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AN ACTIVITY THEORY APPROACH TO AFFORDANCE ACTUALISATION IN MHEALTH: THE CASE OF MOMCONNECT

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Completed Research

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Abstract

There is a substantial body of research on mHealth interventions in low-resource settings, but little empirical understanding of use by staff in established health facilities. What evidence there is indicates divergent outcomes. In order to generate insight into this phenomenon we undertake an exploratory study of mHealth use in several public clinics, where the staff are required to perform a simple registration process for the MomConnect system.

We draw on the lenses of Activity Theory and affordance actualisation to assist in the analysis of the evidence collected, and find that professional identities, local priorities and technology features all interact in shaping the forms that mHealth use takes in practice. Based on this analysis we propose a set of higher-level concepts in order to compare case studies of mHealth use.

This research contributes to theory by proposing a framework for understanding mHealth use in existing facilities, with specific reference to low-resources settings. In addition we contribute to the literature on conceptualising affordance actualisation, drawing on Activity Theory. Finally, we inform practitioners by outlining important constraints that impede staff as they strive to accommodate this additional burden in their daily routines.

Keywords: ICT4D, mHealth, Low-resource setting, Affordance Theory, Activity Theory, case study

1 Introduction

Research on the implementation of mobile applications to support health care (mHealth) has received increasing attention in recent years (Chib, van Velthoven, & Car, 2015; Free et al., 2013). There is limited understanding of the way that these innovations are adopted in practice in existing institutions, and how this relates to the specific characteristics of the technical system. In addition, researchers have questioned whether mHealth solutions are effective and scalable (Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). This emphasises the importance of better understanding mHealth implementations in established health facilities.

Currently it is unclear what the dynamics underlying staff use of mHealth are, and how they are influenced by the technical choices of the mHealth solution. Characterising affordance actualisation in low-resource mHealth implementation is thus a matter of pressing importance to understanding broader issues of scalability and sustainability (Sahay, Monteiro, & Aanestad, 2009; Sahay & Walsham, 2006), that are important for policy makers and scholars alike.

Recent research has convincingly argued that understanding routine IS use requires an attention to the work practices in which this takes place (de Guinea & Markus, 2009; Riemer & Johnston, 2014). Activity Theory is a practice-oriented theoretical framework with which to interpret data gathered from intensive research dealing with information systems (IS) implementations (Kaptelinin & Nardi, 2009; Star, 1998). Situating the concept of affordance actualisation in the framework of Activity Theory

allows us to extend affordance analysis to better take contextual issues into account in understanding the phenomenon.

Affordance theory has been increasingly explored in recent years as a way to come to grips with the specific characteristics of various forms of IT applications, and their use in practice (Balci, Rosenkranz, & Schuhen, 2014; Choy & Schlagwein, 2015; Lindberg, Gaskin, Berente, & Lyytinen, 2014; Pozzi, Pigni, & Vitari, 2014). Aspects of Information Systems (IS) that have been explored include software development (Lindberg et al., 2014), social media (Choy & Schlagwein, 2015) and human-computer interaction (Kaptelinin & Nardi, 2012), as well as more theoretical extensions (Gaskin, Berente, Lyytinen, & Yoo, 2014). Research on affordances in the health sector has been less extensive (Strong et al., 2014).

Our core research question is *what are the key drivers of affordance actualisation in mHealth use by facility staff, in a low-resource setting*? We use a field study to address this question, as the existing literature does not provide a solid basis for advancing understanding. The MomConnect maternal health messaging system was launched in South Africa in August 2014. An empirical study of selected public health clinics implementing MomConnect is reported on in this paper, examining the relationship between a specific system affordance and how it was actualised in practice.

Following this introduction we review the literature on affordances and activity theory, and examine how affordance theory may be framed using Activity Theory. After this we present the study methodology, and the research setting. We then move on to the empirical findings. After the discussion, we present our conclusions.

2 Theoretical Background

2.1 Activity Theory

The most fundamental concept in Activity Theory is that of *activity* (Engeström, 1993; Kaptelinin, Kuutti, & Bannon, 1995; Nardi, 1996). An activity happens when a subject (a person or group of people) attempts to achieve a specific goal (known as the object of activity) using one or more tools (Kaptelinin & Nardi, 2009). This tool is not necessarily a physical object like a hammer, a tool may be a concept that is used to advance ways of reasoning, or an information system that is used to enter and manipulate information (Leonardi, 2012). The concepts of subject, object and tool are interrelated, and together form an activity system. In Activity Theory, the nature of reality (ontology) is fundamentally relational, as the subject, the object and tool derive their nature from their ongoing engagement in goal-directed activity.

Activity Theory argues that the process of attempting to achieve the object of activity is a dynamic one, as the actual outcome may not be satisfactory, leading to a realignment of the activity system as the subject attempts in different ways to realise the intended object of activity (Vygotsky, 1978). Another important concept in Activity Theory is that of contradictions. Activity Theory holds that activity systems generally contain contradictions that place stress on the system, that may be identified from empirical data in the form of breakdowns and recurrent problems (Kuutti, 1999).

An organization may also be understood as a series of nested activity systems. These systems may contain contradictions both within themselves and between the different systems. The constructs of Activity Theory have been used successfully in a small but growing stream of IS research (Karanasios, Allen, & Finnegan, 2015; Korpela et al., 2004), including those with a focus on mobile technology use (Allen, Brown, Karanasios, & Norman, 2013).

Engeström (1999) proposed an expanded version of the activity system that identified aspects of the social world relevant when applying Activity Theory in an organisational context. This model has

found acceptance in the Activity Theory community as a useful device (Kaptelinin & Nardi, 2009) and is shown in Figure 1 below.

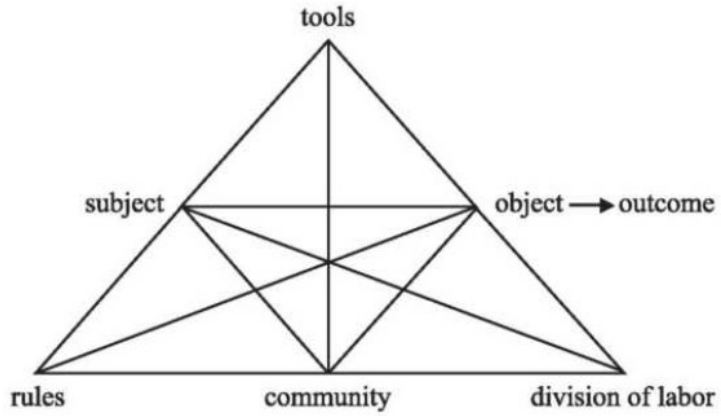

Figure 1 The Activity System Model (Yrjö Engeström, 1999)

We use the lens of Activity Theory in this research to analyse the dynamics of mHealth use by facility staff. Using Activity Theory allows us to consider the influence of the mHealth solution in the context of existing work practices, tools and the broader context of the health facility.

2.2 Affordances

The concept of affordances has been introduced into IS from ecological psychology in order to bridge the divide between the nature of the IT artifact and social context (Leonardi, 2011; Markus & Silver, 2008; Strong et al., 2014). The concept was originally defined as an opportunity for action offered by the environment to an organism (Gibson, 1979), that is perceived directly rather than being the result of rational reflection. The definition of affordance adopted in this research is therefore a relational one, in line with the ontology of Activity Theory, based on that of Markus and Silver (2008). In their words, affordances are "the possibilities for goal-oriented action afforded to specified user groups by technical objects" (p.622).

There has been ongoing debate about the nature of affordances (Baerentsen & Trettvik, 2002; Faraj & Azad, 2012; Gaskin et al., 2014; Kaptelinin & Nardi, 2012), but much of the research to date has focussed on conceptual discussions (Strong et al., 2014). While there is growing support for a relational definition of affordances as appropriate for IS research (Faraj & Azad, 2012; Kaptelinin & Nardi, 2012; Leonardi, 2011), the concept has been operationalised in slightly different ways in empirical studies.

When the concept of affordances is applied in empirical contexts, it becomes necessary to extend it to take account of the complexities of actual work practice involving ICTs (Bernhard, Recker, & Burton-Jones, 2013; Leonardi, 2011; Strong et al., 2014). Some extensions that have been proposed include distinguishing individual from group-level affordances (Leonardi, 2013), as well as identifying "bundles" of affordances and teasing out the actualization of affordances (Bernhard et al., 2013; Strong et al., 2014). Strong et al (2014) is one of the few research papers applying the concept of affordance in a health care context.

Our interest in this research is in mHealth use in practice. We therefore focus on the process of affordance actualisation, and the multiple ways that "possibilities for action" are realised by different user

groups. In the next section we set out the argument for using affordance actualisation as a way to focus Activity Theory analysis to understand mHealth use.

2.3 Activity Theory and Affordance Actualisation

Activity Theory offers a structured framework with which to analyse IS use in practice, in organisational settings. The empirical analysis of affordances actualisation as a relational process is currently underdeveloped. Grounded Theory (Strong et al., 2014) and Critical Realism (Bygstad, Munkvold, & Volkoff, 2016) have recently been proposed, but both approaches lack the strong focus on goal-oriented action that is the hallmark of Activity Theory.

Activity Theory is particularly suitable as a framework in which to analyse activity actualisation because of its strong relational ontology. While the activity system uses terms like "subject", "object" and "tool" that might be mistaken for static constructs, these are all in dynamic relationship and constantly lead to transformation through their interaction (Allen et al., 2013). One of the key dynamics in Activity Theory is the constant tension involved in the attempt to better realise the intended object of activity in relation to actual outcomes, and the internal and external contradictions that need to be managed in this process.

We propose that for Activity Theory offers a suitable framework for empirically analysing affordance actualisation, because of the their overlapping approaches to understanding IS use. The outcome of goal-directed activity may be considered as users' actualisation of the aggregated "possibilities for goal-oriented action" offered by the IS tool. At the level of an individual user, the "tool" in the Activity System may be considered as equivalent to a technical object, defined as "IT artifacts and … component parts" (p.620, Markus and Silver, 2008). The dynamic resulting in the actualisation of affordances may be reconceptualised as the operations of an Activity System, at the level of an individual interacting with the technical features.

In this perspective, activity actualisation may be considered to be the process that takes place as specific user groups make use of the technical features of a particular mHealth system, to realise its functional affordances. This framing of the concept of affordance actualisation provides a way to relate affordances to the organisational context in a structured way. At the same time, using the concept of nested activity systems, Activity Theory allows us to understand how affordance actualisation takes place at different levels of an organisation, and the relationship between these levels. It can also account for broader contextual influences.

3 Research Method

We used an exploratory case study to address the research question, as routine mHealth system use by facility staff is a relatively new phenomenon, and little understood. An inductive methodology was used to identify key themes and concepts (Sarker, Xiao, & Beaulieu, 2013), and then our hybrid lens of Activity Theory and affordance actualisation was used to guide further analysis. The approach was therefore anchored in the empirical data, but full grounded theory methodology was not used (Matavire & Brown, 2011).

Our case study investigated the implementation of the maternal messaging mHealth solution known as MomConnect (SABC Digital News, 2014). We drew on this for our case study, as MomConnect is one of the first large-scale mHealth rollouts in a low-resource setting (South Africa), and we were able to obtain access to a number of sites where the rollout took place. MomConnect requires facility staff to register pregnant women in order for them to obtain the full set of messages from the system.

The field study was carried out approximately six months after the launch of MomConnect, so that we could study routine use of the system. After an initial round of data collection we returned to the field some months later, to conduct additional observation sessions so that we could develop a fuller picture

of how the use practices were playing out. Initial interviews were held with a range of stakeholders to obtain background information on the project. More formal interviews were conducted with clinic staff to obtain their perspective on MomConnect, as the users in the facilities. Non-participant observation sessions were also held. In addition, we collected project documentation and consulted web sites to develop a fuller picture of the implementation. Details are provided in Table 1 below.

Interview Data	Observation and Other Data
• Interviews with Clinic Staff (Four with facility managers, three with ANC nurses, five with support staff)	• Direct Observation of Registration Process (eighteen sessions in total) • General Clinic Observations (six partial and three full days) • Field Notes (Over 192 A5 pages of handwritten notes) • Training and Promotional Material (over fifteen documents)

Table 1. Summary of data collected and analysed

The clinics included in the research were selected on the basis of their accessibility to the research team, through an established association with the Wits Reproductive Health Institute. All of the clinics fall under the City of Johannesburg Health Department. Open-ended interviews were held with the facility manager at each clinic, with the nurse responsible for providing antenatal services, and with any other staff involved in MomConnect registration that were identified by the nurse. Each of these interviews was recorded with the permission of the informant, and professionally transcribed.

Observation sessions of MomConnect registration were also negotiated with the informants, typically for the first half of a morning. General observation of clinic routines was also performed over at least three days, with a minimum of one full day being spent in each clinic. Field notes were made during each observation session, and reviewed as soon as possible afterwards. Work pressure in the clinics meant that interviews and observation sessions not infrequently had to be rescheduled, and lead to substantially more time being spent in the clinics than is reflected in Table 1.

The interview transcripts were loaded into qualitative data analysis software ("Atlas.ti," 2015). Initially the transcripts were coded using open coding (Saldaña, 2013). The initial codes were then grouped according to themes identified from the literature review, and emergent concepts were identified. Hermeneutic analysis (Klein & Myers, 1999) was used to move between the coding of the transcripts and the relevant literature, in order to refine the codes and themes, and develop higher-level concepts. Information from field notes and informal conversation was also taken into account in this process.

4 Research Setting

South Africa is one of the few countries where child mortality has increased since the baseline set for the Millennium Development Goals in 1990 (Chopra et al., 2009). MomConnect is part of the ambitious National Health Insurance initiative, that aims to improve public health by upgrading the availablity and quality of services (Department of Health, 2012a, 2012b).

MomConnect is a free SMS-based mobile messaging service. It provides informative messages to pregnant women, and to mothers with children under one year in age, in order to help them look after their own health. In addition, it provides facilities for them to report on their satisfaction with the services provided in the clinic, as well as to ask questions of their choice to a central team under the supervision of a professional nurse at the NDoH.

Community health workers or pregnant women are able to perform registrations for MomConnect, but a full set of messages will only be provided if the woman is registered at a clinic. The clinic staff are thus involved only peripherally as users of the system, but they are gatekeepers of access to the ser-

vice. Regional health managers also receive statistics of the number of women registered at the clinics from the NDoH central database, allowing them access to these figures well before the rest of the clinic data. Most clinic reporting is provided by the facility in the form of monthly paper reports.

The MomConnect mHealth service uses the Unstructured Supplementary Service Data (USSD) protocol to register users. MomConnect registration involves entering a standard code to initiate the registration process. The phone number for SMS message delivery is then required, followed by the unique clinic code. Finally, the baby's expected date of delivery and the woman's passport or identity document number need to be entered before she can start receiving biweekly messages.

5 Empirical Findings

5.1 Overview

Primary health care clinics in South Africa are run by facility managers, who are typically registered nurses. These facility managers supervise other nurses who provide care in the different sections of the clinic. Primary health care services include HIV testing and treatment, family planning, antenatal and postnatal care, and chronic illness management.

In clinics that we observed, the nurses recorded the patient's details in large registers, that took up a large part of the surface of their desks. Nurses generally did not have access to a computer, and most reporting was done by hand. The ANC consulting rooms typically each contained a desk and chair for the nurse, a chair for the client (or more, depending on the size of the office), and an examination couch. Other equipment such as weighing scales typically stood outside the consulting rooms in a common area.

MomConnect registration typically took place as part of antenatal care services, under the management of the nurse in charge. The nursing staff were supported by a variety of other designated staff, including community health workers, health promoters and volunteers who received a small monthly stipend. There were also clerks and general workers who assist in administrative and other duties. For the sake of brevity we will refer to non-nursing staff as support staff from here on.

The MomConnect registration process within the clinic may be understood as three nested activity systems oriented around three different goals: clinic management by the facility manager, ANC service provision as the responsibility of the ANC nurse, and MomConnect registration as arranged by the ANC nurse (Wolff-Piggott, Coleman, & Rivett, 2016). In contrast to many studies of affordances in the IS literature, MomConnect use is characterised by high levels of professional flexibility by the responsible user group in a front-line service bureaucratic environment, and severe resource constraints. Further, the affordances of MomConnect are primarily intended for the use of pregnant women, rather than the clinic staff.

5.2 Activities and Contradictions

Interviews at facility manager, ANC nurse and support staff levels provided more details of their different levels of focus, and how they related to MomConnect use as a result. The facility manager was concerned with ensuring that all units of the clinic were providing adequate care, and balancing resources across the clinic to ensure that critical shortages were addressed. In several interviews and informal conversations it became clear the clinic management involved continually making trade-offs, as it was not possible to meet all the demands on the clinic with the available resources.

Nurses examined clients and diagnose health issues all morning, and sometimes well into the afternoon from their designated rooms. A nurse was responsible for attending to all clients in her section, before moving across to help out in another one, in case of an event such as another nurse being on unexpected sick leave. The mass of clients requiring attention and the shortage of staff meant that

nurses in particular were torn between attending to each client as rapidly as possible ("pushing the queue"), and taking the time to ensure that no significant symptoms were missed in each consultation.

MomConnect registration practices seldom involved the nurses performing registrations themselves. This trend, and the influential role of nurses in the clinics leant weight to the respondent who stated directly that MomConnect registration was not seen as in line with the scope of professional work of a nurse. Shortage of professional nursing staff and time were also mentioned as constraining the involvement of nurses in MomConnect use: "Work is added ... (by) this Mom Connect, it's on top of other things".

The work practices around MomConnect registration differed in each case, but many of the same themes appeared across clinics. In the one case where there was a nurse present when registration was taking place, it was in a clinic where the support staff member and nurse typically saw patients together. This meant that the nurse was able to expand on key points raised by the health promoter. Pregnant women were then asked to enter the registration information themselves, in a group setting.

In the other clinics, the support staff member would provide an educational talk to the mothers, and close off by introducing MomConnect as an important source of information. They would then write down the mother's details if they were interested in registering, and do the registration on a personal handset later in the day in a staggered process. This had the advantage that the staff member worked with a known (own) handset, as one of the issues raised in the other clinics was that working with the mother's handsets meant having to navigate a wide range of devices every day.

This description has indicated that both the facility level and ANC activity systems operate under severe resource constraints, and contradictions arise as a result. In the following section we discuss the MomConnect registration affordance as it was observed to operate in practice.

5.3 MomConnect Registration: Handset and System Affordances

The literature suggested that mobile phone use, certainly in urban areas such as Johannesburg, should be quite unproblematic. This was not found to be the case, with informants reporting that clients not infrequently either did not have a mobile handset, or there was a perception that they were not able to use it effectively. Urban South Africa has a percentage penetration of cell phones, and most clinic clients had one in their possession when they attended. Concerns cited regarding confidentiality of information submitted at the clinic could explain this: "... some of them are HIV positive so they are scared that we will be sending information on HIV, and some of them haven't disclosed and sometimes they share the phones".

When MomConnect registration sessions are observed, a number of issues were seen to arise. On the one hand, when group registrations were carried out by the pregnant women, language became an issue. There are eleven official languages in South Africa, and large immigrant populations from other African countries in Johannesburg. The pregnant women were not infrequently unable to read English, and the registration menu was only available in English. The registration menu was intended for use by clinic staff, who are all required to be English literate. Some women were observed to need assistance from those sitting next to them, as a result of this issue.

The staggered registration process, carried out by support staff after the individual consultations had been held between the mothers and the ANC nurse, also encountered difficulties. The USSD mechanism for the registration process was familiar to the clinic staff however USSD is the lowest priority protocol handled by GSM cell phone towers, and this service suffers first if there is congestion. Registration sessions were often dropped, which made it necessary to restart the registration process. This was not only time consuming, but also lead to some discouragement of the support staff who were charged with doing the registrations. The more enthusiastic staff resorted to performing registration after hours at home, but this raises a question as to whether this is sustainable.

6 Discussion

6.1 MomConnect Registration as Affordance Actualisation

We took the perspectives and practices of facility staff as our point of departure in our research, in order to develop our approach to affordance actualisation. We drew on Activity Theory as a framework because it provides a structured set of concepts with which to analyse goal-oriented action, while being flexible enough to use in interpreting data collected using open-ended interviews and observation (Kaptelinin & Nardi, 2009; Star, 1998). Prior research on the affordances of mobile information systems has emphasised their relevance for promoting the development of individual routines (Boillat, Lienhard, & Legner, 2015). Our research builds on this by setting affordance actualisation in a socio-technical context, and taking explicit account of the low-resource setting.

Using Activity Theory, we described MomConnect use in the facility in terms of a series of nested activity systems with different goals. At the facility level, the relevant goal of the manager is to ensure the effective operation of the clinic by allocating resources in a way that meets the most urgent needs. The low-resource environment and high demand for services ensure that all the needs of clients cannot be met at the same time, and trade-offs are an integral part of this activity. This issue arises in front-line public service delivery both in developed and low-resource contexts (Lipsky, 2010).

When we considered MomConnect registration in ANC care, we clarified that it is peripheral to the duties of the ANC nurse and her professional identity. In the same way as the facility manager, the ANC nurse has to make decisions as to where to allocate resources and where to delegate less important work, in order to try and offer a high level of service to each woman and still see all those who arrive for service. Pregnant women in South Africa not infrequently struggle to obtain access to public health services (Solarin & Black, 2013), and struggle with multiple health conditions and other poverty-related issues (Scorgie et al., 2015).

This activity system analysis helps explain why MomConnect registration is commonly delegated, either to support staff or to the pregnant women themselves, rather than being carried out by the nursing staff as suggested in the training material. This is in line with related research on the implementation of HIT, where doctors often delegate data entry tasks to nurses. It suggests that the professional aura previously associated with IS, or in this case mHealth (Prasad, 1993; Scheepers, Scheepers, & Ngwenyama, 2006), is no longer evident in this low-resource setting.

We have described the general work practices in the clinic, as well as the specific ways in which registration was carried out. Affordance actualisation at the individual level also gave rise to breakdowns and recurrent obstacles. In the case of the pregnant women, it was most commonly observed as their difficulty in using the English-only registration menu. The quotes regarding difficulties experienced with the absence of handsets suggests that there was possibly passive resistance also happening, as a results with confidentiality concerns.

We present a schematic diagram of the actualisation of the MomConnect registration affordance in Figure 2 below. It indicates how multiple influences interact to result in multiple forms of actualisation. We have simplified the different activity systems within the clinic into one, and omitted the interactions of the pregnant women with the process for the sake of clarity. The actualisations are shown as both being a result of and an influence on the main activity system. A hypothetical example of an influence from the affordance actualisations to the main activity system would be if inefficient registration lead to complaints from pregnant women to the clinics.

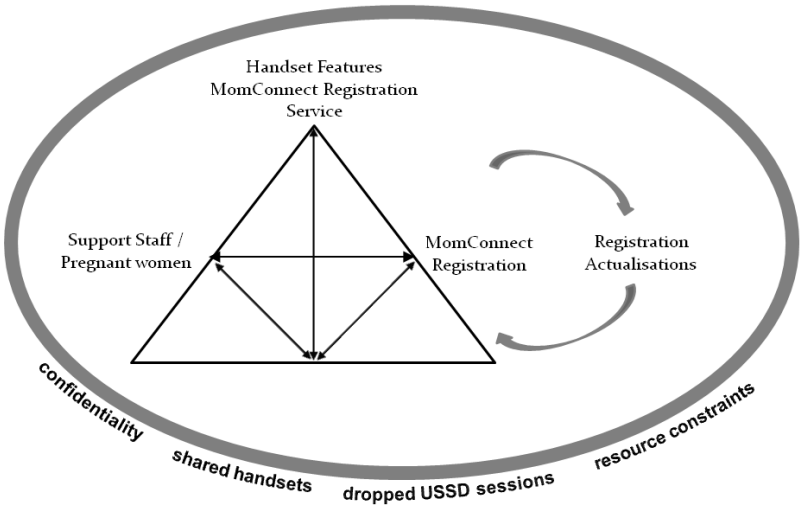

Figure 2 MomConnect Registration as Affordance Actualisation

6.2 Other Frameworks for Affordance Actualisation

Researchers have proposed affordances as a building block within other frameworks, for example mid-range theories of EHR implementation (Strong et al., 2014), Critical Realism (Bygstad et al., 2016) and sociomaterial routine analysis (Gaskin et al., 2014). Sociomaterial routine analysis proposes a computational approach, and the use of affordances in terms of categories of functionality that are incorporated into routines. Gaskin et al (2014) note that this approach may draw on idiographic analyses, but is not directly compatible. Our framework illustrated above is a mid-range formalisation, and we believe that it may be generalised, thereby contributing to narrowing the gap between ethnographic and computational approaches.

Bygstad et al (2016) suggest the use of affordance actualisation as the mechanism by which IS artifacts influence observed outcomes, enabling them to propose a framework for carrying out systematic analysis of empirical phenomena within Critical Realism. This is primarily a methodological contribution, but it is worth noting that their model of "affordance structure" involves interaction between agents, affordances and the environment to produce specific outcomes, quite similar to the model depicted in Figure 2. Activity Theory is broadly complementary to Critical Realist analysis (Allen et al., 2013).

Strong et al (2014) provide an account that also addresses IS implementation in the health sector. Their study dealt with the implementation of an Electronic Health Record (EHR) system, and they identified multiple affordances that they examined in a longitudinal study. Their mid-range theory of EHR affordance actualisation identified goals at different levels in the organisation, and also drew on a relational definition of affordances. We complement their grounded theory-based approach with an Activity Theory framed analysis specifically aimed at mHealth use.

Our use of Activity Theory to analyse affordance actualisation has enabled us to integrate consideration of organisational, technological and individual influences on the dynamic driving the forms that they were seen to take. In this way it builds on the strength of inductive approaches to affordance actualisation (Strong et al., 2014), but can also provide guidance in abstracting to higher-level concepts in a way that preserves the agency of organisations, individuals and the tools that they draw on.

6.3 Derived High Level Concepts

In this section we describe several high-level concepts that we developed inductively in the process described of the analysis described in the previous section. While they are drawn from an Activity Theory based understanding of mHealth, we believe that they are general enough to be useful to most analytical approaches that are based on a sociotechnical approach to the topic. These concepts are not intended as static constructs, but as dynamic and inter-related elements to draw on when framing studies of mHealth use by facility staff, particularly in low-resource settings.

A previous analysis of MomConnect (Wolff-Piggott et al., 2016) indicated that the national implementation of MomConnect could be represented as a larger activity system, with the goal of improving the health of pregnant women at a national level. Facility level registration occurs at multiple local sites that are integrated with the rest of the Health Department via management structures, and the technical infrastructure provided by the cellular networks and the recording of registrations on a central MomConnect database.

Previous research on distributed systems has suggested that this requires a focus that extends beyond the specific sites being studied (Monteiro, Pollock, Hanseth, & Williams, 2012; Williams & Pollock, 2012). Our empirical focus has been on affordance actualisation at facility level. In order to be able to extend our analysis to other low-resource mHealth services we need to distinguish between the types of user targeted in relation to different types of functionality.

Accordingly, we propose the concept of *affordance focus,* to be able to distinguish between situations where the affordances of the system are primarily intended for the use of the facility staff, or for other users (in the case of MomConnect, pregnant women). This is particularly important for mobile service delivery, where there may be diverse user groups who engage with the system. Affordance focus encompasses the designed affordances intended for use at facility level, and the user groups and work practices that are targeted.

Another group of users who are important in HIT implementation, and especially in mHealth, are managers who are enabled by the near real-time data collection activities of the front-line staff (Asangansi & Braa, 2010; Wears & Berg, 2005). This data gives them visibility into the operational activities of staff that is far greater than the largely paper-based reporting systems (Leclercq-Vandelannoitte, Isaac, & Kalika, 2014) in low resource settings allows. Traditionally, health professionals have exercised a substantial degree of discretion in providing their services, and in public health facilities this has been accompanied by a bureaucratic style of organisation. Recent research has suggested that mHealth potentially disrupts these organisational relationships (Asangansi, 2016), by enabling centralised monitoring of progress and reducing the role of middle-managers in information management. We therefore suggest that another important aspect of mHealth use in existing facilities is the level and type of management control exercised on the basis of mHealth use. We term this *external motivation* from the perspective of the local facility.

When we undertook our field study, the level of management feedback was low, and the processes internal to the facility were dominant in driving affordance actualisation. In our empirical work we distinguished different levels of goal-oriented activity, organisational phenomena such as professional identity at work within the facility as well as individual responses that influenced MomConnect registration in practice. We use the term *internal motivation* to refer to this array of influences on affordance actualisation.

Finally, the specific technological features of the affordance (and supporting infrastructure) need to be considered in context, as a sociotechnical complex. In this case study, mobile handset and USSD communication use were familiar to the clinic staff and clients because of their widespread availability. Despite this, some issues arose because of client confidentiality concerns on the one hand, and the

challenges to time-constrained staff because of dropped USSD sessions on the other. We term this-*contextual technology fit*.

We present the four high level concepts with examples drawn from the literature in Table 2 below.

Concept	Description	Examples
Affordance Focus (of mHealth system)	The degree to which the system affordances are directed to supporting or transforming current staff activities, the type of practices involved, and the target user group.	Wolff-Piggott et al (2016): (MomConnect) Low degree of focus, additional rather than supportive/transformative, impacts on ANC work practices, aimed primarily at ANC nurses.
External Motivation (of facility staff)	Influence exerted from outside the facility to ensure system use e.g. Management measures, alignment with other directives or policy initiatives.	Mukherjee (2015): National budget transfers to states and individual remuneration are linked to number of registrations of pregnant women and small children.
Internal Motivation (of facility staff)	The extent to which system usage aligns with motivating factors, professional hierarchies and divisions of labour etc within the facility. At different levels of staff.	Wolff-Piggott et al (2016): (MomConnect) Alignment with professional identity low in the case of nurses. Task-shifting to support staff and pregnant women occurs in line with existing practices in the clinic regarding non-professional tasks.
Contextual Technology Fit (of affordances with the facility activity system)	How well the technical features of the mHealth system fit with perceived needs, available technological resources and skills (activity system) of the facility staff. Consequent requirements to improve this e.g. training, technical support.	Purkayastha, Manda, & Sanner (2013): DHIS2 offers internet-based submission of standard reports. Promises to save out-of-pocket expenses involved in transporting paper reports. Requires provision of internet connectivity and training.

Table 2. Summary of High-Level Concepts

7 Conclusion

The research presented here has summarised our empirical findings and analysis of affordance actualisation, in a clinic-level investigation of the MomConnect project in South Africa. Drawing on this field study we have illustrated how Activity Theory may be used to provide improved analytic insight on key drivers behind the observed work practices, and contributed to the limited empirical literature on the mechanisms underlying routine mHealth use (Chib et al., 2015). We have also tentatively suggested high-level concepts for framing research on mHealth use in existing facilities, providing a basis for comparing case studies more systematically.

We proposed the concept of *affordance focus* to distinguish between situation where user groups and work practices in facilities are centrally or peripherally targeted by the designers. We also argued for *external motivation* as the various means of influence exercised on the facility by higher management. *Internal motivation* describes the motivating and controlling processes occurring within the facilities, such as professional identities, formal hierarchies and personal motivations. Finally, we suggested *contextual technology fit* as the way in which a proposed mHealth solution satisfies actual user group needs, meshes with work practices, and available technical resources.

We contributed to theory more broadly by developing an Activity Theory-framed approach to affordance actualisation that we illustrated in our analysis of the case study. In our belief, this framework provides a sound basis for generalising this approach to other cases of IS affordance actualisation. We also compared this approach to other frameworks which have proposed the use of affordances to investigate empirical phenomena, such as Critical Realism (Bygstad et al., 2016) and sociomaterial

routine analysis (Gaskin et al., 2014). In this way we built on existing research on theorising affordance actualisation, as well as empirical analysis of this process (Strong et al., 2014).

Future research could fruitfully explore how the proposed model of affordance emergence may support future theoretical development, as it is general in nature. In particular, by extending it to cater for more complex affordance actualisation than the one explored here. We are planning to embark on comparative empirical studies of mHealth use, and would welcome collaboration with other researchers interested in this area.

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