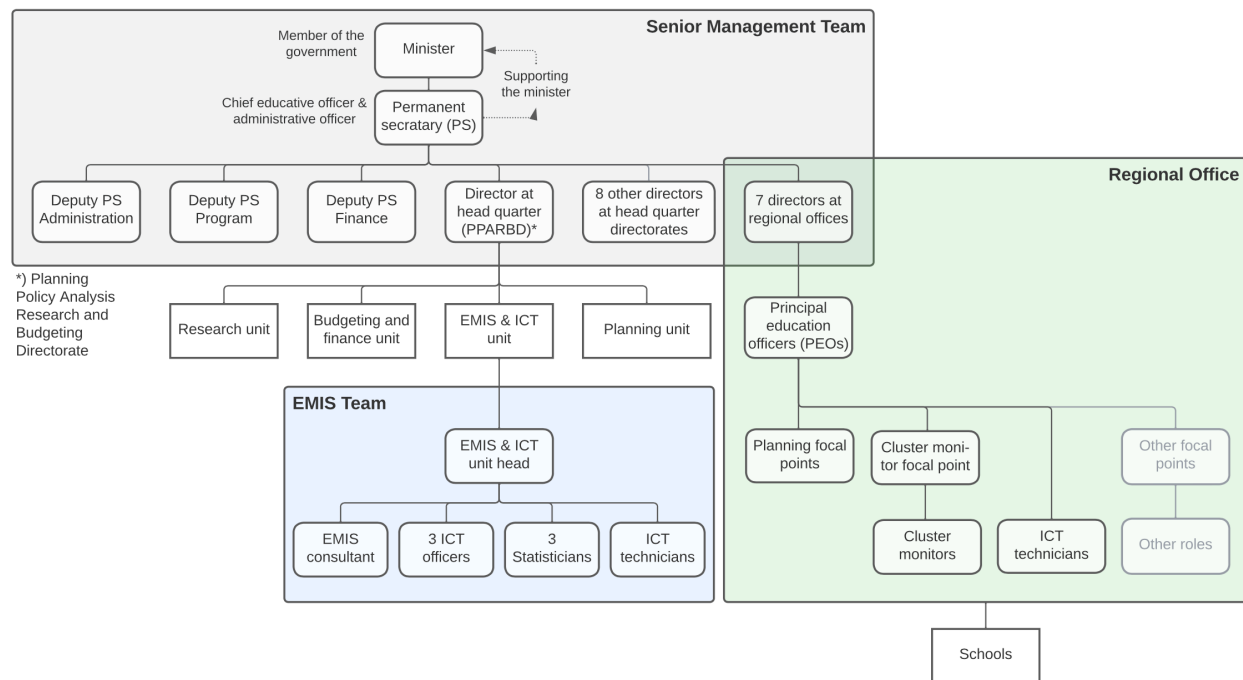


Figure 3. Organigram of the Gambian Educational Sector.

A Head Teacher: Collecting More Data with DHIS2

After the introduction of DHIS2-EMIS, a head teacher explains that more data is collected. Previously when parents came to enroll their children, “we write the name of the child, the date of birth, the address, and then the name of the parents and contacts” (the head teacher). But now they collect more data, like education level and work of the parents, where the child was born, and the child’s ethnicity and tribe. The latter are collected “so that at least we are to distribute them between their languages that they are going to have in their school.” All new information that are collected, are required from the planning unit. When it comes to reporting, the head teacher is currently writing reports using MS Office programs.

FINDINGS: THE DHIS2-EMIS AFFORDANCES

The stories from the employees at different levels in the Gambian educational sector reveal a complex picture. While ministry workers see the potential benefits of the flexible DHIS2 platform and the HISP community, the educational workers at school level are more practically oriented and do not have the same preconditions to perceive all benefits the migration to DHIS2 can bring. To put it bluntly, they just do as they are told, collecting more data than before because they are instructed to do so by MoBSE.

The analysis of the interviews revealed 93 perceived affordances. After thematically grouping these together, five overarching affordances remain and contribute to the explanation of the Gambian DHIS2-EMIS implementation process. These five affordances are presented in the following. Their interdependencies are illustrated in Figure 4.

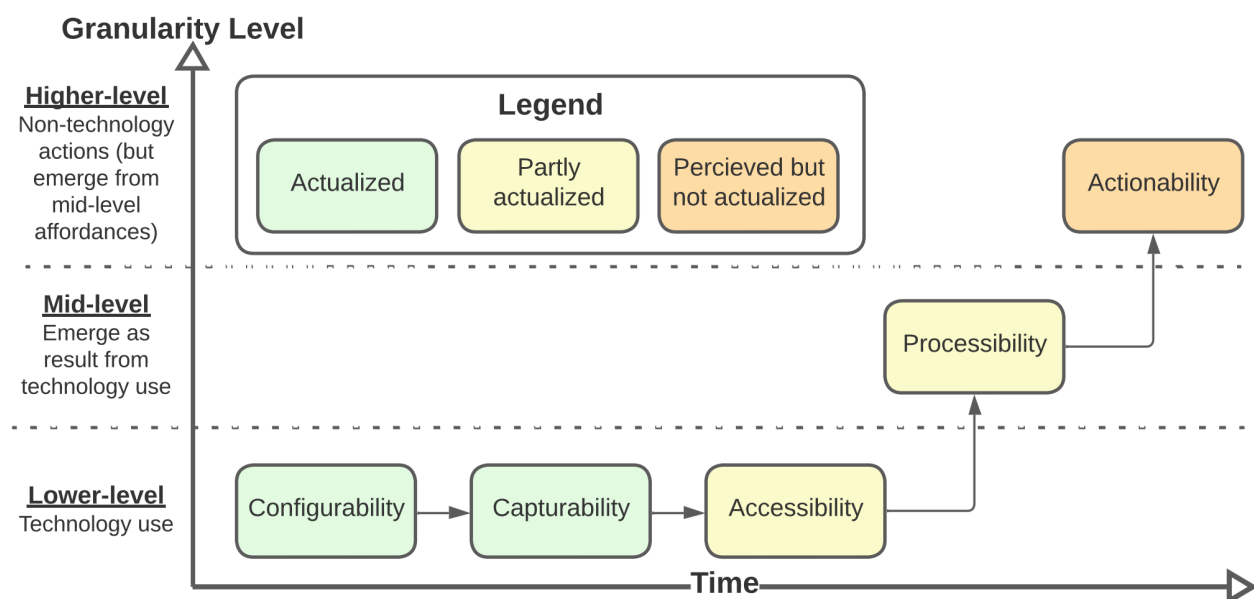


Figure 4. DHIS2-EMIS Affordances

Configurability

Configurability includes both initial and ongoing adaptation of DHIS2-EMIS. Stakeholders can adapt DHIS2 and prepare it for use. The configurability sub-affordances were identified solely by EMIS team members (a leader, consultant, and technician) and include developing apps,

creating dashboards, and designing forms and reports. Configurability relates to direct technology use and is considered a lower-level affordance.

Capturability

When DHIS2-EMIS was properly configured, stakeholders could start using the system. That is, they can now capture data about students and teachers. Once the data is registered, it is immediately accessible to higher-level stakeholders. The identified sub-affordances were perceived by stakeholders from all layers of the educational sectors and include collecting student information, entering children attendance, and sending and syncing data. Capturability relates to direct technology feature use and is considered a lower-level affordance.

Accessibility

Accessibility requires the use of DHIS2 features to access, interact with, visualize, and retrieve data. The accessibility sub-affordances are a 50-50 mixture of affordances that are already being actualized and perceived affordances not yet actualized. Some sub-affordances include accessing registered data, accessing data remotely and anytime, finding out educational level of parents, seeing children's results, and knowing attendance rate. The accessibility affordance entails direct access to data (i.e., no analysis) and is therefore distinguished from the processability affordance, which is explained in the following. Since accessibility relates to direct technology feature use, it is considered a lower-level affordance.

Processability

Once data is accessed, it can further be processed. However, activities such as data processing, analysis and interpretation requires human capacity to a greater extent than mere technology use. Since DHIS2-EMIS is still in an early phase, most of the processability sub-affordances are not yet enacted. Some of these sub-affordances include consolidating data, finding errors, analyze data on time, compare yearly trends, and monitor school clusters. All sub-affordances (except one) for the processability affordance were solely identified by EMIS team members (a leader, consultant, and technician). The processability affordance emerges from (and does not itself entail) direct technology use and is therefore considered a mid-level affordance.

Actionability

Because of timely reported, processed, and analyzed data, educational stakeholders can engage in planned activities and interventions to improve aspects of the educational sector. Some sub-affordances include distributing children according to languages, taking action to mitigate low attendance, and avoiding calling registers every day. These activity and intervention possibilities are included in the actionability affordance. Without processed data, these activities will not be carried out. The actionability affordance thus emerges as a consequence of the enactment of the mid-level processability affordance and is therefore considered a higher-level affordance.

DISCUSSION

The Role of Mid-Level Affordances

Figure 4 illustrates how the five overarching DHIS2-EMIS affordances play out over time and how they relate to each other. Not surprisingly, lower-level technology use affordances are actualized before the mid- and higher-level affordances. The number of lower-level affordances compared to mid- and higher-level affordances may have different explanations. For instance, affordance dependencies are seldom a one-to-one relation. That is, for an affordance to emerge, it may require the actualization of several preceding affordances. The findings from this study may indicate that there are less affordances at a higher granularity level. However, the actualization of one affordance may also lead to several new possibilities and result in the emergence of a multitude of new affordances at a higher granularity level. The latter would thus be an argument for more mid- and higher-level affordances than lower-level affordances. A more plausible explanation for the higher number of lower-level affordances in this study relates to the fact that the Gambian DHIS2-EMIS is still in an initial phase and has not yet been rolled out entirely. Actions that are already realized are obviously easier to perceive than non-realized actions. The mid- and higher-level affordances in this study are mostly perceived (and not yet actualized) action possibilities. In The Gambian case – at this point in time – it would presumably be easier to identify higher-level affordances by first identifying mid-level affordances and then ask the interviewees which action possibilities might emerge from the actualization of those.

What is evident, however, is that mid-level affordances play a vital role in this ICT-based development project, where the aim is to reach societal-level changes (equitable quality education). The trajectory along which higher-level affordances travel, goes from lower-level affordances through mid-level affordances. In this study, the actionability affordance can only be enacted after the actualization of the mid-level processability affordance. The processability affordance in turn depends on the actualization of the lower-level affordances of configurability, capturability, and accessibility.

Towards Societal-Level Changes

An actualized affordance has an outcome. While Volkoff and Strong (2013) speak of “achieving an immediate concrete outcome”, Du et al. (2019) dispute the necessity of *immediate* and *concrete* outcome in the affordance 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). Since the DHIS2-EMIS actionability affordance is not yet actualized, there are still no outcomes to observe and analyze for this affordance. However, the societal effects of an improved educational sector due to data-informed interventions is not hard to imagine. These effects are also presumably not immediate but something that will evolve over time. The *concreteness* of the possible changes in the educational sector and society may also be debated. Nevertheless, the societal-level effects will still be the outcome of the actualization of the higher-level actionability affordance.

Next Steps

Facilitating Conditions

The interviewees that are currently using DHIS2, have all received training in how to use the technology. That is, they have learned how to enter data and access data. But available data alone is not sufficient for decision-making purposes. In order to make informed decisions and act on them, it takes more than knowing how to use certain technology features. The trajectory along which the higher-level actionability affordance has travelled is quite long, from configuring DHIS2 and the first steps of data entry. For the actionability affordance to be actualized, actors must have actualized the preceding affordances configurability, capturability, accessibility and

processability. Additionally, facilitating conditions (Thapa & Sein, 2018) are also necessary for an affordance to be actualized. In a future version of this paper, effort will be made to identify these facilitating conditions.

Hunting Higher-Level Affordances

Since few higher-level affordances were identified, the questionnaire for the third field visit was focused more on future possibilities and dreams, in order to tease out perceived higher-level affordances in a project where few higher-level affordances are already enacted. The 13 interviews from the latest field trip are yet to be transcribed and analyzed.

CONCLUSION

This paper develops a stepwise framework for categorization of affordances in terms of granularity levels. The framework is developed based on 93 DHIS2-EMIS affordances identified through interviews with stakeholders from various levels in the Gambian education sector. The nested affordance process model supported the analysis of the affordances. The 93 affordances were abstracted to 13 thematic affordances, which in turn were abstracted to five overarching DHIS2-EMIS affordances: configurability, capturability, accessibility, processability, and actionability.

The actualization of the mid-level processability affordance is a requirement for the emergence and subsequent actualization of the higher-level actionability affordance. This illustrates the key role of mid-level affordances in an organization which aims for societal-level changes, since the trajectories along which higher-level affordances travel go through mid-level affordances before they subsequently may result in society-level changes.

In future work with this case, more in-depth analysis will be performed to identify the facilitating conditions for the presented affordances. Furthermore, the last 13 interviews have a stronger focus on the identification of higher-level affordances. The future analyses of these will presumably contribute to a deeper understanding of the interdependency between lower-, mid- and higher-level affordances, and how the actualization of these can lead to societal-level changes.

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APPENDIX

Affordance / Thematic affordance / Identified (sub-)affordance	Interviewee	Actualized
Configurability		
Customizability/Adaptability		
develop tools, like apps for teachers	EL	currently
trying to sell it to other institutions	EL	currently
customize almost everything	EI1	currently
create dashboards --> reporting	EI1	currently
capitalize on the functionalities	EC	currently
adjust DHIS2	EC	currently
customize towards our needs	EC	currently
format reports	EC	currently
design questionnaires	EC	future
design forms	EC	future
design reports	EC	future
Capturability		
Data collection		
data collection	EL	currently
collect data from schools and teachers	EL	currently
collect more data than before	HT	currently

collect student information	EI1	currently
Data entry (e.g., individual student info, attendance)		
data entry	EL	currently
CMs enter data	EL	future
enter data	HT	currently
enter children attendance	HT	currently
enter children enrolment	HT	currently
teacher attendance	HT	currently
attendance registering	HT	currently
enroll children	HT	currently
enter individual student info	EC	currently
entered student information to system	EI1	currently
input numbers	EI1	currently
enter student info	EI1	future
Data syncing/sending		
send data / sync data	HT	currently
send daily attendance	HT	future
send data with tablets	EL	currently
sending (attendance)	EI1	currently
send data	EI2	future
send attendance for your school	EI2	future
send data to ministry easily and fast	IT	future

Accessibility		
Accessing/using data anywhere, anytime (because of online availability)		
access data we entered	HT	currently
enable portable apps (i.e., mobile app)	EL	currently
ensures that people can use data, even on their mobile	EL	currently
use data overseas, anytime	EL	future
online access	EC	currently
use web or mobile	EC	currently
access remotely	EC	future
access data anytime	IT	future
parents can log in	EI2	future
Retrieve information		
inform us	HT	currently
know the background of the parents	HT	currently
find out if parents are educated	HT	currently
know if children are out of school	HT	future
get information of individual children	HT	future
see children's results	HT	future
extract tables (in work with yearbook)	EC	future
know attendance rate	EI1	future
get data (when talking about annual census)	EI2	future
outline if this teacher has moved from the school	EI2	future

Processability		
Data reporting		
report all data quickly (15 days)	EL	currently
data reporting	EL	future
Reporting	EI1	currently
generating reports	EC	currently
generating specific reports	EC	currently
generate user-based reports	EC	future
reports for different levels	EC	future
reports for minister, PM, directors, outsiders	EC	future
Analyzing		
consolidate data	EC	future
jump into analysis	EC	future
see interacting phenomenons	EC	future
see trends by regions, districts, and schools	EC	future
compare yearly trends	EC	future
find errors	EC	future
cross data (to have reports for minister and PS)	EC	future
Put information together / data mining	EC	future
link student information with social background of student	EC	future
help understand background of the student	EC	future
help understand the performance the student is able to achieve	EC	future
do investigations (on attendance, when aware of low attendance)	EI1	future

calculate financial spendings	EI1	future
Information processing		
combine reports to a book	EC	future
generate yearbook automatically	EC	future
Monitoring		
monitor your cluster	EI2	future
monitor directorates, regions, schools, teachers, students	EC	future
Tracking		
track student attendance	EC	currently
track the students	EC	future
track schools	EC	future
track children	HT	future
Actionability		
Informing parents		
show parents the children's performance	HT	future
tell parents the children's performance	HT	future
Intervening		
call parents and convince them to bring back their children to school	HT	currently
distribute children according to languages	HT	future
look at the interventions that need to be done (to arrive to the main goal)	EC	future
take action (if you know the attendance is low)	EC	future
fix errors (by studying details and finding errors)	EC	future

Intervene	EC	future
Punish	EC	future
Avoiding time-consuming tasks		
avoid calling registers every day	EI1	future
avoid roaming to see source of a student	EI1	future
<p>Interviewees:</p> <p>EL = An EMIS Leader</p> <p>EC = An EMIS Consultant</p> <p>EI1 = EMIS ICT Officer #1</p> <p>EI2 = EMIS ICT Officer #2</p> <p>HT = A Head Teacher</p> <p>IT = An ICT Teacher</p>		

Table A1. Identified Affordances