MHealth systems, Transformations in Work and Implications for Sustainability

By

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To maama and taata

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<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CHW</td>
<td>Community Health Worker</td>
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<td>DHO</td>
<td>District Health Office</td>
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<td>HIS</td>
<td>Health Information System</td>
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<td>HSA</td>
<td>Health Surveillance Assistant</td>
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<td>ICT</td>
<td>Information and Communication Technology</td>
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<td>ICT4D</td>
<td>Information and Communication Technology for Development</td>
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<td>IS</td>
<td>Information Systems</td>
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<td>IT</td>
<td>Information Technology</td>
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<td>MDGs</td>
<td>Millennium Development Goals</td>
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<td>MoH</td>
<td>Ministry of Health</td>
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<td>NGOs</td>
<td>Non-Governmental Organizations</td>
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<td>SDGs</td>
<td>Sustainable Development Goals</td>
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<td>UN</td>
<td>United Nations</td>
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<td>VHT</td>
<td>Village Health Team</td>
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<td>WHO</td>
<td>World Health Organization</td>
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Abstract
There is an immense proliferation in mobile health innovations in healthcare, also referred to as mHealth systems. These innovations have taken root in developing countries with ambitions to revamp healthcare service provision through mobile technologies that are a cheaper alternative, widely used and reach a clear majority of regions in the developing world. However, the ambitious benefits associated with mHealth implementations have proven difficult to achieve and the mHealth systems, difficult to sustain. Without sustainability, there is no optimization of the potential benefits of mHealth systems and failures impact already weak Health Information Systems in these contexts.

This thesis is positioned within the Information and Communication Technology for Development (ICT4D) field that has indicated sustainability as both hard to actualize and conceptualize. The thesis develops a refined understanding of mHealth sustainability by using material from two interpretive case studies in Uganda and Malawi. In Uganda, the mHealth system was designed to support weekly reporting on maternal and Infant health data and was rolled out to Village Health Teams in over ten districts. The Case in Malawi was designed for decision support and rolled out to Health Surveillance Assistants in two districts.

Through this work, the thesis proposes a reorientation of the way the concept of sustainability is dealt with by positioning work practices as an integral part of the concept. mHealth sustainability in this thesis is translated into a need to understand work transformations that occur in the work practices of community health workers. The thesis draws inferences from these transformations to identify how local sustainability is achieved and then broadly links local sustainability to the health system organization by identifying organization structures that should be in place to maintain both the mHealth systems and the work practices they support.

This work contributes to literature concerning Information Technology for Development by uncovering micro-level based social activities and how they generate reinventions in work and the technology to sustain mHealth solutions. The thesis also contributes by further linking work transformations to broader health system organizational structures of sustainability. By linking local practices to broader organizational structures, the thesis also makes practical contributions to health providers and policy makers by deemphasizing controlled approaches to mHealth systems development and implementation to enabling more open strategies that
accommodate learning to identify locally relevant solutions. This can guide policy to make corresponding modifications in the organization structures to sustain mHealth initiatives.
Chapter 1: Introduction

1.1. mHealth systems, whose sustainability?
On a hot afternoon in January 2017, two colleagues and I are on our way to meet a village health team member (VHT) at her place. In an earlier telephone conversation, she told us she would be available at 2pm after working in her garden in a small village in Kibaale district, western Uganda. We are driving from a small trading center where we found some basic lodging. We drive on a dirt road for 6 kilometers. “It should be impossible to drive on these roads when it rains”, my colleague comments on the rough roads in this remote area. “They get muddy in the rainy season”, she adds. As we drive further to our destination, there is no evidence of electricity but only a few small houses sometimes separated by big bushes and a few gardens. Carol (alias) is walking on the side of the road when one of my colleagues from the implementing partner organization recognizes her. We stop, exchange greetings and offer her a lift to her place. She declines and decides that we should have a chat with her right there. She places the bag of food she has been carrying on her head by the side of the road.

We sit on the grass by the side of the road and talk about her work in general. I can see she takes pride in her work but also wants to share with me her challenges. She narrates how using the mobile phone in her work was a very good idea. “It was simply more than just sending text messages (SMS) about infant and maternal deaths in our villages. We acted on the data we sent especially if there was a death in the villages. The implementing organization and a representative from the District Health Office would come to the villages and work with us to educate community members.” She adds, “… but now we do not send SMSs any more. We stopped getting monthly airtime credit and we resorted to adding it ourselves because we acted on the data to prevent maternal and infant deaths. The messages now simply do not go. And I talked to the community mobilizer (my colleague) at the office (implementing organization), but I did not get help.” She does not understand how such a helpful initiative in her work could simply stop. Attempts by her and her colleagues to continue using the SMS system by buying their own airtime credit and paying to charge their battery phones were futile. She wonders if I can help revive the SMS project especially because it was contributing to her work in the community.

For Carol and many other community health workers (CHWs), mobile health solutions (mHealth) are introduced to their work practices, capitalizing on their knowledge and
proximity to rural populations to support Health Information Systems (HIS) (Braham and Finch, 2004). However, majority of these mHealth projects are frail and prematurely die after initial project support (Kimaro & Nhampossa, 2005; Robert and Woodward, 2017; Braun et al, 2013). Carol is seeking answers to the failing SMS project. On our way back after the interview, I ask my colleague from the implementing organization why the SMS project is failing. “…some VHTs still send data but most of them do not now. Most VHTs broke or lost their mobile phones and every time they get a new mobile phone, they also get a new number. These new numbers are not registered in the database, so they cannot be used to send data. We cannot register the new numbers. It is the technical support team in the capital that can do this. But they do not. We also cannot provide new mobile phones every time. There is no funding for that. Maybe the funding stopped for this project.” He responds.

For these two people in different roles, the sustainability of the mHealth system means different things to them. The VHT is glad to maintain the system considering that it matches and supports her work. My colleague insinuates that the project will last for as long as there is funding and its implementor’s support. So, should the mHealth project sustain for as long as it supports Carol’s work, or should it sustain for as long as the implementing organization supports it? These and more are some of the issues embedded in the sustainability challenge of most Information and Communication Technology for Development (ICT4D) projects. Indeed, the term sustainability eludes researchers and has been classified into; financial, technical, social, institutional aspects (Ali and Bailur, 2007). The social approaches to sustainability emphasize understanding the context in which ICT4D initiatives are embedded. From the vignette, sustaining the mHealth system is also linked to the work practices it mediates and supports.

The challenge of sustainability is not only limited to mHealth solutions although it is particularly more pronounced with these initiatives (Meacheal et al 2010). Broadly, Information and Communication Technology (ICT) initiatives have been overshadowed by failures to sustain. Concerns about struggles and failures to sustain in tele-center initiatives (Hosman, 2011), Geographic Information Systems (Walsham and Sahay, 1999), Health Information Systems (Heeks, 2006, Jacucci et al, 2006, Braa et al, 2007, Braa et al, 2004, Kimaro and Nhampossa, 2005, 2007), information infrastructures (Aanestad et al, 2014, Karasti, et al, 2010) and ICT4D initiatives in general (Heeks 2002; Pade-Khene et al, 2011;
Kleine and Unwin, 2009; Ali and Bailur, 2007) continue to prevail. What is particular about mobile technology is that it is not entirely external to existing health systems’ contexts. Wide network coverage and relatively cheap mobile handsets are some of the factors that have made mobile telephones accessible to so many people in the developing world (Heeks, 2008). Mobile technologies are already adapted in the lives of many people including health workers. Innovators (mostly external) draw on this access to develop and implement mobile based solutions on already existing technologies. The potential for services on these initiatives are speculated to transform health systems (Estrin and Sim, 2010) and mobile based solutions are envisioned as the silver bullet to revolutionize HIS in developing contexts. However, a lot of evidence has indicated that they fail to deliver and endure past their project pilot phases (Mukisa et al, 2015), and this is a continuing problem.

1.2. The state of mHealth systems
In the last decades, ICTs have evolved dramatically, both technically and in our application of them to support various social development programs including health. These advances have seen the emergence of mobile health systems (mHealth) applied to support healthcare delivery (Free et al, 2013) and transform national HIS. They can take the form of personal digital assistants (PDAs), mobile-based phone tools and solutions (SMS, java applications, mobile web browsers), wearable devices, enterprise digital assistants (EDA) and handheld and ultra-portable computers like tablets and other wireless devices (Free et al, 2013). They take on various uses including; data reporting, decision support and health care support delivery especially for less professional cadre, self-monitoring of chronic diseases, sending patients and clinicians reminders, population surveillance, monitoring communicable diseases, stock-outs monitoring, health record systems, among others (Istepanian et al, 2006; Smahel et al, 2017; Fox and Connolly, 2018). A shared definition of mHealth is yet to be established (WHO, 2011; Meacheal, 2009) given their wide range of application and uses. Several researchers seem to agree to defining mHealth as the use of mobile and wireless technologies to support the delivery of healthcare (WHO, 2011; Levina, 2016; Estrin and Sim, 2010; Park, 2016; Free et al, 2013; Istepanian et al, 2006; Kwon et al, 2016; Beratarrechea et al, 2014). In this thesis, I refer to the use of mobile phone-based solutions used to support primary healthcare delivery among CHWs.
The mHealth field is a rapidly expanding area and an integral part within e-health (Free et al., 2013; Blaya et al., 2010), telemedicine (Istepanian et al., 2006) and ICT4D (see Thomas and Narayan, 2014; Qureshi, 2016) as it grows fast in its support to achieve healthcare objectives. In developing countries, mobile communication technology is the fastest growing sector and the wireless coverage network is high (Donner, 2008; Kaplan, 2006; Kwon et al., 2016; Heeks, 2008). Mobile phones are used throughout the developing world more than any other technologies (Kahn et al., 2010) and are a financially cheaper technological option in these countries. These expanding networks and the relatively inexpensive mobile handsets (Norris et al., 2009) have enabled people access to digital information technology capabilities. mHealth solutions have particularly become appropriate in resource deprived countries especially due to their popularity, mobility and technological capacities. Various players, often external donors tap into the popularity of mobile solutions to create innovative mobile based systems to serve numerous healthcare programs (Mecheal, 2009). For example, these systems are relied on to support the reduction of disease burdens (Free et al., 2013, Kahn, 2010). For remote areas where infrastructures are poor and professional health personnel limited, frontline health workers are equipped with mHealth systems to capture health data in their communities (Braham and Finch, 2004; Busiku, 2014; Kiberu et al., 2014; Braun et al., 2013). Mobile phone-based solutions have shown potential to meet the information and communication needs of national HIS (Blaya et al., 2010). Ezenwa and Brooks (2014) for example note that mHealth systems support routine and non-routine data reporting from lower levels of the health system into national HIS without necessitating travel. Through this routine data, indicators can be calculated to describe health trends, monitor health service coverage and allocate resources effectively to the entire population (Jacucci et al., 2006).

However, despite this popularity, mHealth systems often fail to sustain in practice (Franz-Vasdeki et al., 2014) and continue to be very hard to integrate with national HIS (Braa and Sanner, 2011; Braa and Purkayastha, 2010). Successful projects usually do not grow beyond their settings of use while majority are doomed to fail, crippling already weak and underperforming HIS. Failures are due to technical, practical, institutional and economic barriers (Franz-Vasdeki et al., 2014). Considering that most ICT systems are designed and simply transferred to local settings (Vikkelsø, 2005) in developing countries, their recipients are usually not co-producers of the technologies (Kleine and Unwin, 2009; Avgerou, 2008).
They focus on the supply side, making technical improvements, innovations and infrastructures without necessarily paying equal attention to users (Sarker and Wells, 2003). Therefore, any potential long-term benefits of these systems cannot be fully realized, contributing to their failure (Hosman, 2011). Many researchers are calling for the evaluation of mHealth systems to assess their potential and sustainability (Norris et al, 2009; Jutel and Lupton, 2015). Attempts to conduct such evaluations are limited in developing countries (Kahn et al, 2010; Gurman et al, 2012), due to funding priorities.

1.3. Motivation: The promises and pitfalls of mHealth systems
My motivation for this study comes from my education background and observations. I think that development initiatives should be sustainable to be impactful. I come from Uganda and I have observed many challenges surrounding mHealth systems in the developing world more broadly and in Uganda, where they don’t sustain beyond the framework of external donor support. There is limited evaluation of such systems (Jutel and Lupton, 2015; Kahn et al, 2010), but plenty of enthusiasts promising their potential. For example, Beratarrechea et al (2014) generally present mobile based solutions as effective technology interventions to address access, coverage and equity of health services. Developing countries and societies are often mere receivers of these externally funded initiatives. McCann (2012) described Uganda in 2012 as a “perfect storm” for funds based on the upsurge of mHealth initiatives in the country at the time.

The scale of growth of these systems is often unsupervised, uncoordinated and their impacts almost unknown. Considering the untamed mushrooming nature of these systems, the Ugandan government halted further implementation until systems could align themselves to the national HIS (McCann, 2012). In financially challenged countries, the funding and technical support for the development of mHealth innovations is often derived from international donors, each with their own prioritized agendas that are frequently poorly aligned to local health system priorities. It is no wonder that various mHealth systems support different vertical disease specific programs. Recipient countries merely establish political and symbolic roles as these HIS are introduced (Kimaro and Nhamposa, 2007). They lack the necessary resources (human, financial, policy and strategies) and commitment to sustain mHealth initiatives even when they are successful in their pilot contexts. Once external players achieve their agendas and financing ceases, so do mHealth projects. Therefore, whatever benefits and
potential the mHealth systems would have reached in remote areas where most of these systems are planted, remain unknown. This leaves a gap and a failure to understand not only how positive outcomes can be reached but also how technology systems that support them can be sustained. Understanding how these knowledge and practice gaps can be filled, provides the basic motivation for my research.

1.4. Research Problem: (un)sustainability of mHealth systems

The research problem this thesis addresses is related to the sustainability challenges of mHealth systems in developing countries. A tremendous amount of research on mHealth systems in developing countries is based on their benefits towards supporting the improvement of health services even in remote regions (Blaya et al., 2010, Beratarrechea et al., 2014; Gurman et al., 2012). The WHO even referred to mHealth systems as having the potential to transform health service delivery in the world (Beratarrechea et al., 2014). However, some research has shown that these interventions are merely a quick fix for solving healthcare challenges in developing countries referring to their failure to sustain. Some researchers have labeled the field with the term ‘pilotitis’ to show a pronounced failure of mobile based initiatives especially during and after their pilot phases (Franz-Vasdeki et al., 2014; Huang et al., 2017; Mecheal et al., 2010; Källander et al., 2013).

Like most ICT systems, mHealth solutions are introduced as technical approaches to health challenges (Huang et al., 2017), follow a top-down method and minimally engage users hence deflecting from actual work practices (Walsham, 1992; Luff et al., 2000; Lamb and Kling, 2003). ICT4D initiatives grapple with unsustainability (Kleine and Uwin, 2009; Heeks, 2002, 2006; Ali and Bailur, 2007) and HIS in developing countries are especially vulnerable (Kimaro and Nhamposa, 2005; Braa et al., 2004; Moucheraud et al., 2017; Garde et al., 2007). mHealth systems are implemented as silo systems, supporting vertical and narrow disease specific donor programs (Meheal et al., 2010, Braa et al., 2004, Chilundo and Aanestad, 2004, Estrin and Sim, 2010). These uncoordinated projects create a surge of new tools, methods and practices that burden national HIS and frontline health workers that use them.

There is a realization that the benefits and sustainability of mHealth systems and HIS in general depend on their users’ adoption (Fox and Connolly, 2018; Huang et al., 2017, my emphasis). For example, Heeks (2003) proposed filling the design-actuality gap to meet users’ actuality. Estrin and Sim (2010; Gizaw et al., 2016) suggested the use of open architecture to allow users
to design and appropriate systems based on local needs. Kimaro and Nhamposa (2005), Braa et al (2004), Wilson et al (2014) and Avgerou (2003) recommend the institutionalization of HIS. Despite, these theorizations and approaches, mHealth systems and HIS in general still struggle with unsustainability. Practically ICT4D projects and mHealth solutions continue to be implemented as top-down technical solutions dependent on external support (Sanner, 2015, Kleine and Uwin, 2009) that can exert influence on the institution. Users’ interests are not always translated into systems. The users and their work are usually abstracted (Zuboff, 2001; Orlikowski, 2010; Aanestad et al 2014; Robey and Boudreau, 1999) and considered a homogeneous organizational entity in most research, yet health system organizations have various levels of users contributing to the broader health system organization.

Despite, enormous proclamations on the relevance of users in ICT systems’ sustainability, we are yet to see research that intricately uncovers how technology users are linked to these systems’ sustainability. Studies on technology users are quite scarce in the case of the mHealth literature (Smahele, 2017). Focus is often on the short-term project goals and development outcomes (Heeks, 2014) without understanding the overall long-term sustainability. And since most mHealth implementations are made by external players, they are not always conversant with local public health systems, hence decontextualizing these innovations from the users’ environment (Levina, 2016). I argue that research on mHealth systems, can benefit from looking beyond top-bottom approaches of sustainability if we are to understand the wider context in which mHealth systems are used. I believe that the sustainability of ICT systems can be seen through the work practices they support, where users’ actions and work transformations to accommodate new technologies have potential to influence broader organizational structural changes that sustain them. I refer to work practices as purposeful activities regulated by structures that guide them with rules and resources (Giddens, 1984). These activities can change to create work transformations when technologies are introduced (Nicolini, 2012; Orlikowski, 1996) hence impacting the structures that moderate or sustain them.

Gaining knowledge about the use of mHealth systems in the work practices of users is highly relevant for two main reasons. First, understanding how mHealth systems relate to the users’ context enables an accommodation of the reinterpretation of these interventions within the broader community context. mHealth systems are not developed in a vacuum and it is
important to understand how reinterpretations of systems by users can be fed into already existing HIS such as, electronic patient systems, administrative systems, logistics systems among others and the broader organizational structure. Second, understanding mHealth systems through the user’s work environment also helps to understand how successful mHealth interventions can be maintained to realize long-term effects and keep these resources in the communities where they are most beneficial.

1.5. Research aim
This research was initially guided by the belief that mHealth systems should be aligned with the work practices of their users and maintained, sustained or expanded into HIS upon their fit with these work practices. Based on the above discussed concerns, identified gaps and the papers that make up this thesis, I wanted to understand how the sustainability of mHealth systems can be facilitated. I investigated the use of mHealth systems in the work practices of CHWs. My research objective was to better understand the work transformations occurring through mHealth mediated work. Work transformations, I refer to here relate to changes in work practice activities. It is in these work transformations, I believe that mHealth system users interpret their work and the technology to locally accommodate and maintain it or even reject it.

I limited work transformations to change outcomes while using mHealth systems rather than the processes of transformation. Not all work transformations can account for the sustainability of mHealth systems as some might result in their rejection locally. The ones I argue should be sustained, are those that support and are supported by technology users in their work practices. The aim of this thesis is therefore to illuminate the work transformations related to the introduction of technology in a work practice and show how we can draw on these work practice transformations to understand sustainability. This aim translates into the following research questions:

- What is the nature of mHealth systems mediated work transformations of the community health work practice?
- How do we sustain work transformations and the mHealth systems that support them?

To answer these research questions, I investigated two cases to understand how mHealth systems are experienced in the community health work practice. Research question one is
aimed at getting CHWs’ descriptions and interpretations about their work and its associated changes as technology mediates it. Research question two is aimed at drawing implications for sustainability from the response to research question one. In this thesis, I give insights into how CHWs engaged with the mHealth systems and reinterpreted them and their practice. The unit of analysis is the group of CHWs and their work practice.

1.6. Empirical basis
I conducted two case studies of mHealth systems use; the Short Message Service (SMS) project in Uganda and the mobile technology enabled Decision support system in Malawi. In the two cases, I collected qualitative data between March 2015 and January 2017 through interviews, group discussions, document studies and observations.

- The SMS Project is implemented by the Ministry of Health (MoH) in Uganda together with implementing partners. The SMS project uses SMS texts for reporting weekly data on maternal and infant mortality across the country. This case was chosen because it illustrates an effort to develop and use mHealth systems in community health work on a national scale.

- The Decision support system is a mobile based solution developed by D’tree. It was designed to guide CHWs through the process of evaluating a patient and developing a diagnosis or course of action. This case was chosen because it illustrates an effort to integrate mHealth systems into community health work.

I present the empirical material in more detail in chapter four of the thesis.

1.7. Research contributions
The study will make both theoretical and practical contributions in respect to mHealth systems sustainability in developing country contexts. I emphasize the importance of viewing sustainability from a work practice perspective. I intend to extend existing literature on ICT4D and IS sustainability which has often offered top-down strategies for their long-term survival. I make the following arguments and contributions

C1: I conceptualize sustainability from an integrated perspective of technology and work practices. I argue that the sustainability of mHealth systems is entangled in the work practices and accruing work transformations they support.
C2: I link work transformations associated with mHealth system use to broader organizational structures associated with their sustainability.

C3: I give an explicit elaboration of the empirical and theoretical use of practice theory as I consider the context and material properties implicated in practices.

C4: I contribute practical implications and guidelines to policy and practice through emphasizing a link between micro and macro elements in the health system organization that are essential for sustainability.

1.8. Thesis Organization
The structure of the remaining chapters is as follows.

In Chapter two: I review related literature on sustainability of ICT systems. I revisit the conceptualization of sustainability and how it has been adopted in ICT4D research. I introduce and problematize the concept of sustainability that is endemic to ICTs in developing countries. The chapter reflects on how sustainability has been previously approached with a top-down approach to motivate a revisit to the micro-aspects that require to be matched with the macro perspectives of sustainability. In chapter three, I create my analytical perspective and give the theoretical perspectives used in the thesis. I present a review on current and previous research perspectives to identify gaps. In chapter four, I present the two cases that served as an empirical basis for this thesis. In chapter five, I outline the interpretive philosophical underpinnings of my research, I explain my methodological approach, data collection methods and data analysis. The chapter also highlights my ethical reflections and the strengths and weaknesses of my methodology. Chapter six provides a summary of the findings in the papers that form the basis of this thesis. I present a synthesis of the findings in the papers. In chapter seven: I discuss my findings in relation to theory, identify the gaps in my findings and state the theoretical and practical contributions this thesis makes. In chapter eight, I reflect on avenues for future research opportunities and provide some concluding remarks.

Appendices
The appendices include:

- Papers 1-5
Chapter 2: Related Literature
This chapter outlines some related research on the approaches and interpretations that have analyzed ICT4D sustainability within the broader historical context of ICT initiatives and mHealth systems. The chapter focuses on the notion of sustainability and the next, emphasizes the relationship between work practices, transformations, technology and sustainability. This chapter first discusses the origins of the sustainability discourse and then focuses on its reinterpretations and how its applied in the ICT4D literature. I conclude the chapter by revisiting the notion of sustainability to include sustaining the work practices and transformations that mHealth systems support.

2.1. Historical origins of the sustainability discourse
The Brundtland report of 1987 by the United Nations World Commission on Environment and Development, proposed the idea of ‘sustainability’ on the global development stage. Predicting an impending doom to our survival from the depletion of natural resources, the report set to reconcile nations’ aspirations for better lives with limited natural resources. In the environment and development domains, the report set the predominant understanding (Hilty et al, 2011) of sustainability as,

“development that meets the needs of the present without compromising the ability of future generations to meet their own needs”

2.2. Re-interpretations of the concept of sustainability
Sustainability as a concept has been highly contested leading to high degrees of ambiguity (Kuhlman and Farrington, 2010). It has been reinterpreted to fit different contexts since the Brundtland report, and to comprise of three inter-connected dimensions: economic, social and environmental (see: Kuhlman and Farrington, 2010; Kates et al, 2016; Sanner, 2017). These dimensions are themselves considered ambiguous with no universal agreement to what they entail (Kates et al, 2016). Should all the dimensions receive equal weight? Is it not sustainability when one dimension is emphasized over others?

The goal of the Brundtland report was to reconcile ‘development’ with ‘sustainability’. Kuhlman and Farrington (2010) in their agenda to reconcile social-economic welfare and sustainability, argue that the social-economic aspects described as welfare are limited in their conceptualization of prosperity with respect to material needs. They propose to instead use the concept of wellbeing for the social-economic dimension of sustainability to consider
human development and those intangible needs such as, happiness, freedom, education, justice etc. They lean their conceptualization towards ideas of Sen’s capability approach that sees well-being past material or basic needs but as capabilities to achieve one’s potential (Sen, 1993). Kuhlman and Farrington (2010) thus define sustainability as, “maintaining well-being over a long time, perhaps even an indefinite period”. This conceptualization has however been criticized for paying a lot of attention to the micro elements without describing how they are needed for macro-level sustainability (Wiener, 2000).

Sustainability as a term is also surrounded with questions of what should be sustained and what should be developed? Notably, sustainability is not synonymous with the term ‘environment’ although most sustainable development literature concludes that the environment is what is to be sustained (Kates et al, 2016). Some other re-interpretations view sustainability specifically in terms of what it seeks to achieve (ibid). For example, the short term (2015) Millennium Development Goals (MDGs): peace, development, environment, human rights, the vulnerable, hungry, poor, Africa and the United Nations. These were subsequently followed by the Sustainable Development Goals (SDGs): poverty, hunger, health and wellbeing, education, gender, water and sanitation, clean energy, work and economic growth, industry, innovation and infrastructure, reduced inequalities, sustainable cities and communities, responsible consumption and production, climate action, life below water, life on land, peace, justice and strong institutions and partnerships for the goals, set out to achieve socio-economic wellbeing while preserving the environment (UN, 2017).

Similarly, sustainable development has also been defined in terms of how it is measured (Kates et al, 2016). There have been attempts to define it in terms of indicators that measure progress towards sustainable development in global, national and local initiatives. For example, efforts by the UN commission on sustainable development, developed 59 indicators on global coverage using country or regional data. Indicators were defined to show what was to be sustained (for example, clean air, ocean productivity) and what was to be developed (for example, health, education, security) by 2015 through the MDGs (Kates et al, 2016). The challenge with this conceptualization is that it is seen with a more top-down approach and it does not describe the criteria for micro-level activity needed for macro-level sustainable development to succeed (Wiener, 2000).
Sustainability as defined by the Brundtland report is therefore imbued with various reinterpretations but all under its umbrella. Wiener (2000) asserts that the Brundtland report’s definition has allowed some creative tensions among stakeholders regarding its core principles and it remains open to reinterpretation and adaptation to different social and ecological contexts (Wiener, 2000). For example, its original emphasis on economic development and environmental protection has been broadened and deepened to include alternative notions of development (human and social) and alternative views of nature. A common understanding in these reinterpretations is that the environment should be maintained overtime and it should have a continued existence. But the definition to reconcile social-economic development and environmental sustainability has also been critiqued for failing to observe the middle tier between the top-down (sustainability) and bottom up (social-economic development) focus. That is, the institutional aspect of human society, conceptualized to consider the set of structures in and through which people interact to attain their objectives (ibid). Notably, the four dimensions of sustainable development are mutually dependent. The economic system and institutions are embedded in social systems which are embedded in ecological systems (Marais, 2015). This is articulated in the SDGs.

2.3. Re-interpretations of the concept of sustainability in the ICT4D concept

What is clear is that sustainability as a concept is broad and should allow for different stakeholders (local, national) to reshape it in accordance to their values and goals. These goals, activities and innovations at the local level should work towards achieving complementary activities at higher levels (institutional capacity) through aligned interests and mutual interdependence. This is also reflected in the evolving approaches of the ICT4D concept (Marais, 2015). The ICT4D field has long been concerned with the use of ICTs for international development (Walsham, 2017). Heeks (2008) described the evolution of ICT4D, from phase 0.0 when ICTs were used to facilitate government administration and economic growth until 1990. Phase1.0, shifted to viewing ICTs as a tool for development in response to the growth of the internet and the adoption of the MDGs. In this phase, ICT solutions like tele-centers were delivered to poor rural communities in a top-down approach. These initiatives failed leading to a focus on sustainability, scalability and evaluation and contributed to the adoption of new approaches in phase 2.0. There was therefore a shift from ICTs being seen only as tools for development- a means to an end, to using them as platforms for development. This view sees ICTs as having the potential to transform development processes and structures and
therefore are regarded as productive tools that can be adapted by people to fit their aims and facilitate economic goals (Marias, 2015). This is beyond the passive diffusion of technology to an active adoption where interventions are required through innovations to achieve development goals. Heeks (2008) describes these innovations to occur in three different ways: pro-poor (for the poor), Para-poor (working with the poor) and per-poor (innovations by the poor in their communities). ICTs like mobile communication and social networking platforms have been cited to enable per-poor innovations that empower people (ibid).

2.4. Sustainability of ICT4D initiatives
Sustainability has long been a preoccupation of ICT4D literature in developing contexts especially because most ICT initiatives in these contexts fail to mature beyond pilots (Avegrou, 2006; Walsham and Sahay, 2006, Heeks, 2002, 2006; Walsham, 1992; Moucheraud et al, 2017; Garde et al, 2007; Braa et al, 2007). Countless ICT deployments have been made across developing countries especially driven by external donors. Majority serve donor interests hence creating fragmented systems and those deployed towards healthcare are not aligned with the agendas of national HIS (Grade et al, 2007).

Mobile technology-based systems (referred to as mHealth) are pertinent examples to understand the problems of sustainability in ICT4D initiatives as they are heavily relied upon to support national HIS and health systems in developing areas (Mukisa et al, 2015). There is tremendous growth and investment in mHealth initiatives, but these are accompanied by similarly big failures to sustain especially because majority of them are deployed as silos (Kleine and Unwin, 2009). They exacerbate already fragile HIS in developing countries that cannot sustain them in terms of skilled capacity and resources. Researchers characterize the failure of mHealth initiatives as them dying away while ‘pilots’ (Heeks 2006; Källander et al, 2013). Their failure to sustain has been attributed to more than technical challenges to include rejection and lack of long term plans to be integrated within existing HIS (Heeks 2006), being disconnected from health workers practices, and unsustainable funding (Ali and Bailur, 2007; Leon, 2012; Ramadani 2017; Sanner and Sæbø, 2014), narrow interventions, inadequate focus on local expertise and the pilot orientation of interventions (Jacucci et al, 2006) among others. There are limited examples of successful mHealth pilot interventions in developing country contexts.
Njihia and Merali (2013) have however criticized research that identifies failures of ICT4D initiatives to sustain. They argue that most of this work focuses on developing countries rather than on the use of ICTs for development. They cite Brown and Grant (2010) who argue for a difference between ICTs in developing countries and ICT for development because “in developing countries”, work is often judged against for development accounting for all the ICT failure reports in developing countries. Certainly, accounts of ICT4D failures (Heeks, 2006; Kimaro and Nhampossa, 2007) in developing countries cannot be dismissed. There is a need to understand why these projects perpetually fail to sustain or meet their agendas. Walsham et al (2007) and Avgerou (2008) categorized most of the constraints driving ICT unsustainability to derive from a neglect of context specific social and cultural dimensions. Njihia and Merali (2013) argue that ICT project actors do not have much influence on the broader context (political, economic and social) in which ICTs are implemented although these are important for their thriving.

2.5. Sustainability as applied in the ICT4D literature: addressing and reconceptualizing it

Given the high degree of sustainability challenges, the notion of sustainability has been taken and reinterpreted in ICT4D research with an aim to understand the survival and success of ICT interventions. Ali and Bailur (2007) identified five kinds of sustainability in ICT4D literature consisting of: the technological, economic, social, institutional and environmental dimensions. Some studies limit their narratives of sustainability to financial and social imperatives (Liu, 2015). For example, Heeks and Bhatnagar’s (1999) critical success factor (CSF) approach identified ten critical factors for sustaining technology initiatives: people, information, technical, management, structure, culture, politics, process, strategy and environment. Hosman (2011) and Hosman and Fife (2012) proposed the public-private partnership financial model to ease the financial burdens of ICT initiatives emphasizing their profit-making potential. These partnerships were however found inadequate when deployed in poor communities (Avgerou, 2008) and the ICTs’ success dependent on their continued relevance to users.

Some researchers proposed theoretical conceptualizations to information systems (IS) sustainability that are more socially inclined. For example, Heeks (2003) proposes identifying “design-actuality” gaps to ensure a fit between technology design and the local user’s actuality
or context. Ali and Bailur (2007) suggested Ciborra’s (1994, 2002) notion of bricolage as an alternative to sustainability citing insufficiencies in the dimensions they identified in ICT4D research. To them, ICT4D initiatives should take cues from their context, be more open to local improvisations, unintended consequences and the changing nature of the ICT artifact. By considering the self-reliance of local users and their context specific resources, resulting local innovations have consequences towards making an ICT4D initiative fit and endure with user groups. The ICT4D system is maintained while it pays attention to developing local capacities that can innovate around it. This is often ignored by externally implemented ICT projects with vested interests. Similarly, Henfridsson and Bygstad (2013) emphasized the role of context and the technology staying relevant in its context of use as essential to its survival. Relating to a case of the Norwegian airline use of information technology (IT), they note that successful IT initiatives should evolve to fulfil their roles over time through three generative mechanisms of innovation, adoption and scaling. The generative mechanisms are causal structures that create observable events. The innovation mechanism is a self-reinforcing mechanism process in which new products and services are created as the IT malleability spawns recombination of resources. A successful technology initiative should expand beyond its scope through creating possibilities for innovation. The adoption mechanism is also a self-reinforcing mechanism process by which more users adopt the IT as more invested resources increase its usefulness. Henfridsson and Bygstad’s (2013) last mechanism, scaling, is a self-reinforcing mechanism by which the IT expands its reach through attracting new partners by creating incentives for collection. The three generative mechanisms interact for the successful evolution of the IT.

Ospina and Heeks (2010) redefined sustainability as a systems’ potential to stay resilient, implying that IT systems should be able to endure external disturbances and change to survive through, robustness, scale, redundancy, rapidity, flexibility, self-organization and learning of the system. A sustainable IT should emerge in the context it is applied to withstand and absorb external instabilities, anticipate future failures and sustain gains (Halden et al, 2017). These accounts emphasize that technology initiatives can be sustainable when they are useful and meet stakeholders’ needs while staying locally relevant (Ali and Bailur, 2007). This requires users’ participation in ICT initiatives while accounting for local traditions, differences in communities, empowering marginalized groups, sharing and aligning goals with community
needs (ibid). It has often remained hard to understand or determine what is considered locally relevant and for whom? Taking an illustration from a hospital, a HIS should not only create demand for data reporting from health workers. It should for instance collect data to inform local decision-making (Braa et al 2014), also appropriately accommodate their work practices and flexibly adjust to support emerging ones.

Other researchers have proposed embedding ICTs in the social institutional structures of the systems they support so that they become part of the acceptable social order. They argue that once ICTs are institutionalized, they are sustained because of their legitimacy regardless of evidence of their technical value (Ali and Bailur, 2007; Avgerou, 2000, 2003). Actors therefore continue the use of ICTs through actions that uphold standardized practices. Kimaro and Nhampossa (2007) and Chilundo and Aanestad (2004) have for example emphasized the importance of institutionalizing HIS initiatives where roles, structures and resources are enabled for the HIS to become a part of organizational routines. Sanner (2015) observes that HIS sustainability also involves institutionalization of routines, practices and the development of local capacity to innovate. For this to happen, it requires the acceptance of key institutional actors because the implementation of ICT4D projects can be a highly political process (Sahay and Walsham, 2006). The challenge with this reconceptualization of sustainability is that it can easily become highjacked by powerful players like donors who create their own institutions of reporting or reinforce existing hierarchical organizations of control rather than change them to support micro endeavors. This becomes a top-down approach to sustainability and actions that may be rational for top management, might seem irrational for field-level health workers.

2.6. Summary: What should be sustained?
The ICT4D field is using a highly contentious term to epitomize successful ICT initiatives, and its understanding continues to remain elusive. Although the environment and development research domains have been quite specific about environmental resources being what should be sustained (Marias, 2015), ICT4D research takes various perspectives to elucidate sustainability. Earlier studies focused on the advancement of resources (finances and people) to sustain ICT initiatives, and others focused on the longevity of the technical artefact. For example, Walsham and Sahay (2006) referred to sustainability as sustaining ICT projects over extended periods with appropriate resources like money and people. Shortages in these approaches, especially the financially inclined understandings, later paved way for
understanding the socio-technical aspect of sustainability. These approaches saw earlier accounts as eluding the use and context in which ICTs were implemented. The socio-technical based approaches illustrate how elements of use, adoption, innovation, scaling, evolution, among others are important for successful ICT4D initiatives. For example, Sanner (2015) and Moucheraud et al (2017) assert that sustainability is the “persistent adoption and use of a technology beyond external finance and technical support. Ideally, successful ICT4D initiatives should then be able to exist long after their initiation. They should be adopted, evolve, persist and serve their users’ needs overtime while considering the necessary resources to sustain them.

However, not much has practically come out of this work and suggested approaches have limitations. For example, efforts for building local capacities to maintain ICTS are limited to training seminars and workshops (Sanner and Sæbø, 2014). Although the role of users and their work contexts are emphasized in sustaining ICTs (Ali and Bailur, 2007; Leon, 2012; Levina, 2016; Ramadani 2017), there are not enough detailed accounts of this especially in developing contexts. I lean towards these socio-technical underpinnings of sustainability and argue that the sustainability debate can additionally benefit from uncovering the work practices of technology users. By exploring work practices, the work transformations that emerge when ICTs are introduced, then we can understand how users act, interpret, negotiate and interact with the technology system locally. From this, we can look beyond sustaining the technical artifact for instance, to understanding how to sustain important work practices and the technology systems that support them. Practically, technology users are usually left on the receiving end, given that ICT4D initiatives are externally delivered with top-down approaches (Kimaro and Nhampossa, 2007). Studies that try to detail ICT use at the micro activity level, for example work studies, are often narrow and do not relate them back to macro-level concerns (Haried et al, 2017) to understand how they can be implicated in the broader challenges of sustainability. The potential for local ICT sustainability especially in small rural areas receives limited attention (Jacucci et al, 2006). User groups like CHWs although are increasingly utilizing ICTs in their work remain marginalized in research accounts, especially in understanding their motivations, retention and everyday work practices (Otieno et al., 2012; Busiku, 2014).
User accounts are also sometimes abstracted at the level of the MoH or a health facility which tends to make invisible the micro-level dynamics. As an organization entity, a MoH is made up of various levels of users each contributing to the uptake and use of the HIS. Kimaro and Nhampossa’s (2007) description of a mutually interdependent relationship between ministries, donors and software developers is one such account, which emphasizes the significance of developing a stable network among these actors to support HIS sustainability (Marias, 2011). Their approach gives a social perspective to ICT sustainability and observes the inability of donor driven projects to deliver without the role of the users. They noted the exclusion of the actual users of ICTs in the negotiations and decision-making processes even when ICT initiatives are expanded across regional or even national levels. Users tend to have no control of the ICT4D systems they eventually use or are responsible for to continue. This is perpetuated in the way ICTs are delivered. Top managers will own these ICT initiatives and donors will provide infrastructures and roll out large numbers of technical solutions in a ‘one-size’ fits all manner across districts, regions and even national levels with limited attention to local differences and emerging improvisations.

2.6.1. The misconception of scaling?
Scaling has been related to the success of ICT innovations (Walsham and Sahay, 2006, Henfriedsson and Bygstad, 2013; Braa et al, 2007; Braa et al, 2004). It refers to rolling out of small pilot technology innovations across wider reaches (Walsham and Sahay, 2006). Scaling involves taking an ICT initiative from one setting and expanding it in size and scope within the same setting or in other settings as well. (Braa et al, 2007; Walsham and Sahay, 2006). Considering that mobile phone solutions compensate for the infrastructural reality in developing countries (Avgerou, 2008), they are often simply rolled out in large numbers to support national level HIS. Countries are often faced with the “all or nothing” quandary of HIS where they should be scaled to the ‘whole’, for instance, to all data collection facilities to gain useful and meaningful information for public health decision makers. However, many of these attempts fail.

Technologies may be rolled out in large numbers across wider reaches, but still fail to produce valuable health outcomes and sustain over long periods. Avgerou (2010) and Toyama (2011) are critical about large-scale dissemination of technologies being considered as the primary means for positive change. It is merely a discourse of diffusion and adaptation of technologies
with an erroneous belief that their large-scale dissemination can provide solutions to social problems. Braa et al (2004) give a striking example remedying this through their networks of action approach in the global scaling of the DHIS2 software developed in South Africa in 1994. At the time of their study, the DHIS2 software had scaled to 21 countries, and is currently scaled to over 70 countries. In these networks of action scaling, and sustainability of this software occurs when similar strategies are pursued, and alliances forged. Often governments in developing countries have jumped to rolling out big numbers of technologies to digitalize their health systems (Wambugu and Villella, 2014) and equating technology penetration with success of improving their national health systems. However, because most a majority of ICT4D initiatives are donor driven, they carry donor interests without necessarily paying attention to local needs and improvisations (Ali and Bailur, 2007).

Therefore, scaling up systems although essential to ICT initiatives sustainability (Braa et al, 2004) should not be made under the assumption of a “one size fits all” and simply spreading them across sites in large numbers. Careful considerations should be taken to determine the aspects of the system that can be scaled, and those which require translation, adaption and local customization (Avgerou, 2010; Sahay and Walsham, 2006). Scaling therefore requires an understanding of local improvisations as they emerge in the contexts where ICT4D initiatives are embedded and scaled. The local improvisations can then gradually become institutionalized as they become a part of everyday practices. Overall, this creates an understanding of the local needs and priorities around the ICT system and draws scaling away from mere technical issues, although crucial, to include practices, people and infrastructural aspects in the context of use for example.

2.7. Revisiting mHealth sustainability

Most ICT4D research generally acknowledges that ICT systems are context sensitive and urge for a stronger focus beyond financial and technical issues to recognizing socio-cultural contexts where ICTs are embedded (Avgerou, 2010; Avegerou and Walsham, 2000; Beratarrechea et al, 2014; Garde et al, 2007; Henfridsson and Bygstad, 2013; Mecheal et al 2010; Walsham ad Sahay, 2007). Each context and users are unique in their local appropriation of technology and therefore simply rolling out ICTs does not guarantee their success, scale or sustainability. To comprehend sustainability therefore, should also involve understanding the
intricacies in the work context of technology users and how they engage with the technologies in their work practices.

The technical artifact, resources and overall projects are important but can all end when external project-based support ceases or in the face of low political commitment that is prevalent in developing contexts. I thus define the sustainability of mHealth initiatives to also include the work practices and work transformations supported by the mHealth system and their supporting structures. For anything to be sustainable, it should be capable of being maintained or continued at a certain rate or level (Oxford English Dictionary 2018). Sustainability thus involves stability and movement in the sense that the ICT initiative should be maintained and simultaneously expanded at a certain rate or level in a relevant way by its users. With embedding work practice transformations in the definition of mHealth sustainability, the practices associated with the technology in their context show new local uses, work reinventions, improvisations and applications of the technology which if relevant to users should be maintained while allowing for system evolvement. Sustainability is thus also about the users of the technology systems and work practices they mediate. This stand gives sustainability a human centered stance towards developing and sustaining ICTs and particularly mHealth initiatives, which is important for developing sustained demand and scale (see Aanestad et al, 2014).

Toyama (2011) foregrounds the human dimension of ICT4D sustainability emphasizing that the success of ICT initiatives depends on human intent. This can be in the sense that users interpret a technology as being of benefit to them, meets their needs and hence adopting it over time. Ali and Bailur (2007), Gizaw et al (2016) and Jacucci et al (2014) realized the importance of local users in driving sustainable technology systems. This stand recognizes the agency of ICT users or their capability to act (Giddens, 1984) in matters important to them. Ali and Bailur (2007) for example, elaborate that new uses can emerge around a technology system and emphasize that it is in these twists and turns that sustainability can be reached. While exploring work practices, Aanestad et al (2014) illustrated that the sustainability, successful adoption and scaling of a hospital pilot information infrastructure from a single district to 21 others, evolved around the work practices and work transformations of the health workers. I argue here that the alterations and transformations in practice can be a way for users to mold technology systems to fit their needs. It is through the transformations that
we can identify those missing resources to maintain the use of mHealth systems at the local level and inform broader organizational structures. These structures are what I refer to as being made up of rules and resources that enable or even constrain existing practices (Giddens, 1984) and even new ones over time. For example, a CHWs’ choice to use a mobile based solution in online data reporting may be sustained or hampered by the existence of infrastructure conditions like electricity, network connectivity among others. These are material and symbolic properties of these infrastructural conditions which exist as rules and resources in memory traces of the CHW.

I do not dismiss the relevance of other approaches to sustainability (financial, technical, institutional etc.) but I believe this thesis offers a distinct and important analytic advantage of understanding the role of users, work practices and work transformations in mHealth systems’ sustainability. I argue for an increased attention to and explicit consideration of work practices that users engage in as they go about their everyday activities. We need to understand how local users proactively reinvent and translate their work and the mHealth systems to continually fit their context by independently reflecting on their practice. Sustainability is thus dependent on achieving local sustainability of the mHealth system where local users create, reinvent and continuously negotiate to appropriate the technology system on their own terms to fit their work rather than following impositions from higher hierarchies (Jacucci et al, 2006). Local adaptation of a technology system is important in obtaining adoption of the system which in turn is important in ensuring sustainability (ibid). It is also important that the user level is aligned and balanced with the top level since mHealth systems are a part of the broader national HIS. Transformations at the level of the users should be matched up with higher hierarchical frameworks and structures that establish and guide priorities and activities (Norris et al, 2009). As the new improvisations and work alterations are put into practice, they over time nurture broader organizational supporting structures for both the mHealth systems and the reconfigured work practices they mediate. It is the natured structures that are supposed to sustain the practices, new practices and the mHealth systems.

Therefore, the sustainability of mHealth systems is intertwined with the work practices that they support. As practices are implemented in the everyday work of users, they reinforce and are reinforced by organizational structures. Practices therefore give sustainability a temporal element of existence. This is in the sense that structures that sustain the ICT system and the
work practices it mediates, exist if those practices exist. They are both mutually dependent on each other where technology mediated practices reinforce broader organizational structures of sustainability and those structures reinforce the practices in turn. These temporal scales can also change as actors shape and reinforce practices and structures according to changing circumstances and interests. Notably, temporal scales exist beyond clock time and event time and can also be embedded in the social practices of contextual settings (Orlikowski and Yates, 2002; Karasti et al, 2010). Therefore, the temporality of structures that sustain practice and the technologies that mediate them are institutionalized in the production and reproduction of practices.

As practices reinforce and are reinforced by organizational structures, they also give sustainability a spatial element. As practices and the new practices associated with technology use are enacted, they become routinized in the everyday practices of technology users, thus becoming institutionalized (Walsham, 1993; Nicolini, 2012). The routinized practices become repetitive, recognizable patterns of interdependent actions carried out by multiple actors (Feldman and Pentland, 2003). The routinized practices are conditioned by existing structures and they create and recreate those structures through enactment. Like other social phenomena, they embody a duality of structure and agency (Giddens, 1984), where structure and agency are mutually interdependent. Feldman and Pentland (2003) have referred to them as the ostensive and performative aspects of routinized practices. The ostensive aspect gives the routinized practices their abstract idea or structure. The performative aspect consists of the actual performances of the routine activities by specific people at specific times and in specific places which is related to agency. Note that these two aspects are interdependent and as patterns of action are performed by organization members, they reinforce and reproduce underlying structures. Routinized patterns of action are argued to have a social stock of knowledge necessary to perform the routine that is unevenly distributed among multiple individuals across time and space (Feldman and Pentland, 2003). Individuals rely on the ostensive aspect or structures to perform their routine activities, but they can reflexively change their practices. Therefore, when new practices associated with technology use develop and become new routinized patterns of action, they alter existing structures to create new ones. They are conditioned by those new structures and create and recreate these structures as they are enacted (Giddens, 1984; Feldman and Pentland, 2003). As routinized
work practices persist, they are stabilized in the institutional structures and thus sustained over time and space (Feldman and Pentland, 2003). They can also change when actors respond to changes or even through reflexive monitoring (ibid).

This chapter has brought me to my building blocks: technology, work practices, work transformations, sustainability and structures which are informed by the implications from the transformations. These building blocks will inform my analytical perspective. I explore the relationships between these building blocks and conceptually build my perspective in the next chapter.
Chapter 3: Analytical Perspective: ICTs, Work Practices, Work Transformations and Sustainability

In this chapter, I present the relevant building blocks for my analytical perspective, that is; technology, practices, work transformations, structures and sustainability. Based on the discussions in chapter two I will examine the relationships between these blocks and relate them to theoretical concepts from structuration theory to frame my empirical analysis. First, I will show how they have been studied before and suggest what and how I approach these relations. Chapter one has stated my research aim, which is to understand sustainability by exploring work practices and work transformations in which ICTs are implicated. I argue that work transformations are important in understanding the sustainability challenge with the users’ perspective in mind. The chapter begins with discussions on ICTs and work practices which helps me to put the research into context. I then discuss technology and work transformations which is the focus of my empirical work. I discuss how I related with theory and I lastly present my conceptual framing.

3.1. ICTs, work practices and the role of technology in mediating them

ICT initiatives like mHealth and other Health Information systems (HIS) are considered key enablers in supporting efficiencies in health care service provision (Lippeveld et al, 2000). Various mHealth system innovations are relied on to reach remote areas and for their simplicity that affords low cadre workers like CHWs to deliver health services in those areas (Braun et al, 2013; Kanjo, 2012; Damtew, 2013; Ayiasi et al, 2015). They are increasingly relied on to mediate and support the work of these health workers to address disease specific health programs, aid data collection, give decision support, create reminders among others (Medhanyie et al, 2015; Busiku, 2014; Kiberu et al, 2014; Braun et al, 2013). However, the design and implementation of these ICTs in the work of technology users has historically been top-down driven, supply-driven and inadequate at addressing many organizational and social issues in the local contexts and work activities they support (Sarker and Wells 2003). Amidst these shortages, ICT4D research has mainly been concerned with the consequences of technologies, understanding how ICTs contribute to development and not specifically on the demand-side of use and work for instance (Aanestad et al, 2014; Singh et al, 2018). Hence a bottom-up approach is called for (Kleine and Unwin, 2009) to help us understand the organizational and social issues in which ICT4D initiatives are embedded. These organization and social issues such as, practices and processes, structures (Avgerou, 2008), have been cited...
for enabling or constraining the success of various HIS (Avgerou and Walsham, 2000; Luff et al, 2000, Heeks, 2002). Aanestad et al (2014), Karasti (2001) and Hanseth and Lundberg (2001) are some of the scholars that have called for an understanding of work practices to address organizational issues and ICT failures.

Some ICT4D work has focused at the level of ICT users to understand their work practices. Each has taken different approaches to understanding work practices and the role of technology in mediating them. For example Chawani et al (2014) called for a need to balance work practices in the design of electronic medical systems in Malawi. They saw technology as mediating work practices through inscribed protocols but observed a need for flexibility in their approach to accommodate discrepancies in order for technology design to be successful. In his study of cross-cultural working, Walsham (2002) viewed technology as mediating practice through embodying modalities that link practice to structures. He found that software development work across two groups from India and Jamaica was engulfed in cultural conflicts based on the differences in the way they organized, managed and interpreted work. These studies project a crucial observation of the relevance of work practices in uncovering important phenomena in the success of ICT implementations.

However, often micro-work studies are presented with a narrow focus and not linked back to broader organizational concerns of sustainability (Monteiro et al, 2013). They concentrate on understanding work place studies and small interactions without understanding their larger implications for ICT implementations (Firtzpatrick and Ellingsen, 2013). Haried et al (2017) reviewed information systems journals¹ between 2000-2015 for studies related to ICT use in healthcare and found that considerable attention is given to understanding micro-level ICT use. Often implications are drawn for system design (Firtzpatrick and Ellingsen, 2013), but Haried et al (2017) noted that these studies were not linked back to macro-level challenges such as sustainability. This is especially a concern since mHealth systems are part of wider national HIS implemented to facilitate the delivery of healthcare in developing countries. The essence of studying work practices is in uncovering users’ subtle situated practices and the

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way they engage with technologies and how various processes and alterations are brought into play (Fitzpatrick and Ellingsen, 2013).

Others have pointed to ICT4D research limiting its analysis at the surface and abstracting important phenomena like work practices and organizational interactions necessary for accomplishing technology implications. Aanestad et al (2014) for example noted how ICT4D research focused on the level of the organization while annotating work as a concrete activity. For example, Kimaro and Nhamposa (2005) emphasize the relationships between Ministries of Health (MoH), donor agencies and software developers as being essential in the sustainability of HIS implementations. The challenge in their approach is that the MoH is an abstract representation of the health system that has various levels within it, each with various work practices and stakeholders that play a role in the adaptation and adoption of new technologies like mHealth systems. In such approaches, the focus is often directed at getting the HIS to work at the centrally driven level of the MoH. This can be through developing centralized standards and statistical indicators that simplify health phenomena like maternal mortality and are far from the social practices (Sahay and Lewis, 2010; Jacucci et al, 2006; Sahay and Lewis, 2010) of the health workers supposed to use the HIS and feed data into it.

This focus takes attention away from the local and social practices that surround ICTs. I do not dismiss the relevance of this research, but its tendency to emphasize higher systems that enforce technologies while overlooking its users, their work and organizational interactions, deem ICTs to fail. These failures are characterized by low adoption, low use and low sustainability (Matavire and Manda, 2014; Braa et al, 2004). Ramadani et al (2017) have emphasized that nation-wide HIS are particularly prone to failing when implemented in favor of the government without significant participation of health workers at the micro-level. Therefore, for technologies to be successful, there is a need to also understand how work gets done, changes with new technologies and how users accommodate them in their practices (Aanestad et al, 2014). This is one way to bridge the gap between practice and system design (Karasti, 2001) that has been linked to the failures of many ICT4D systems in developing countries (Sahay and Walsham, 2006; Avgerou, 2008).

Persistent failures have particularly led researchers to explore ways in which the peculiarities of contexts and existing work practices can be understood. For example, Hanseth and Lundberg (2001) describe the challenges of large-scale implementations and suggest that
technologies should be designed and implemented by users based on their actual uses of the technology. Star and Ruhleder (1996), relate technologies to practices and argue that they emerge from people in practice connected to activities and structures. Karasti (2001) explores how work practices can be integrated into systems design. Chilundo and Aanestad (2004) discuss the integration of public HIS with emphasis on the consideration of existing local practices. Aanestad et al (2014) through Zuboff’s notions of automating and informating, detail the emerging and recursive interplay between technology and work based on existing organizational realities. They show how technology impacts existing work and organizations to understand how new technologies can function in their contexts.

Like these researchers, I propose to explore the work practices in which technologies are embedded. I conceptualize a work practice as a normatively regulated activity (Giddens, 1984; Schmidt, 2014) and I see technology as a medium that mediates work practices. The relevance of exploring ICTs in work practices, is in uncovering concomitant changes and work transformations that occur when technologies are introduced in organizations and work. These capture the sensitivities in work during system development, implementation, use and evaluation which is crucial for systems’ success (Aanestad et al, 2014). I suggest that such a study can draw implications for addressing challenges in the broader organizational context which ICTs are a part of. Challenges such as; adoption, integration, scaling and sustainability. I suggest a focus on understanding how the micro-level engages with ICTs in its work practices and the associated transformations as it meets the mandate of the macro-level. This not only accounts for how the micro and macro interlock but work changes can be channeled back to understand new technologies especially in forgoing previous challenges and spreading success from local implementations in large scale ICT implementations like those in public healthcare.

3.2. Technology, work transformations and the role of work transformations in sustainability

Technology implementations have long been linked to wider organizational changes (see; Avgerou, 2008; Brynjolfsson and Hitt, 2000; Barrett and Walsham, 1999; Orlikowski, 1995; Barley, 1986). Studies have often highlighted the relationship between technology, work and organizations majorly focusing at the organizational level (Zuboff, 2001; Vikkelsø, 2005; Orlikowski, 2010; Aanestad et al, 2014; Robey and Boudreau, 1999). Work is sometimes considered a concrete activity and abstracted in narrations of organizational change. ICT4D
research in developing contexts has focused on the consequences of technology with limited attention to the work or organizational interactions needed to accomplish the implications of technology (Aanestad et al, 2014, my emphasis). As technologies become an integral part of organizations, they are also implicated in the micro activities of organizations such as work and the everyday lives and practices of technology end users (Orlikowski and Barley, 2001; Forman et al, 2014) that implicate broader organizational structures. As they become embedded in work practices, the new systems alter tasks and skills, enable new ways of organizing, doing old things and they facilitate new modes of interaction (Nach, 2009; Aanestad et al, 2014; Nicolini, 2012). These are what I refer to as work transformations, or changes in work practices. They relate to new ways of doing things. In this thesis, I do not describe the processes of a work transformation but limit myself to the outcome of change as a work transformation.

Aanestad et al (2014) emphasized that understanding work and organizational transformations brought about by the introduction of technologies in a work practice is a “prerequisite for new technology to work” (p. 836). At the turn of the 20th century, Yates and van Maanen (1996) called the rhetoric of IT and organizational transformation ‘apocalyptic’ in the 1996 Information Systems Research (ISR) special issue on “Information Technology and Organizational Transformation”. They observed that organizational changes involving technology are not always technologically determined and involve an array of social, technical and political issues. They point to the incrementalism in work practices as involving the interaction of various factors embedded in the everyday practices of technology users. They also note that these transformations, are not what is intended by technology designers.

Orlikowski (1996) looked at the situated every day practices of technical support employees to understand how their work changed. She found that changes were emergent through ways employees fashioned their use of the new technology and not through the technological or the managerial imperative. This posits that there is a reciprocal relationship between technology and organization. Change has been described as inherent with new technologies with descriptions of work transformations in various components of work like; work tasks and skills (Barley, 1990), learning (Robey and Sahay, 1996), work identities (Barrett and Walsham, 1999), communication practices (Feldman and Orlikowski, 2011) among others. Refuting both organizational and technological imperatives (Aanestad et al, 2014; Orlikowski, 1996), these
changes have also been characterized as emergent in the actions of situated actors. Actors improvise around a new technology in their work to accommodate it in their practice.

Orlikowski (1996) argued that these transformations can be small, subtle and almost invisible changes grounded in individual and group work practices. Aannestad et al (2014) noted that they are also not unidirectional or linear and they are an ongoing process of change. Research has characterized them as, emergent, innovations, improvisations, local adaptations (see Orlikowski 1996; Brynjolfsson and Hitt, 2000) among others. Work practices and their organizing structures are bound together in a dynamic tension. The structures are the rules and resources that organize practice. On the one hand, organizing structures define ongoing patterns of work. On the other hand, if the nature of work changes for example with new technologies, then organizing structures have an opportunity to change or are pressured into adapting to the changes or else risk being misaligned with the work they organize (Barley and Kunda, 2001). ICT4D research has been criticized for abstracting work at the level of the organization (Aanestad et al, 2014) and attempts at work practice studies remain narrow and not connected to broader organizational aspects (Firtzpatrick and Ellingsen, 2013; Haried et al (2017).

I propose a study into micro-work activities to understand concomitant work transformations. Understanding these work transformations has been linked to enabling the long-term sustainability of technologies through realizing the demands for new skills, actions, resources and technology modifications at the level of work (Aannestad et al, 2014). I focus on work practices while simultaneously foregrounding the significance of workers or technology users (Hanseth and Lundberg, 2001). Knowledgeable actors conduct work practices and are capable of handling variations, planning for contingencies, envisioning outcomes, devising methods, identifying tasks and allocating and assuming responsibility (Schmidt, 2014). Therefore, it is also important to be aware of the particularities in the context that shape work practices such as, the historical, socio-political processes and external factors (Orlikowski, 2002; Nicolini, 2012). People through their agency can reflexively redefine and modify meanings, properties and applications of technologies. For ICT4D research especially in healthcare, most solutions to address sustainability challenges in developing countries take centralized approaches that enforce many technical solutions without necessarily addressing local social practices and technology users (Sahay and Lewis, 2010). There is thus a need for an understanding of field-
level work practices and their changes. Although important, an understanding of these work practices and changes should be supplemented by linking them and their implications to broader organizational and institutional structures (Ferrarro et al, 2015) in which ICTs are increasingly implicated. As changes in practices occur and new practices are routinized like I elaborate in the conceptual framework in section 3.4., they influence changes in broader organizational structures that will sustain the practices and the mHealth system over time and space. I understand that not all work transformations may be desirable, but I argue that those transformations considered important to technology users, have the potential to inform sustainability for both mHealth systems and the work practices they support.

I consider a practice theory to be essential here in helping me understand the social world and the dynamics, interactions and enactment that occur in practices (Feldman and Orlikowski, 2011). Giddens (1979, 1984) account of structuration theory provides a useful micro foundation for change in situated practices that can be interlinked to macro level institutional processes. I relate my building blocks to the theoretical concepts in structuration theory to frame my empirical analysis.

### 3.3. Structuration Theory

Structuration theory was developed as a theory of social organization by sociologist Anthony Giddens (1984). The central concept of structuration theory is the duality of structure (Giddens, 1984) where human action (agency) and social structure are inseparable and reciprocally dependent on each other in a social system. Agency is the capacity to make a difference (also known as transformative capacity). It is therefore ones’ ability to define their goals and act upon them. This agency is guided by structure and it either reproduces existing structure or produces new structure. This is because human agents are autonomous, are considered knowledgeable and reflexive, continuously monitoring their actions and those of others and their intended and unintended consequences. This reflexivity enables human agents to either reproduce existing structures or to produce new structures, often in unintended ways. If individuals start to act differently contrary to existing structures, and if these new actions become institutionalized as a broader pattern, then the new pattern becomes the operating structure. The structure changes.

Structures give form and shape to social systems, but they are not themselves a form and shape. They are embedded in the activities and practices of human agents in which they are
recursively implicated (Giddens, 1979, 1984). Structures denote to the rules and resources organized as properties instantiated in social systems (Giddens, 1979, 1984). Giddens emphasizes that structures exist as structural properties in human minds, which they draw upon in shaping their social actions. It is important to note that they both enable and constrain but do not determine, human action. Rules are generalizable procedures applied by knowledgeable actors in the enactment and reproduction of social practices. These rules guide one on how to carry on in a given situation. Resources on the other hand are the means through which intentions are realized, goals achieved, and power exercised to shape choices. Resources are of two types: authoritative resources which relate to control over people’s activities, and allocative resources that are derived from control over physical things (Giddens, 1984). To analyze structures, they are distinguished in three dimensions: signification/systems of meaning, domination/forms of power relations and legitimation/sets of norms. There are corresponding dimensions of human interaction (agency) described as: communication, power and sanctions. These are linked to structures through modalities of interpretive schemes, facilities and norms. This illustrated in figure 1 below.

**Source:** Giddens (1984, p. 29)

*Figure 1: Dimensions of the duality of structure*

As human agents communicate, they draw on interpretive schemes which are stocks of knowledge, that help them to make sense of their own and others’ actions and interactions. These interactions reproduce and modify those interpretive schemes that are embedded in social structures as meaning or signification. The facility to allocate resources is enacted through exercising power and produces and reproduces social structures of domination. The moral codes (norms) help to determine what can be sanctioned in human interaction which iteratively produces structures of legitimation. This is the duality of structure where structure and agency are dependent upon each other and are recursively related (Walsham, 1993).
Structures are sustained by the ongoing reproduction of practice by social actors, but they can be changed. Routinization of new patterns of action can become established as standardized practices which over time become institutionalized creating new structural properties. It is important to note that the separation of structure and agency (action) into the three dimensions is merely for analytical purposes since the dimensions are interdependent.

3.3.1. Criticism towards structuration theory and why I use it
Giddens work has been used extensively to theorize ICTs in IS studies but has been cited for weaknesses such as; being abstract, its neglect of the technological artifact and difficulty to apply empirically (Lizardo, 2010; Nicolini, 2012; Pozzebon and Pinsonneault, 2005; Pscheidt, 2011; Jones, 1997). Some other scholars have been criticized for their stance and application of the theory. It was argued that their use of structuration theory was contrary to Gidden’s meaning of structures and the theory’s overall shortage in explaining materiality was a main concern (Nicolini, 2012). For example, Barley (1986), Orlikowski (1992), Poole and DeSanctis (2004) set out to develop Giddens’ idea that technology does nothing except when implicated in the actions of people (Giddens and Pierson, 1998). Orlikowski (1992) was criticized for giving structures material existence in technology and she later dropped the theory to conceptualize “technologies-in-practice”. This conceptualization started with practice to examine how practice enacts emergent structures through recurrent interaction with technology hence giving attention to the material property of the technology (Nicolini, 2012).

Other researchers have extensively relied on structuration theory (see for example, Orlikowski, 2000, 2002; Walsham, 1993, 2002; Jones and Karsten, 2008; Orlikowski and Robey, 1991, Barret and Walsham, 1999, Walsham and Sahay, 1999) and devised approaches to their analysis. These studies have increased our understanding of the technology phenomena by, elucidating how users’ interactions with technologies evolve, the implications of these interactions and dealing with intended and unintended consequences (Pozzebon and Pinsonneault, 2005; Barley, 1986). These studies show structuration theory’s potential to integrate subjective and objective phenomena and theorize technology as both a product of human action and a medium for human action (Orlikowski and Robey, 1991; Pozzebon and Pinsonneault, 2005).

For ICT4D research, structuration theory presents a challenge and opportunities to address underexplored issues of Gidden’s work and a more thorough applicability of his ideas in
contexts where they have been criticized (Jones and Karsten, 2008). Despite the numerous accounts disregarding this framework, the link between the individual micro-level action and macro-level institutional processes and Giddens’ reconciliation of agency and structure are what draw me back to his theory of structuration. I am particularly intrigued to understand the practices of CHWs associated with using mHealth systems and the actions and choices CHWs make in their practice as they use the mHealth system in their work. Through structuration theory, I am then able to understand how emergent practices associated with technology use at the micro-level reverberate at the macro-level through progressive accumulation over time and space to create new structures. It is these new structures I will later argue are crucial to sustaining both mHealth systems and the work practices they support over time and space. The theory not only offers me practical insights in understanding the sustainability of mHealth systems based on the notion of practice but gives me an opportunity to further explore its applicability in research (Jones and Karsten, 2008).

3.4. How I used theory: Relating theory to my building blocks
Structuration theory is complex and diverse to be used in its totality of concepts, and I have selected some concepts, adapted as relevant to my empirical analysis. Where I have found gaps, I adopt other concepts to aid in filling them. I used structuration theory as a way of thinking about the world. I used it as a meta theory within which I discuss action and structure in the CHW practice as mHealth systems are used. As a meta theory, it also helped me explain the themes in my findings. I did not mechanically apply the theoretical constructs of the theory in their ontological sense in the two cases. I did not use the theory for what to look for in the empirical cases or test its theoretical constructs in the field. I used it as a source of inspiration, ideas, creative associations and a vocabulary to talk about what I observed and experienced in the two cases. Giddens has referred to this, as structuration theory being a sensitizing devise. I used it to understand the different elements in work practice organization and its distinction between the micro and macro elements was important. I have used the concepts of structure and agency and the related terms of reflexivity, tensions (contradictions and conflicts) and negotiations.

I have used structuration theory to describe how I picture a work practice to work and how I envision the workings of a social system. A work practice is therefore not mere work activities but is made up of normatively regulated contingent activities. A structure regulates the
contingent activity regarding appropriate criterion of conduct. The structure is composed of rules and resources that are applied routinely in the everyday practices of its collective actors to regulate work activities. For example, a CHW is aware that before the end of each month, he must send a report to supervisors at the health facility using paper forms. These rules and resources therefore regulate contingent activity, the construction of meaning, continuous interaction, joint sense-making and knowledge integrations.

The structures are the medium and outcome for the production and reproduction of practice. The human agents in enacting practice draw on these structures (rules and resources such as protocols) in their heads and routinely apply them to guide their everyday work. Actors in a work practice are not merely producing and reproducing the structure of their practice through their agency but are also capable of ignoring, altering and circumventing the same structures by reflexively refining their practice to create new work transformations. For example, in a given setting where technology is introduced in his work, the CHW may choose to ignore it or disregard paper forms and replace them with the technology because of its better efficiency in his work. Thus, the work practice is not a stable entity but can be changed by human action which subsequently changes the social structure rooted in the practice.

I lean towards Walsham’s (1993) analysis of technology in structuration theory and away from Orlikowski’s (1992) conceptualization of technology in structuration theory. Orlikowski (1992) conceptualized technology as having structural properties that enable or constrain action. This was criticized for being misleading given a lack of separation between physical structures and the social structures that exist as memory traces in people’s heads as intended by Giddens. Walsham (1993) instead argues that technology is implicated in the modalities of structuration whereby actions of technology users are mediated by interpretive schemes, coordination and control facilities and norms that are embodied by the technology. As they draw on these modalities in their work activities, they either reinforce or change work structures. For example, the actions of CHWs using the mHealth system will be mediated by the assumptions, options and demands built into them.

In this thesis, I have primarily tried to understand the CHWs’ actions, their interests to produce, reproduce or transform social practices to substantiate new technology in their practice. The introduction of new technology in a work practice is grounded and implicated in ongoing human action. The way workers engage with the technology in their actions can
explain work transformations and changes in the technology itself. Human agents are knowledgeable and can monitor their actions and those of others to reflexively change their practices (Giddens, 1984). It is relevant to understand these changes and their linkage to broader social and organizational structures in which the technologies are implicated.

The engagement in practices and the way new technologies are implicated in those practices is a social process involving negotiations between different interests. For example, a CHW who uses ICT systems to make monthly reports might face tensions, when his supervisors instead use the system to increase surveillance and control of his work. The CHW then adjusts his actions to fit his practice and may choose to make visible those activities important to the supervisor while ignoring others or simply disregards the new stringent rules. It can therefore be a process entailing tensions with conflicts that can be actual struggles between groups or contradictions that are the structural contradictions of system organization and are a potential basis for conflict (Giddens, 1984). Where there are no contradictions and tensions, the actors tend to allow practices to endure favoring practice reproduction (Ellway and Walsham, 2015). Work practices and organizing structures can be bound in dynamic tension especially where organizing actors change structures, then they invariably alter work patterns. When the nature of work changes to create new work transformations for example because of the introduction of new technologies, then organizing structures either adapt or risk being misaligned with the work activities they organize (Barley and Kunda, 2001). Therefore, because work and organizing are interdependent, work change can lead to the emergence and diffusion of new organizational and institutional structures (ibid). These are the structures that sustain the practices and the technologies that mediate them.

3.4.1. Theorizing the technology
I understand that Giddens work has been criticized (Pozzebon and Pinsonneault, 2005) for undermining material components and not explicitly addressing technology (Orlikowski, 1992). Notably, structuration theory and all of Giddens’ writings are a part of a single intellectual project (Giddens and Pierson, 1998) implying that it is also important to look at his later writings. In his later work, Giddens clarifies that technology and other material resources like land can be implicated in the structuration process when actors draw on them in their practices. He simply delineates the effects of physical and structural features. He recognizes that there is interaction between human actors and material aspects such as technology that
may be significant for shaping social practices (Jones and Karsten, 2008). He however neglects conceptualizing the interaction between human actors and the technology. This is an opportunity for the thesis to delve into understanding the interaction between human actors and the ICT artefact by conceptualizing the IT as a medium of practice with affordances. In this way I will give a theoretical account of the IT artifact as called for by Orlikowski and Iacono (2001).

**Conceptualizing technology as a medium**

I conceptualize technology as a medium through which practices are mediated (Lanzara, 2009). I used this conceptualization to help me understand the role of technological mediation in the processes and interactions of human action in social practice and also to facilitate an understanding of how human actors appropriate the technologies (Verbeek, 2016). The notion of a medium is ambiguous (Lanzara, 2009) and is defined here and limited to a material media that mediates a practice. Mediums can be signs and symbols, or artifacts used to represent a practice or in which a practice is formed and lives (Kallinikos, 2003; Lanzara, 2009). The medium therefore possesses characteristics it purports to convey (Kallinikos, 2003). For many workers, the execution of their practices is dependent on material mediation. For example, architects think and act through their pencils and sketch boards. Healthcare activities of doctors, nurses and clerical workers have traditionally been mediated through paper-based patient records (Lanzara, 2009). Therefore, a change in medium, may create tension and affect practical and sense-making abilities of users to cope with ambiguity and make sense of the new medium. They cope and restructure their practice, so it can be appropriately hosted by the new medium (Lanzara, 2009). The medium itself is also not neutral and can actively shape the practice it mediates (ibid). It has different functions and can therefore afford various activities for users. For example, an accumulation of data about a patient in the mHealth system can create possibilities for secondary data use such as, supporting following up patients, research and administration. A new medium in work may have capabilities that support novel ways of working. The medium thus becomes an essential part for changes in a work practice to occur (Berg, 2000).

**Characterizing the medium**

Different media have important and unique characteristics that can form the basis of how they can and should be used (Lanzara, 2009). These I broadly refer to here as affordances where the material media (in this case the mobile phone and the mHealth system) possess some
affordances for manipulation by actors. Note that I earlier stated that modalities are embodied in the technology and are implicated in the action that either reinforces or changes existing work structures. I realize that they are not the only existing characteristics in a technology. For example, a mobile phone-based system may have protocols guiding data collection, but the mobile phone also has other functionalities like a touch, calculator etc. that users can draw on in their social action. I therefore use the notion of affordances to encompass modalities but also capture the overall characteristics of the IT artifact to understand how CHWs appropriate the technologies that mediate their work practice.

The notion of affordance originated in ecological psychology perpetuated by Gibson (1979). He did not offer a concrete definition for the term affordance but noted that,

“the affordances of an 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, 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)

Affordances are therefore what the environment offers the animal, what it provides or furnishes for good or ill. These can be the acts or behaviors that are permitted by the environment-object, place, event etc. (Markus and Silver, 2008). The environmental objects possess properties responsible for giving off affordance information (ibid). To Gibson (1979), this is information of what the environment can afford. The values and meanings of things in the environment can be perceived and this information can be linked to the action possibilities offered to the animal by the environment. Affordances are also relationships, exist naturally and do not necessarily have to be visible, known or desirable (Norman, 1999) They are also unique to the animal.

The notion of affordances has also garnered interest in ICT studies especially in studies that seek to understand the relationship between technology and human actors in fostering organizational change (Norman, 1999). There is however debate on whether affordances are embedded in the artefact and having an independent existence or whether they emerge through use and action in user-artefact interaction (Thapa and Sein, 2017). I believe that IT artefacts have affordances offering possibilities for action to a user with a goal to achieve by
using the artefact. The affordances exist regardless of the user’s perception but will have meaning in the social context in which the artefact and actor reside (Thapa and Sein, 2017). How they are perceived and actualized is contextually influenced by cultural, social and technical factors. Therefore, affordances will vary. For example, some are functional because they are influenced by the material properties of the artefact and will emerge through a discovery process. Others are related to the needs and goals of the actors and vary between individuals arising in specific-social-cultural and historical contexts. Such affordances emerge through social constructions.

Therefore, conceptualizing the mHealth system as a medium with potential affordances offers an avenue to understand the dynamics between the material technology and social action. It therefore facilitates an understanding of what is possible and not possible to do around and through the technology artefact (Hutchby, 2001). The technology is implicated in the structuration process through its affordances which give information for potential action by embodying interpretive schema or stocks of knowledge that guide action taking, providing coordination and control facilities to exercise power and communicating norms of what is approved or disapproved. The technology is not seen as determining action rather as defining a space for potential action in a work practice context. I have shown that technology is implicated in the practices of the actors. I have a rather narrow focus on workers and their actions to understand their agendas in their social interactions in which technologies are embedded. Jones and Karsten (2008) have shown that the study of day to day life is integral to understanding the reproduction of institutionalized practices. Therefore, to understand large scale, institutional phenomena that persist over a long time, I sought to understand the everyday practices of CHWs that constitute their practice.

3.5. Overall conceptual framework: work Practices and the broader organizing system
The framework presented in figure 2 below illustrates the key concepts that I drew on to guide my data collection and analysis. It illustrates the social process in which human actors actively engage with technologies in their everyday work practices.
Figure 2: Illustration of the conceptual framework

The figure summarizes the key concepts and relationships in my proposed conceptual framework.

- I see work practices as purposeful work activities of individuals that are regulated by structures. The structures are made up of rules and resources that can be in the form of protocols and equipment that are influenced at the macro level by the institution of the MoH or donors and NGOs among others. Human agency draws on these structures to enact work practices in their everyday activities.

- When technology is introduced as a medium to mediate a practice, human agents reflexively revise their work practice leading up to maintaining existing practices or work transformations based on existing structures in the work context.

- I see the technology as embodying modalities: interpretive schemes, facilities and norms to link action and structure, which are drawn on in interaction to reinforce or change structures. These modalities are enveloped in the affordances that characterize the technology, that users can interpret as they perform their work and can be enacted in the changes to work.
• As the changes (work transformations) occur, they happen at the micro-level in the work practice of technology users but can be implicated in broader organizational structures. As the new work transformations become routinized and seep into the fabric of everyday work, they progressively require corresponding organizational structures to support them and the technology system.

• These I refer to as the structures of sustainability. From the work transformation, we can draw implications for sustainability and identify required structures to support new practices. It is these broader organizational structurers that can sustain both the new work transformations and the technologies that support them over time and space. However, changing broader existing organizational structures to accommodate new practices, in this case, those associated with technology use is not easy and is accompanied by tensions and negotiations.

These concepts provided me with a sensitizing lens that served three main purposes. First, during my data collection, the lens helped me to understand what issues to focus on. For example, as I discussed with CHWs, I would try to understand what guided their actions in work, the choices and changes that they made with the new ICT. Second, the concepts become the focal points around which I developed and analyzed the different themes in the papers that are included in the thesis. For example, I used structuration theory as a meta theory to give me insight into each of the themes; identity, mobilities/structural changes, visibility, power and knowledge changes, in the papers and how they are implicated in sustainability. Through the perspective of structuration theory, identity was related to the performative action of individuals in their work practice. As a group of CHWs conduct the activities they relate to their work identities, they reproduce existing structures or create new ones. And activities that disrupt this identity may be changed or dropped and likewise corresponding structures. The theme of mobilities is related to Giddens’ structures in the sense that as work activities change, existing structures become mobile or destabilized. The theme of visibility is related to Giddens’ notions of contradiction and conflict where wanted visibility encourages the continuation of practices while unwanted visibility creates some tension. Power is related to Giddens’ notion of agency and ability to act. And knowledge in the perspective of structuration theory is seen as the knowledgeability of human actors with the potential to reflexively monitor their action. All the themes were related to the sustainability of work.
practices and the mHealth solutions when they were implicated in the structures of the CHW practice. Third, the conceptual framework has guided the overall analysis in this thesis.
4.2. Research Context

4.2.1. Uganda

Uganda is a landlocked country located in East Africa. It boarders South Sudan to the north, Kenya to the East, Tanzania to the South, Rwanda to the South west and Congo to the west. It has an area of 240,038 square kilometers (MoH- Uganda, 2010). The country is administratively divided into districts that are further sub-divided into lower administrative units such as, counties, sub-counties and parishes (MoH- Uganda, 2010). Uganda’s districts have grown from 21 in 1969 to over 121 districts. This growth was to bring administration and social service delivery closer to the people. Health service delivery was decentralized to districts and health sub-districts but health service delivery at these levels is challenged by inadequate supervision, funding and weak management (MoH- Uganda, 2010).
Uganda had an estimated population of 34.6 million people in 2014 (Uganda Bureau of Statistics, 2016) and a population growth rate of 3.2%, one of the highest in the world (UNDP, 2018). 85% of Uganda’s population lives in rural areas (Kiberu et al, 2017) with limited access to health services. 23% of the population is under 18 years (Uganda Bureau of Statistics, 2016) and nearly half of the population is under the age 15 (Kiberu et al, 2017; MoH- Uganda, 2012). This makes the country one the youngest nations in the world with a high dependence prevalence. The high population growth puts pressure on the health systems requiring more
health investment to match population demands. The country’s economy has been through some turmoil and has consequently struggled to meet its health demands.

Uganda gained its independence from Britain in 1962 and it registered economic growth during this time. However, in the 1970’s and 80’s the economy declined due to political instability, poor governance and economic mismanagement (UNDP, 2018). By the 1990’s the economy was slowly revived and the population living below the poverty line declined from 31.1% in 2006 to 19.7% in 2013 (The World Bank, 2016). Agriculture is the main economic activity employing 80% of the country’s population (Uganda Bureau of Statistics, 2016). Although the population living below the poverty line has been falling, the year 2017 saw a reverse trend where it rose up to 27% of the population compared to 19.7% in 2012 (National Population Council, 2017). Economic funding from the national budget has been directed to other sectors at the cost of public health. The public health sector has remained under funded, for example, its national minimum health care package designed to ensure cost-effective service delivery to all, only gets 30% of the total funding required for its provision (MoH-Uganda, 2012). The health sector also heavily relies on international funding and in 2009, 50% of the health budget was donor financed (ibid). This does not guarantee the sustainability of various health programs when donor funding stops.

4.2.2. Healthcare delivery and state of health in Uganda
The public health system in Uganda is decentralized within national, districts and health sub-districts. (MoH-Uganda, 2010). The lowest level of health service delivery is the Village Health Teams (VHTs) in communities that drive primary healthcare delivery, promotion and community participation. The secondary level is the district level which consists of health centers III and II. Health center II is the first interaction between the formal health sector and communities. At this level, outpatient and community health services are provided. Health center IIIIs provide basic preventive, promotive and curative healthcare services. The tertiary level consists of general hospitals or regional referrals that give more specialized clinical services and engage in teaching and research. On the top, national referral hospitals are the quaternary and highest level providing more comprehensive specialist services in addition to all clinical services (Nabukeera, 2016). These different levels are linked through a referral system which fails to function because of poor transport and communication infrastructure, lack of medicine and other health supplies, and staff shortage leaving majority of the
population to rely on nurses, aid workers and Traditional Birth Attendants (TBTs). The ratio of physician to the population is 0.12:1000 (United Nations Department of Public Information, 2017).

Health services in Uganda are also provided by the private sector comprised of private for profit and not for profit sectors supplemented by traditional and complementary medicine (kiberu et al, 2017). The private sector contributes 50% of healthcare delivery (MoH- Uganda, 2010). About 60% of Uganda’s population seeks healthcare from traditional and complementary medicine practitioners like herbalists, TBTs, spiritualists among others before and after visiting the formal sector (ibid). These practitioners are not affiliated to the formal health system and there is still no clear framework regulating them.

Although there have been some improvements such as a drop in HIV/AIDS infections, a progressive growth in health financing among others, healthcare and health status indicators remain poor (Kyetume et al, 2011). Communicable diseases account for the highest disease burden and the burden on non-communicable diseases is growing (MoH- Uganda, 2012). Rural poor communities are the most affected. Malaria is the leading cause of morbidity and maternal and child health conditions carry the highest disease burden in Uganda. Yet, the country has a low contraceptive prevalence rate and high fertility rate of 5.8 children per woman. (Kyetume et al, 2011; MoH- Uganda, 2010). Infant mortality at 53 deaths per 1000 live births and maternal mortality rates are at 438 per 100,000 births (UNDP, 2018). Sex, residence, socio-economic status are big determinants of health in Uganda with these indicators being better in urban areas, among the wealthy and educated. (MoH- Uganda, 2010). Like many other sub-Saharan countries, Uganda is in dare need for health personnel to service the growing population and health burden.

4.2.3. The role of VHTs in Uganda

CHWs were identified by the Alma Ata (1978) and the Ouagadougou (2008) declarations as an important cadre in driving our efforts to achieve universal primary healthcare coverage. Uganda established its CHWs referred to as Voluntary Health Teams (VHTs) based on these declarations to improve equity in health service access. Uganda struggles with a limited health work force and VHTs are relied on to extend primary healthcare to inaccessible areas of the country. They are highly engaged in health promotion, disease prevention and community health initiatives (MoH- Uganda, 2010). The MoH in 2001-2010 rolled out the VHT strategy.
(MoH-Uganda, 2016) based on notions of community consensus and volunteerism. VHTs are members of the communities they serve and are chosen by the community. According to Turinawe et al (2015), about 77% of all districts in Uganda had trained VHTs by 2009, responsible for providing newborn care, distribution of health commodities, simple community case management, and community information management among others. However, since its implementation, the VHT roll out program has faced several challenges including low retention, inadequate training and poor sustainability due to inadequate funding (MoH- Uganda, 2010; Ludwick et al, 2013).

VHTs are attached to the lowest level of the health centers although they are supposed to conduct their work in the communities where they live (Busiku, 2014). They are given training and in turn expected to mobilize and sensitize their communities to utilize available healthcare services. They are the link between communities and health facilities. They also engage in health promotion, education, disease surveillance, provide simple treatment to diseases like malaria, pneumonia, diarrhea among others and collect and report data from their communities (MoH- Uganda, 2015, 2018). They work with both government and its partner institutions. Many of these institutions have spearheaded the introduction of mobile technologies into health systems to strengthen linkages between community health services with formal health systems (Busiku, 2014). This has led to a proliferation of mHealth programs in the country (McCann, 2012) under the MoH’s coordination. These initiatives have also been introduced to VHT programs with broader ambitions to empower, retain and motivate VHTs, while supporting them in their everyday work of data collection and community disease management (Källander et al, 2013).

4.2.4. Health Information Systems and mHealth systems In Uganda

Uganda’s first HIS was designed in 1985 to capture and analyze data on communicable and non-communicable diseases (Kiberu et al, 2014). Until 1993, Uganda had a centralized health management information system (HMIS) that focused on morbidity and mortality reporting, with data flowing from health units to the district and national level (Gladwin et al, 2003; Kintu et al, 2005). The MoH in 1997 implemented a health management information system that emphasized the use of information at the point of collection (Gladwin et al, 2003). This was part of the country’s reform to collect more relevant data on human and financial resources, drug and equipment and routine disease data (Kiberu et al, 2014). This was also part of the
country’s effort to decentralize and transfer power to lower levels although districts continued to rely on the central government’s funding (ibid; Bossert and Beauvais, 2002).

The function of the HMIS was to maintain a comprehensive source of health and management information for planning, monitoring and evaluation of the health sector strategic plan. It focused on strengthening:  i) data collection and compilation of health events, ii) timelines, completeness and accuracy of reported data, iii) analysis, interpretation and utilization of evidence-based decision-making and action, iv) regular dissemination and feedback to all stakeholders and v) enhancement of knowledge and skills of health workers in data management, analysis and utilization at all levels of service delivery (Kintu et al, 2005).

Another revision of the HIS was conducted expanding the HMIS to capture more data on vital indicators previously not captured to guide planning, monitoring and evaluation of the health sector (Kiberu et al, 2014).

The HMIS completely relied on paper tools that health workers at the lower levels were supposed to compile. The VHT compiled a monthly report which was submitted to the health center and the health center compiled a report which was sent to the District Health Office (DHO) and eventually to the MoH. This was a cumbersome process that required health workers to spend a lot of time tallying and summarizing data elements often resulting in inaccurate data (Kintu et al, 2005).

Computerization of the HMIS in Uganda has been a slow process due to financial and technical challenges but has been progressively supported by multiple international donors (ibid). The MoH data bank was between 1997-2001 computerized using MS-Access and EpilInfo software in 2002 for district health analysis (ibid). With donor support, the MoH piloted a web-enabled platform in 14 districts of the country in 2009 but only a few districts adopted it by 2009 (Kiberu et al, 2014). This was due to poor infrastructure, poor management capacity, uncoordinated data collection, fragmented HIS and HIS silos and inadequate resources (ibid). And therefore, the HMIS continued to be dependent on paper forms at community and health facility levels between 2000-2010. The HMIS also relied on emails, text messages, faxing and physical delivery of HMIS forms. The District Health Information System (DHIS2) was made the central database for the analysis of national level health services data in 2011 (Kiberu et al, 2014). This web-based HIS was anticipated to strengthen routine district-level health reporting and the University of Oslo customized the DHIS2 for Uganda. Training was
undertaken for users, computers were distributed to 53 districts during the national rollout and financial and routine technical support were arranged. However, challenges of human resource capacity, poor infrastructure continue to challenge its implementation (ibid).

The country recognizes computerization and specific solutions like mHealth systems in the delivery of primary healthcare through disease surveillance, data collection and analysis, CHWs’ support, tele education among others (Kiberu et al, 2017). Internet penetration (at 31%) and cellular phone coverage have facilitated connectivity to districts and rural areas and enabled innovations around mHealth solutions. For example, the mTrack, a Rapid SMS-based HMIS tool designed to report on disease surveillance, and ‘WinSenga’, a fetal heart rate monitor using smart phones among others (ibid). While there have been attempts by both the government and international agencies to improve routine data systems, there are still various vertical HIS systems implemented as silos for example for AIDS, TB, and malaria programs among others (Huang et al, 2017; Kiberu et al, 2017). Various HIS initiatives emerged in Uganda but often lacked clear evaluation and ended in pilotitis. This instigated the Ugandan government to initiate a moratorium in 2012 that demanded all future interventions to prioritize interoperability, sustainability and conformity to existing MoH laws, policy and data requirements (McCann, 2012). However, failures continue regardless of existing implementation guidelines because of limited skills, inadequate policy and low adoption of these HIS by health workers (Kiberu et al, 2017).

4.2.5. Empirical Case in Uganda
The Elimination of Mother to Child HIV Transmissions (eMTCT) program is implemented as a collaboration between the Ministry of Health and other Implementing partners (IPs), to curb maternal and infant mortality in Uganda. The Monitoring and Evaluation Technical and Support Program (METS) in Uganda developed a mobile based application for the Ministry of Health to monitor the eMTCT program. The mobile application is used at the community level by VHTs to report on maternal and infant mortality cases. Over 4000 VHTs were engaged in preventive health activities in their respective communities. The program was running in over 10 districts in the country, but I visited the two districts of Kibaale and Kyenjojo which represented high and low mHealth usage rates respectively. The MoH and implementing partners attempted to improve data reporting on maternal and infant mortality from communities through engaging VHTs to send weekly SMS reports that are registered in the
national DHIS2 database. VHTs were trained to understand the relevance of weekly data collection, how to make weekly reports and send them using their newly acquired mobile phones. In addition to SMS reporting, any reported cases of maternal or infant mortality are investigated by implementing partners for intervention. The figure below illustrates an example of the SMS text.

Figure 4: Example of the weekly SMS report

4.3. Malawi
Malawi is a land-locked country located in southern Africa. It boarders Tanzania to the north and northeast, Zambia to the west, and Mozambique to the east, south and southwest (UN, 2014). The country has a land area of 118,484 square kilometers (WHO, 2018). The country has three administrative regions: the northern, central and southern regions. There are 28 districts: six in the northern region, nine in the central and 13 in the southern region (WHO, 2018a). The districts are further divided into traditional authorities headed by chiefs and the village is the smallest administrative unit headed by a traditional village headsman. A group of village headmen oversees a group of villages (MoH, 2016). Politically, a district is divided into constituencies represented by members of parliament (ibid). The northern region is characterized by a patrilineal system and a matrilineal system in the central and southern.
Malawi’s population was estimated at 13.1 million people and is growing steadily at a rate of 2.8% per annum (Mgawadere, 2017; WHO, 2018a). The high population growth is attributed to a high fertility rate and low contraceptive prevalence especially linked to gender-related traditional and cultural practices, values and norms. Overall, low literacy especially among women and the prevailing cultural diversity impact the lives of Malawians including their health seeking behavior and new developments in agriculture, education and health among others (WHO, 2018a, MoH, 2016). Almost half of the population is under 15 years with a high dependence ratio. The proportion of the population living in rural areas is high at 84.7% (WHO, 2018a). This posits that the increasing population requires increased funding in sectors such as health that are dependent on a limited resource base (WHO, 2016).

The country, once a British colony gained its independence in 1964 and only become a multiparty democracy in 1994 (WHO, 2009). And after over 54 years of self-governance, Malawi immensely struggles economically. Malawi is one of the poorest countries in the world with an estimated GDP of US$3.5 billion (UN, 2014). Notably, there have been some decline in the proportion of people living below the poverty line from 52% in 2004 to 39% in 2009 (WHO, 2018a; MoH, 2016). However, there is a higher disease prevalence among poor people (MoH, 2016). The economy is agriculturally based and donor dependent. It crashed in 2012 partly due to reduced donor inflows (UN, 2014). The economy cannot therefore sufficiently facilitate some of the country’s important sectors like health. The budgetary allocation to the health sector was 12.2% of the national budget in 2010 despite the recommended 15% by the
Abuja Declaration (WHO, 2018a). The country has a life expectancy of 54.8 years, a high disease burden, high infant and maternal mortality and an overall high vulnerability in health (UN, 2014). There were efforts by the MoH to rejuvenate the health sector through strategies such as the Essential Healthcare Package (EHP) that tackles diseases affecting majority of the population through free services (MoH, 2016). This accounted for some progress in programs such as, immunization, malaria, malnutrition, maternal and infant health between 2004 and 2010 (ibid).

4.3.1. Healthcare delivery and the state of health in Malawi

The Ministry of Health in Malawi is the main provider of healthcare services in the country. It collaborates with other development partners to implement a health delivery strategy based on the Essential Healthcare Package that consists of promotive, preventive, curative and rehabilitative services to all people in Malawi (MoH, 2016). Healthcare delivery in Malawi is set up in a three-tier system; primary, secondary and tertiary. The primary level consists of community initiatives, maternity posts, health centers, health posts etc. (WHO, 2018). The secondary level has district hospitals that give specialized services to patients referred from the primary healthcare level. And the tertiary level offers specialized services at central hospitals that give specialized care for specific disease conditions. The three tiers are linked through an elaborate referral system within the health system. Besides the MoH, the private sector also provides healthcare services. NGOs, private for-profit providers, faith-based organizations like the Christian Health Association of Malawi (CHAM) and community-based organizations deliver healthcare services to people (WHO, 2014). The informal health system provides traditional health services although there is no formal linkage policy between the MoH and traditional healers. The MoH has mainly involved traditional birth attendants (TBAs) to expand maternal and child health services in communities.

Despite tremendous efforts to provide quality health care services to Malawi’s population, this is hindered by the existing poor infrastructures, weak management, lack of equipment and drugs and lack of qualified medical personnel (WHO, 2018). This discourages people from seeking professional medical services. The country faces a heavy disease burden like much of sub-Saharan Africa (WHO, 2014). There is a high prevalence of communicable diseases like HIV/AIDS, malaria, TB; a high incidence of maternal and child health problems, an increasing burden of non-communicable diseases etc. In 2008, the prevalence of HIV among adults in
Malawi was estimated at 14.2% and rising to 28% in urban areas (Nyirenda et al, 2008). Malaria was reported to be responsible for over 40% under five deaths (WHO, 2009). In Malawi, maternal mortality is as high as 634 per 100,000 live births (Mgawadere, 2017). And the Infant mortality ratio is at 22 per 1,000 live births (UNICEF, n.d). These maternal and infant mortality rates are considered the highest in Africa (UNDP, 2015). In the face of this high disease burden, Malawi struggles with a critical shortage of professional health personnel (Kok and Muula, 2013).

4.3.2. The role of Health Surveillance Assistants
Malawi lacks an adequate medical workforce. In 2005, an emergency Human Resource Program (EHRP) was started to build the size and capacity of the health workforce (Kok and Muula, 2013) to meet the country’s pressing health needs. A new workforce made up of CHWs or Health Surveillance Assistants (HSAs) as they are referred to in Malawi, was reinvented to support the health system in the delivery of primary healthcare to all. This was in accordance to the Alma Ata declaration of 1978. HSAs are formal non-clinical health workers that have at least 10 to 12 years of education and undergo a 6-10 weeks basic training for their position (Callaghan-Koru et al, 2013). However, this training is changing due to their shifting tasks (Smith et al, 2014). HSAs evolved from temporary staff called “smallpox vaccinators” in the 1960s and “cholera assistants” in the 1970s to officially becoming part of Malawi’s Health System in 1995 (ibid). They now constitute the community-based health structure and are formally employed by the Ministry of Health with paid monthly salaries. By 2009, Malawi had over 10,507 HSAs constituting the country’s largest health workforce (Kok and Muula, 2013). HSAs are attached to a health facility but are expected to reside in their catchment areas (Kok et al, 2016). They are often the only health workers serving rural areas where they reside (Smith et al, 2014). Some of the recruitment for HSAs is aided by donors such as, the Global fund, UNICEF and WHO among others, to support programs such as; AIDS, Tuberculosis and malaria (Callaghan-Koru et al, 2013).

HSAs serve both urban and rural areas although majority are posted in rural areas where they are supervised by Assistant Environment Officers (AEHOs)- non-clinicians under the MoH’s Preventive Health Section based at health facilities (Callaghan-Koru et al, 2013). They are also supervised by a more experienced HSA who is referred to as a senior HSA who is posted to the community and promoted to a supervisory role (ibid). Supervision is supposed to occur during
monthly field visits by the AEHO and the HSA supervisor and during quarterly review meetings (ibid). In the community, HSAs work in designated catchment areas of approximately 1,000 people and their main function is to provide primary healthcare in the form of, preventive, promotive and some curative health services (MoH Malawi and ICF International, 2014; Callaghan-Koru et al, 2013). They are responsible for community level delivery of the MoH’s Essential Healthcare Package, the minimum services to Malawians provided for free. And as part of the Essential Healthcare Package, HSAs deliver community case management (CCM) which is an extension of the integrated management of childhood illnesses (Smith et al, 2014; Kok et al, 2016). They promote community participation in healthcare activities, conduct disease surveillance in villages and some tasks are added to them formally or even informally hence increasing their workload (ibid; Kok et al, 2016). For example, HIV testing and counselling. They also record various kinds of data from different programs they work with in several registers such as, the village health registers (VHRs), Health Management Information System (HMIS) registers and registers for specific programs (Kok and Muula, 2013).

At the community level, HSAs are assisted by Village Health Committees (VHC) consisting of 10 volunteers representing the community and elected by the community (Smith et al, 2016). They are also assisted by other volunteers such as HIV/AIDS support groups, TBTs and local village chiefs. Village chiefs usually support HSAs work through effectively mobilizing community participation in healthcare service programs (Manda-Taylor et al, 2017; Kululanga et al, 2011;). In the communities, they operate in a local structure called a village clinic where community members meet HSAs if they do not visit them in their homes.

4.3.3. Health Information Systems in Malawi and the use of mHealth systems
By 1999, Malawi’s HIS were numerous, uncoordinated and could not produce required information for decision-making (Chaulagai, 2005). To achieve its primary health care strategy goals, the country restructured its HIS to feed information to the users at the community, health facility, district and national levels (ibid). Since 1999, the country embarked on strengthening efforts that saw a comprehensive review of the HMIS, commissioning of a desktop-based HMIS software solution (DHIS 1.3) in 2002 and the development of HIS implementation capacity (Manda, 2015). By 2003, the reforms developed an indicator handbook, data collection tools, training manuals for health workers and managers and a national HIS policy and implementation strategy. The digital HMIS solution (DHIS 1.3) was
implemented by 2002 to support routine data storage, analysis and presentation at district and national level. Through the HMIS, data required for health service planning is collected as part of routine health service delivery and through non-routine exercises such as censuses. At the community level, field level staff like HSAs report to the health facilities they are attached to. The health facilities in turn report to the DHO which in turn reports to the Ministry of Health Headquarters.

By 2009, efforts to update the national HMIS software from DHIS 1.3 to DHIS2, an internet server-based solution were facilitated by the MoH and HISP Oslo. (ibid). The HMIS has continued to be supported by external support which has sometimes instead constrained some efforts when it ends. This is because available support is inadequate to sustain gains registered in the efforts (ibid). Despite tremendous efforts to have a unified HIS by fostering collaboration amongst stakeholders, Malawi is crowded with various HIS systems introduced as parallel program specific systems (Chikumba and Kaunda, 2012). Existing IT expertise and policies are insufficient in managing implemented HIS solutions or guide HIS strengthening efforts including the utilization of emerging technologies like mHealth solutions (Manda, 2015). MHealth systems in Malawi are being positioned at the forefront of facilitating community-based health initiatives including quick disease diagnosis, administrative functions relating to data reporting and HIS (Joos et al, 2016). They are also implemented to support specific programs such as, maternal and child health, malnutrition and malaria (Källander et al, 2013). Considering HSAs’ community presence (Kok et al, 2016), various institutions integrated mHealth solutions into their work to extend the reach of the formal health system.
However, these systems are often implemented as pilots without sufficient evaluations (Joos et al, 2016).

4.3.4. Empirical case in Malawi

The mHealth system studied was developed as an initiative to support HSAs in addressing Maternal and Infant health and mortality in rural villages. D’tree in 2014 developed a mobile decision support system to aid decision-making for HSAs while providing care to infants and expectant mothers. The mHealth system was first piloted in two districts- Dowa and Machinga districts where HSAs attached to health facilities were trained on how to use it. The initial pilot period involved D’tree getting a lot of feedback to improve and upgrade the mHealth system. HSAs were given smart phones with the mHealth system. At the time of the study, the system was being rolled out to two more districts and over 90 HSAs from those districts were receiving training conducted by the district health office and staff from D’tree.

The mHealth system was developed based on existing paper protocols that are incorporated into mobile phone systems to support HSAs in accurately assessing, diagnosing and treating mothers and infants. The mHealth system guides HSAs as they assess signs and symptoms of patients in their communities. It takes HSAs through a step by step analysis and treatment plan for health conditions like malaria, malnutrition, and pneumonia among others. For example, if the HSA is assessing the health of an expectant mother, s/he goes through a step by step inquiry of danger signs and symptoms during a pregnancy. Based on the answers entered into the mHealth system, a diagnosis or a recommendation for action is generated such as; treat the patient with this medication, counsel the patient with the recommended information or make a referral to a health facility. As patients are registered, data is also immediately captured in the organization’s database. At the time of the study, there were plans to integrate this data into the national HIS facilitated by the DHIS2 software at the MoH. Consequently, individual data reporting is made with the mHealth system unlike before. HSAs can also use individual records to follow up cases in their communities. The mHealth system also has a provision for HSAs to make logistic requests.
Figure 7: Paper forms previously used by HSAs which are now integrated in the mHealth system
Chapter 5: Research methods
This chapter presents my methodological considerations during the research. My research aim has been to examine the work transformations that evolve when mHealth systems are introduced in community healthcare work and how these are sustained over time. Thereby contributing to a better understanding of how work practice transformations can inform efforts for sustaining mHealth systems particularly and other health information systems more generally.

My research focuses on the following two primary research questions;

i. What is the nature of mHealth systems mediated work transformations of the community health work practice?

ii. How do we sustain work transformations and the mHealth systems that support them?

The phenomena studied are work practices, conceptualized as work transformations when they change as they interact with technology use. The study is part of the DEMCA project (Design Methods for Complex Architectures), a research project at the Department of Informatics at the University of Oslo. The project has run between 2014 to 2018 with an aim to develop a reconceptualization of the nature of inter-dependent large-scale ICTs (dubbed information infrastructures) and develop approaches to their design, development, governance, monitoring and assessment founded on the theoretical understanding of their complexity. I investigate an implementation of mHealth systems and conceptualize the work transformations that evolve around them to draw implications for their sustainability in the wider HIS they are a part of.

The papers in the thesis have detailed methodological sections which I further elaborate in this chapter. I detail my research foundation, research design, how I gained access to the field, data collection methods and also reflect on the research process and practical considerations I undertook. I give an account of my data collection methods and my role as a researcher. I then describe my approach to data analysis and reflect on the ethical considerations, limitations and the generativity of this study.
5.1. Research Foundations

Pasian (2015) emphasizes the importance of a methodological fit that involves the choice of a right research strategy to fit the situation and purpose of the research. The current standing of knowledge on mHealth implementations and their sustainability in developing countries, requires a qualitative and exploratory study. For me this was so that I could evaluate my research questions in great detail while relying on the rich descriptions of mHealth system users in their everyday lives to form a basis for credible arguments in my findings.

The research design forms the overall structure of the research entailing a strategy employed to integrate the various components of the research in a logical way to effectively address the research problem (NYU, n.d). Exploratory and explanatory approaches form the main distinctions of a research design (ibid). The exploratory approach seeks to describe the nature of a research problem. Explanatory approaches seek to develop explanations about a research problem hence answering why questions. They seek causal explanations of the phenomenon they investigate. Good descriptions on the other hand can provoke the why questions of explanatory research. The choice between the two approaches is highly determined by the research question one seeks to answer (Yin, 1994) and is also linked to their epistemology.

Epistemology refers to our assumptions about knowledge and how to obtain it. Epistemological distinctions are made between positivist, interpretivist and critical approaches to research (Orlikowski and Baroudi, 1991). A positivist approach assumes that knowledge is objective, and that facts and values are distinct (Walsham, 1995). This approach sets out to test theory to increase the predictive understanding of phenomena. Critical approaches seek to transform the social realities they investigate by critiquing and disclosing any contradictions and conflicts within existing structures. This tradition holds that social reality and knowledge are historically constituted and that people are not confined to exist within a particular state (Myers and Avison, 2002; Orlikowski and Baroudi, 1991;). The interpretivist position assumes that reality or knowledge about the world is subject to people’s subjective and intersubjective meanings (Orlikowski and Baroudi, 1991). Interpretivism rejects an objective reality and underscores a relativistic and socially shared understanding of phenomena through interpretation and meanings people assign to them (Cardoso and Ramos, 2012; Walsham, 1995, 2006). It therefore gives a nondeterministic account with intent to elucidate phenomena in their sociocultural and contextual settings. For example, an
interpretivist approach would aim to produce an understanding of the context of the information system and the process where the IS influences and is influenced by the context (Walsham, 1993). This approach is especially important when the research is of a social or socio-technical nature.

In this thesis, I position myself within the interpretivist strand and I understand that knowledge is socially constructed from the active participation of people. Therefore, people give me (the researcher) accounts of their active interpretations and constructions of their situation. The data I collect with an interpretive approach is thus an account of the interpretations made by the people and my own interpretations of their interpretations. My role has been to report my interpretations of their interpretations of their social reality. Another researcher could have different interpretations all together. With the interpretive approach, not only do I understand the actions people undertake but the interpretations they attach to their actions. To address my research aim, of understanding the work transformations that accrue with new technologies in the community health work practice, I have attempted to understand the various perspectives of the people involved in using mHealth systems. The work of Klein and Meyers (1999) has had significant impact in IS research, offering solutions to methodological rigor. Their principle of contextualization requires a critical understanding of the social and historical aspects of the phenomena under investigation. Throughout the papers, I have attempted to provide the context for the cases.

Interpretivist research has also extensively drawn on ethnography methods (Walsham, 1995). Research, especially that studying healthcare work practices has especially employed methods inspired by ethnography and ethnomethodology, using a mix of observation and unstructured interviews (Fitzpatrick and Ellingsen, 2013). The ethnography approach sets to understand people’s everyday lived experiences in their natural context (Warren, 2001; Myers, 1999). For the ethnographer therefore, a phenomenon is understood in its lived experience set in the present (ibid). Ethnographies often require long periods in the field and detailed observations. Ethnographies are powerful in the sense that they enable a researcher to gain an in-depth familiarity and understanding of the people and the broader context (Myers, 1999). However, these studies are very time consuming with a danger of the researcher going native and failing to question phenomena that become mundane to him. An interpretive researcher on the other hand tries to understand what people say, extending into the past and the future and
beyond the accounts of behavior. Data collection methods for interpretive case studies therefore extend beyond detailed participant observation to include interviews for example. I cannot claim that this study is exclusively an ethnography, but I do draw inspiration from ethnography methods like participant observation to understand the context of mHealth systems use.

5.2. The research design
The study is based on two longitudinal case studies; the SMS case in Uganda and the Decision Support system case in Malawi. Between the period of 2015 and 2017, I went back to follow up on the same respondents at different time points. A Case study is described as an empirical inquiry that investigates phenomenon within its real-life context (Yin, 1994). The boundaries between phenomenon and context are not clear and case studies employ multiple approaches to data collection (Yin, 1994; George and Bennett, 2004; Benbasat et al, 1987). In this study, I undertake a multiple case study where each of the two cases presents some similar approaches to health service provision and some different approaches in management. The two cases were chosen because the two countries have had tremendous development in mHealth systems in the work of CHWs but still struggle with sustaining them. The multiple case study design was undertaken to enable me to gain a broader exploration and understanding of sustainability issues as mHealth system use unfolded in the two contexts.

There are some similarities and differences in the cases and I was curious to understand if they were implicated in the sustainability of the mHealth systems. First the cases represent efforts to improve health service provision in maternal and infant programs on a local and regional level using mHealth systems. The two cases also were developed and run differently. In Uganda the SMS case is developed and run by the MoH together with implementing partners. In Malawi, the case is run by an independent partner with minimal interference from the MoH. The functionalities of the systems differ in terms of scope and types of services in the mHealth systems. VHTs in Uganda are community selected and work as volunteers while HSAs in Malawi are employed and paid by the MoH.

Prior to my choosing the cases and negotiating access, I had observed the number of mushrooming mHealth systems in Uganda. Often these emerged to address specific health projects but there was no evidence of their continuity or contributions to the goals they set out to achieve. It triggered my interest in understanding how these technology efforts can be
given grounding in the local contexts they set out to support since so much is invested in their operation. My professional background is in development studies and I have been interested in understanding local interventions that can sustain development efforts. The SMS case appealed to me because I wanted to understand how CHWs experience technology use in their work practices. The Decision support system was interesting because it offered a deeper engagement in the work of CHWs. There were various things to learn in the implementation of these systems in CHWs’ work. My underlying research approach was therefore interpretive, and practice based as I tried to understand CHWs interpretations in their work practices as they used mHealth systems. I drew on qualitative methods of interviews, participant observation, focus group discussions and documents to gain deep insight into the everyday lives of CHWs.

The unit of analysis is the same throughout the cases; the work practice of the CHWS and the group of CHWs. I focused on the work activities they perform, their work interactions, work relations and networks, emerging work transformations around mHealth system use and how mHealth systems influence and are influenced in their work. The unit of analysis helped me address my research questions where I took to understanding CHWs’ experiences with the mHealth systems in their everyday lives, the changes that emerged in their work and the actions they took to reject or sustain both new practices and the mHealth systems. I also observed some health consultations between community members and the CHWs. This data served as background to understanding the organization of CHWs work and its current interactions with mHealth systems. The unit of analysis was therefore how CHWs engaged with the system in their work and what transformations emerged.

5.3. Accessing the Field
Gaining and maintaining access to a research field can be challenging. Walsham (2006) has suggested that good social skills coupled with self-reflection are essential in gaining and maintaining access to the research field. As a researcher, it was important to reflect on my role, who I needed as informants and how long I would stay with them. I gained access especially through managers of mHealth implementations. Having continued access to the field required renegotiation and I made sure that I gave some feedback to the organizations that I worked with. At the same time, I stayed in touch with managers and CHW coordinators.
I often made phone calls to CHWs’ coordinators with a few follow up questions after I had left the field and I also gave them some feedback regarding my findings.

I am affiliated to the Health Information Systems Program (HISP) research group at the University of Oslo that has extended contact with the University of Malawi and the MoH. The University of Malawi and the MoH have extended contact with mHealth implementations across the country. When I started my research, the University of Malawi put me in touch with the D’tree project, although it is not associated with HISP, so we could draw some implications from their mHealth implementation for a new mHealth project that HISP was going to implement. The new mHealth project was approved by the research council in Malawi and is implemented in partnership with the university of Oslo through the mHealth4Africa project. I was warmly welcomed by the D’tree team who invited me to join in their initial training meetings with HSAs. This was an opportunity for me to join the team, and to continue following up the mHealth system users (HSAs). I was introduced to the HSAs and together with their coordinators, I asked for permission to conduct my research. Kaplain and Maxwell (2005) emphasized the importance of involving all participants in the negotiations for a researcher’s entry into their world as this raises ethical issues as well. The MoH provided me with support to follow up HSAs in the field. While I was involved with the D’tree project, I maintained contact with the HSA coordinator who always arranged my interactions with other HSAs during every visit. In return for their generosity, I sometimes contributed suggestions in their meetings especially with infrastructural challenges.

In Uganda, a branch of the Health Information Systems Program (HISP) team collaborates closely with Makerere University Monitoring and Evaluation Technical Support (METS) program. METS is in charge of monitoring and evaluating mHealth implementations in the country. Among such implementations is the Elimination of Mother to Child HIV Transmissions (EMTCT) program. It uses the DHIS2 software to enable SMS reporting of maternal and infant mortality cases from CHWs’ villages. I was attached to the METS team that introduced me in two districts where SMS reporting occurs. There, I was supported by the VHT coordinators during my visits. The METS team provided information material such as documents on implemented DHIS2 mHealth projects for maternal and infant health support. They also offered me transport to the field and a staff member familiar with the work in the two districts accompanied me. While I was involved with the team, I sometimes made presentations and
reports regarding the state of the mHealth implementations from the districts that I visited. I was engaged in the meetings of the team and it was important that I gave some input. I also stayed in touch with the contact person in METS and the VHT coordinators. In this way, I was able to continuously negotiate my access to the research field.

**5.4. Data Collection and my role in the field**

Data collection methods refer to the tools or techniques used in the process of inquiry (Pasian, 2015). The methodology on the other hand is an intricate set of ontological and epistemological assumptions that a researcher brings to their work (ibid). The research methods should be an appropriate way for generating valid evidence for the research (Orlikowski and Baroudi, 1991) and anchored in the theoretical and philosophical framework. Qualitative methods were employed as an array of interpretive techniques to seek, describe, decode and translate the phenomena or people and the social context they live in (Garci and Quek, 1997; Myers and Avison, 2002). This thesis is based on field studies and qualitative data that enabled me to examine participants in their social settings, the activities they engage in, their interpretations of the social actions and alterations in their work. I drew inspiration from ethnography techniques although the study is not a proper ethnography. This was so that I could consider the participants context and their interpretations of their actions. Data was collected through, interviews, Participant observation, Focus Group Discussions and document studies across both cases. The table below summarizes data collection across the two cases.

**Table 1: Summary of research methods**

<table>
<thead>
<tr>
<th>Case</th>
<th>Number of interviewees</th>
<th>Number of hours Interviews</th>
<th>Number of FGDs</th>
<th>Number of hours FGDs</th>
<th>Number of hours Observation</th>
<th>Document Studies</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMS project</td>
<td>35</td>
<td>29</td>
<td>3</td>
<td>4</td>
<td>19</td>
<td>Yes</td>
</tr>
<tr>
<td>Decision support system</td>
<td>44</td>
<td>44</td>
<td>2</td>
<td>3</td>
<td>67</td>
<td>Yes</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>79</strong></td>
<td><strong>73</strong></td>
<td><strong>5</strong></td>
<td><strong>7</strong></td>
<td><strong>86</strong></td>
<td></td>
</tr>
</tbody>
</table>

Below I detail the data collection methods across both cases.

**5.4.1. Interviews**

Interviews were chosen because they are the best technique for accessing people’s experiences regarding social actions and their views and aspirations of other participants
(Walsham, 1995). I relied on semi-structured interviews with open-ended questions so that I could elicit participants’ views in their own terms while not limiting myself to the rigid format of structured interviews.

CHWs were selected as respondents based on having at least one-year work experience and having used the mHealth systems within that period. They were identified by the CHW coordinators and sometimes CHWs themselves. CHWs live in dispersed villages and we (coordinator, I and sometimes a translator) made calls to them to explain the purpose of the research. After giving their consent, we then visited them in their villages, so they did not have to travel to meet us. Consent was again sought before progressing. I used semi-structured interviews and prepared an interview guide for all interviews. The interview guide included open-ended questions on the topics that I wanted to address so that I would steer the interview in the direction that I wanted it to go. The open-ended questions gave interviewees freedom to express themselves and their views on the topics asked. I was also able to follow up with probing questions, but I was careful to contain the interview within the types of answers I wanted. For example, I asked participants to describe to me how they engaged with the mHealth systems in their work and in these discussions, they also elaborated other uses that were not specific to the system design. They shared other uses they developed around the new technologies in their work as illustrated below.

Researcher: How do you use the phone in your work?
CHW: When for example a woman brings her child to me, I will ask her questions about the child. These are mostly signs and symptoms if a child is not feeling well. I enter it in my phone and it says for example test the child for malaria...I also use the timer in my phone to measure a child’s breathing. This is very efficient when I want to determine if a child is experiencing heavy breathing...

I mostly relied on field notes which taken during the interviews to capture people’s interpretations of their work, their experiences with the mHealth systems and those aspects of their work they thought were changing. The challenge with this, is that it is not so easy to maintain normal social interchanges during interviews. I often made rough notes to maintain normal conversations during interviews so that I was able to observe how they acted when using mHealth systems. At the end of the fieldwork day, I would make more detailed notes on the interviews. Sometimes, interviews were recorded instead and sometimes recording was combined with field notes.

Social skills to keep the interview going are important. I read about their work before the interviews so that I had some prior knowledge. This was for me to keep normal conversation flow. I sometimes brought up what I had read to clarify with them my preconceptions of their work.

5.4.2. Participant Observation
I was introduced to all CHWS by the organizations implementing mHealth systems. It can be said that it was possible for the CHWs to consider me as part of the organizations’ team and partly as an insider set to understand and implement mHealth systems. But I did not want CHWs to assume my role was that of a supervisor because I did not want them to withhold information from me. So, when I was invited to participate in meetings for two weeks when CHWs were being trained to use the mHealth systems in Malawi, I attended and engaged in dialogue with them, posing questions and making suggestions when I was asked. I did not participate to any substantial degree in decisions concerning the project. I also joined them during home visits that lasted over 30 minutes per visit and observed care giving activities and how the mHealth systems were used. I simply did not want to rely only on interview data because as Suchman (1995) noted, work tends to disappear as workers may disregard the type of work they do not see or what they take for granted. Workers apply the term work selectively (Nicolini, 2012) and a reliance on only interview accounts implies practice selection
and deletion. I therefore adopted observations and informal chats to understand the practice as it happened.

I become a temporary member of the participants I was studying when I joined in their training sessions during the mHealth systems’ implementation. This helped me to get an insider view and understanding of the users’ expressed interactions. The challenge with this approach is that the researcher maybe seen as having a personal stake in various views and some participants may become guarded (Walsham 1995). In this case I made sure to assure participants of confidentiality and the aim of my research. I told them I wanted to understand how they experience the mHealth systems in their work.

I was involved in the day-today happenings of CHWs. I was invited to observe how they used their mHealth systems to diagnose patients. In Uganda, I accompanied VHTs on home visits and observed how they collected data on maternal and infant health from households. They also showed me how they used their mobile phones for SMS reporting. After observations, I often had informal chats with CHWs on our way back from the field. I wondered about how the mHealth systems influenced traditional processes of diagnosing, reporting, interactions with patients and the rest of the health system organization. This was for me as a researcher to step back and examine the interpretations of participants in accordance to what they said they did and what they did. It also assisted me to refine my interpretations. The informal chats and interviews were also used to fill in the meanings around the observed social interactions. I made observational field notes and the respondents gave me permission to take pictures which helped me to build my interpretations.

5.4.3. FGDs

In both cases, focus group discussions were conducted twice so that I could get the groups’ interpretations of their experiences with mHealth systems. In the group discussions, members shared their collective interpretations of their experiences from using mHealth systems in their work. In these meetings, I acted as a moderator making sure that all participants got an opportunity to speak without a few participants dominating the discussions. I encouraged the quiet ones to speak and encouraged everyone’s opinion. It is challenging to make field notes during these group discussions or catch participants expressions. I therefore mostly used my tablet to record these discussions and field notes to capture expressions that stood out. These were later transcribed to assist my analysis process.
5.4.4. Secondary data from documents

In both cases, I studied documents especially before initial data collection. The documents described the role of CHWs and mapped out events of the project history. For example, in Uganda, I studied reports on the implementation of the SMS project, areas of operation in the country and the performance of the project in various parts of the country. It was upon these initial document studies that I for example decided to visit a district with good performance and one with low performance to understand these varying levels of mHealth system use. In Malawi. I got documents that descriptively detailed the work of HSAs. For example, the national guideline and strategies for community health work. Most of these documents were reviewed before I started interviews and were helpful in the preparation of the interviews. In the table below, I illustrate the different documents studied and the insight I got from them.

Table 2: Documents studied and insights from them

<table>
<thead>
<tr>
<th>Document type</th>
<th>Insight from document</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reports</td>
<td>Project history and timelines of the projects</td>
</tr>
<tr>
<td></td>
<td>Strategies of how mHealth systems were introduced and maintained.</td>
</tr>
<tr>
<td>Performance Reviews</td>
<td>Project performances based on mHealth system use in various regions.</td>
</tr>
<tr>
<td>Community health work strategies</td>
<td>Description of the community health work practice and its varied tasks.</td>
</tr>
</tbody>
</table>

In the next sections, I describe data collection process in each case.

5.5. Data collection in the SMS Case

I collected data for the case in Uganda in two phases- March-April 2015 and December 2016-January 2017. I was the principle investigator in this case even though I joined the METs team in Uganda that was already evaluating the SMS project. The main source of the data was semi-structured interviews, participant observation and Focus Group Discussions (FGDs). I conducted 35 semi-structured interviews each lasting between 40-60 minutes. I interviewed 27 VHTs, two VHT coordinators, three community members in Kibaale and Kyenjojo districts. Two of the interviews were conducted with the METs team involved in the implementation and evaluation of the mHealth system. These were two IT managers (one involved in system design and the other in project management) at the METS office and I sought their understanding and considerations of the VHT work practice in system design and
implementation. All interviews were recorded in fieldnotes and sometimes I used my tablet to record conversations alongside the field notes. The VHTs were chosen based on their work duration (one year and more) and having used the mHealth system for at least one year. I believe these VHTs had the potential to reflect on their uses of the mHealth systems and share their interpretations of their experiences. Since not all VHTs in the two districts were using the mHealth systems, some VHTs suggested other VHTs to interview. This snowballing technique helped me to identify respondents that were added to the interviewing process.

During interviews, participants were asked to elaborate on the nature of their work, how they use the mHealth systems, the impact of mediating their work through mHealth systems and the changes accruing from this. Paper one is especially based on these data. They were also asked to share the challenges of mHealth systems mediated work. The two IT managers were asked to elaborate their understanding of the VHT practice and their processes of mHealth system design.

At the start of the research in Uganda, I reviewed documents and reports that described the mHealth systems, the performance of the various districts with SMS reporting and the work of VHTs. I read these documents to familiarize myself with the practice of VHTs. This resulted in guiding my choice of districts to visit based on performance and it also guided the development of some research questions. I was also allowed to make eight observations of VHTs’ work resulting into useful insights of how mHealth systems are experienced in their context during home visits, at health centers. Table two below summarizes data collection in Uganda.

**Table 3: Data collection in the SMS case**

<table>
<thead>
<tr>
<th>SMS project</th>
<th>Data collection method</th>
<th>Focus of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td>March- April 2015</td>
<td>- Interviews: VHTs, coordinators, community members and managers in implementing organization. - Observations of VHTs work in villages (19 hours). - FGDs (4 hours). - Documents (monthly reports, brochures).</td>
<td>- Understand the work of VHTs. - Understand the uses of the mHealth system. - How mHealth systems were implemented and the level of engagement by VHTs. - How the use of the mHealth system changed work.</td>
</tr>
</tbody>
</table>
5.6. Data Collection in the Decision Support system case

In the case of the decision support system in Malawi, I also collected data in two phases—September and October 2015 and September-October 2017. I joined an on-going research project (mHealth4Africa) which was implementing a new mHealth system for clinical workers but wanted to take lessons from existing mHealth projects like the decision support system. I personally conducted interviews, observations and FGDs. I conducted 44 semi-structured interviews lasting 30-70 minutes for in-depth data on the work practices of HSAs and their use of the mHealth systems in their work. This case also focused on similar participants as the case in Uganda; HSAs, their coordinators, community members, managers in the implementing organization and health personnel at the health facilities. The key informants were helpful in identifying various interactions, networks, activities and changes. The interviews also sought to understand the nature of work for HSAs and the dynamics between this work and technology mediation. All interviews were recorded in field notes which were sometimes complimented by recordings on my tablet. The interviews were transcribed to assist me in developing organized and coherent data for analysis. All the papers illustrate various aspects of work that were transformed when the mHealth system was implemented.

I was also allowed to make observations of the HSAs’ work practice to understand how it interacted with the mHealth system. These observations brought insights to data collected during interviews. I made 17 observations of training meetings in which HSAs learned how to use the mHealth systems. I also observed work activities like treatment and follow-up home visits in which the mHealth was engaged. I observed their interactions with other health personnel as they collaborated with them in their work. Focus group discussions were used to corroborate findings from interviews and observations. Table three below summarizes data collection in Malawi.
Table 4: Data collection in Malawi

<table>
<thead>
<tr>
<th>Period</th>
<th>Data collection methods</th>
<th>Focus of data collection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Decision Support system</strong></td>
<td></td>
</tr>
<tr>
<td>September -</td>
<td>Interviews: (HSAs, community members, coordinators, Organization managers, health personnel).</td>
<td>Nature of HSAs work.</td>
</tr>
<tr>
<td>October 2015</td>
<td>Observations of HSAs work (19 hours).</td>
<td>How mHealth systems are used in HSAs work.</td>
</tr>
<tr>
<td></td>
<td>FGDs with HSAs (1 hour)</td>
<td>What are the changes to HSAs work around the use of the systems.</td>
</tr>
<tr>
<td></td>
<td>Documents (brochures, reports, strategies)</td>
<td>What is enabling and challenging the mHealth systems’ use.</td>
</tr>
<tr>
<td>September -</td>
<td>Interviews.</td>
<td>Nature of HSAs work.</td>
</tr>
<tr>
<td>October 2017</td>
<td>Observations of HSAs’ work (48 hours).</td>
<td>How mHealth systems are used in HSAs work.</td>
</tr>
<tr>
<td></td>
<td>FGDs (2 hours)</td>
<td>What are the changes to HSAs work around the use of the systems.</td>
</tr>
<tr>
<td></td>
<td>Documents (National community health strategy, Community health guidelines, reports etc.)</td>
<td>What is enabling and challenging the mHealth systems’ use.</td>
</tr>
</tbody>
</table>

5.7. Recording of data during data collection
Most of the data was recorded using field notes where I made rough extracts during the interviews. The challenge with this is that as a researcher, one might fail to maintain normal conversation, come off as extremely passive, unknowledgeable and uninteresting (Walsham, 1995; Warren, 2001). It is important that a researcher has good social skills and personal sensitivity to access people’s thoughts and views (Walsham, 1995). It is also important that the researcher maintains a balance between being able to adequately listen and interact with the respondent while capturing data. During interviews in Uganda and Malawi, majority of the interviews were recorded using fieldnotes and at the end of the day, I would revisit my fieldnotes to write them out in more detail. In Uganda, some interviews were recorded using my tablet especially where some respondents were not very conversant with Luganda or English. I had to replay them to understand certain phrases and I sometimes used a translator to explain meanings both during the interviews and after. In Malawi, I also sometimes combined both fieldnotes and recorders especially when the respondent was not very
conversant with English. As I wrote the field notes, sometimes I would ask the respondent to clarify meanings. I revisited recorded interviews on the tablet with the translator to clarify certain phrases that were said in Chichewa.

During observations, I took notes in meetings and healthcare exercises in the community. I revisited these notes with the CHWS to clarify meanings of events I had observed. For example: “Today is the village clinic day for Petter (alias). He has attended to 3 patients since we arrived. As he examines a baby boy (less than two years old) he follows standardized protocols in his mobile phone. A patient register book is also open on his table. And after examining the boy, he turns to the open book register and writes something. I ask him what he is writing after the mother and boy leave. “I have to enter this data from the mobile phone into the book register as well because we (HSAs) have to send paper reports to the health facility”. I also took notes of my own reflections of what I saw and heard in the field. For example: “The VHTs are encouraged to send weekly SMS data on maternal and infant mortality because they get attention to their villages from supervisors and the DHO. Supervisors come to villages to clarify causes of maternal and infant mortality and work with VHTs to establish solutions. This is a form of recognition for them by both the supervisor and the villages they work in.”

I also recorded explanations, for example: “Sarah (alias) is no longer sending SMS data because the messages do not go when she sends them. According to the supervisor from the implementing organization, this is because Sarah has changed her telephone number and the system does not recognize her new number. All new numbers should be registered in the DHIS2 database for weekly SMS reports to be received.”

When observing home visits, I sat quietly on the floor or a chair in the corner of the room. During observations of consultation activities and care giving tasks at the village clinic, I often sat quietly on a stool in the corner or close by to the HSA when s/he determined the case was not very sensitive. I took notes of these interactions and what was discussed between the patients and the CHWs:

“Lady, approximately in her early twenties is 7 months pregnant and this is the second time the HSA is conducting a home visit. The woman is ready with her health profile card which shows that she has been to the health facility once for antenatal care. The HSA reads it and
proceeds to say, ‘I see you have had only one antenatal visit to the health facility. It is important that you go to the health facility as soon as possible when you are pregnant’. The lady nodes. She asks the patient to tell her what she learned during the previous antenatal home visit. The patient recites what she learned. However, it seems like she has forgotten some things. The HSA reminds her and prompts her to remember before she proceeds with more education in this visit.”

In a conversation after this home visit,

“The HSA says it is important to revisit knowledge from previous sessions because the ladies need to understand danger signs at each stage of the pregnancy. And we encourage partners to attend these sessions with the expectant ladies so that if one forgets, the other might remember what was taught. ‘Two heads are better than one.’ She adds.

5.8. Drifting during the research
Klein and Myers (1999) suggest criteria for evaluating interpretive research with a hermeneutic orientation. Their hermeneutic principle is the first upon which the rest of the six principles are drawn to conduct and evaluate interpretive research. The hermeneutic principle suggests that human understanding is achieved by iterating between the interdependent meaning of the parts and the whole they form. The part and whole can be at various levels like historical and social aspects. The contextualization principle emerges from this idea suggesting a critical understanding of the social and historical aspects of the phenomena under investigation. The third principle of interaction between subjects and researchers suggests a critical reflection on how research material is socially constructed through the interaction of the researcher and the study participants. The fourth principle of abstraction and generalization requires researchers to relate the idiographic details from data interpretation to theoretical and general concepts that describe the nature of human understanding and social action. Their principle of dialogical reasoning requires sensitivity to possible contradictions between the theoretical framing that guides the research and the actual findings. The sixth principle of multiple interpretations requires sensitivity to possible differences of interpretations of events among study participants. This is lastly followed by the seventh principle of suspicion which requires a researcher to be sensible to the potential biases and distortions in narratives from participant.
Their first principle was especially central to my research aim as I sought to understand changes in CHWs’ work practice mediated by technology. Klein and Myers’ (1999) fundamental principle of the hermeneutic circle states that, “we can understand a complex whole from preconceptions about the meanings of its parts and interrelationships.” This implies that, interpreting and understanding a complex phenomenon is an iterative process of movement between a precursory understanding of the parts of the whole and an emerging understanding of the whole context and then back to a renewed understanding of the parts. The parts as a whole are part of some larger context and I sought the meanings of the participants interpretations in their context. Walsham (1995) has cited three uses of theory in interpretive research; an initial guide to research design and data collection, part of an iterative process of data collection and analysis and a final product of the research. For a researcher, preconceptions are important starting points that guide the research design. However, these can bias the research and as a researcher engages with the field and the phenomenon under investigation, these preconceptions can be modified or even abandoned. It is therefore important to make the underlying assumptions that guided research transparent to illuminate how one reaches their results. I now discuss how this process played out in my study and the figure below shows how events unfolded in my research.

![Figure 9: Illustration of research events](image)

I have followed mHealth implementations in Uganda and Malawi for three years and my focus and understanding of the cases changed. In the first year, I had a focus on understanding the role of collective work identity in the implementation and survival of HIS. Conversations with
colleagues and supervisors prompted me to be quite more open to observe what other changes happen in technology mediated work. At this stage, I had not yet been exposed to the empirical field. I merely went into the field with an ambition to understand how technology use influences users’ identities and a little openness to understand other changes although this was not with a clear focus. This was partly because of my interest in understanding the interplay between people and technology. It was also influenced by my previous studies in development. I think my background in development studies sensitized my understanding at the time that people’s development is in their freedoms to pursue what they value. Therefore, who we are, what we stand for, and what we aspire to achieve, might promptly influence the way we engage with technologies.

I relied on Giddens’ modernity theory, but I soon realized that it was constraining me and a conversation with the field data revealed that identity was part of the broader aspects of the work practice of CHWs. I also learned that the mHealth systems are part of the wider HIS and therefore implicated in the wider organization structures. Walsham (1996) has warned about using theory as an initial guide to inform early empirical work as this creates rigidity where the researcher sees only what the theory suggests. This stifles how much a researcher can see and he suggests that interpretive studies should reserve a degree of openness to field data and modify assumptions and theory. During my initial empirical work and as I inductively analyzed the data, I realized that I identified more themes regarding different aspects of work that changed and were not only limited to work identity. For example, there were aspects of work transformations, work structural changes, visibility, power and knowledge changes. After this iterative process of data collection and analysis, I abandoned the theory, refined my research questions and set out to understand the dynamics between technology and work practices. I then adopted Gidden’s structuration theory to guide my understanding of social change in an iterative process. I used it as a meta theory to give me insight into each of the themes that were identified in my research. My changing focus was not only driven by a growing familiarity to the field but also some practical issues. For example, at the end of 2016 and early 2017, I learned that the SMS project in Uganda was partly unfunctional in the field and I could not rely on the observations of mobile telephone use in VHTs’ work. I had to rely on interviews to try and understand this dwindled use of the mHealth systems. In Malawi, it was easier to
observe, interview and communicate informally with HSAs, health personnel and supervisors. During this time, I refined my research questions.

Conceptualizing users’ engagement with mHealth systems in their work practice and context therefore become the focus during data collection to obtain information about the work practice transformations, how actors related with the technology and how the technology influenced their relations with work in their context. My research also conceptualized the role of technology as mediums with affordances through which work practices occurred. Using the Structuration lens led me to look for actors’ role in altering their work as they employed technologies. I also sought to understand how the technology influenced work transformations. Theory in this case guided the development of my research questions and how my data was collected.

5.9. Data analysis
Data analysis was conducted in several iterative cycles both within each case and paper and in the thesis. This gave me different insights at varying times. This section explains how I iteratively made sense of my data.

First data analysis was conducted during data collection where at the end of the day when I was organizing my data, I developed impressions, themes and issues from the field. These I shared with colleagues in the field or through email and sometimes discussions on skype. We pondered upon several issues, some practical like how data collection is working or not and others theoretical especially how the data related with the theory. I sometimes had to go back and collect more data and verify our interpretations with the participants.

Data analysis continued after the fieldwork when I returned to Oslo. I sometimes conducted data analysis on my own and I returned to the data to refine my analysis. I also typically conducted data analysis with my co-authors. Some of these colleagues had been to the field as well. They had questions, new input and angles to approach the analysis. It is worth to mention the role of theory here. Walsham (1995) noted that one of the ways theory can be used is when it is part of an iterative process in data collection and analysis. In so doing, it allows for modifications in initial assumptions. He uses the metaphor of scaffolding where theory is used for support but can be let go when it has served its purpose. Sometimes theory was used in this way. For example, in the paper on identity (Namatovu and Sahay 2016) where
Giddens (1991) modernity theory was used. I later dropped this theory and the rest of the papers draw on data to inform the analysis. The analysis was inductive with the empirical material informing my theoretical concepts. For example, the paper on visibility from Malawi. On returning from the field, my co-author and I discussed several challenges and arrived at issues around CHWs’ recognition by different actors in the health system organization. We developed our analysis around the idea of recognition which was our interpretation of the situation. We then turned to the literature on visibility and place. Both data analysis on my own or together with a colleague had strengths and weaknesses. In the case where data analysis was done jointly, I was prompted to go back and ask more questions in the field that I initially did not think about. During the analysis, there were several interpretations of the data that were discussed and sometimes this took a lot of time. Data collection and analysis on my own was more challenging as we had to refine the analysis so that the co-authors could assess it. It was important that I shared and explained the data with an outsider as it provided additional reflections.

Overall, I relied on Braun and Clarke’s (2006) thematic analysis to aid my data analysis process. They give a step by step process from data to the final report (pg.16-24). It was a back and forth process. Field notes from interviews were transcribed and expounded at the end of the interviews and the research. The transcripts were read and reread in search for interesting issues, meanings and patterns. I returned several times to informants to verify my interpretations and issues of interest in the data. Data from the interview transcripts were manually given codes that put together similar data. I wrote texts to identify segments of data with similar patterns. The coded data was later assessed in relation to broader themes (identity, mobilities, visibility, power and knowledge) that helped me to understand sustainability. As I revised the themes, some were not entirely themes on their own, and others were merged. For example, I had identified feedback as a theme on its own from my data, but it was merged with the other themes. Data on feedback was again coded into the other themes. The themes were refined for analysis in relation to broader meanings and implications in relation to the literature on sustainability. The table below illustrates an example of this analysis.
Data was analyzed inductively, and the empirical insights helped me to develop my theoretical concepts. The empirical data on various aspects of work change, is from which themes were identified. This inductive approach is not like a grounded theory approach because I started out with some theoretical and conceptual insights on practice, structures, reflexivity, tensions and negotiations to sensitize my empirical work. As I navigated through my empirical work and observations, I revised my initial preconceptions in greater detail. For example, in paper

<table>
<thead>
<tr>
<th>Code</th>
<th>Sub-theme</th>
<th>Example from empirical data</th>
<th>Main theme: Sustainability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Changes in conduct of work</td>
<td>-Identity: Refining view of one self in relation to new ways of doing work.</td>
<td>- “The phone is fast and recommends solutions when checking for danger signs with a pregnant woman for instance. It even suggests what course of action to take hence making us more competent and ‘professional’ in our work”</td>
<td>-CHWs’ continued use of the mHealth system in new activities that promote a sense of work identity growth. -CHWs pay for airtime and phone charging on their own</td>
</tr>
<tr>
<td>Bypassed hierarchies in work</td>
<td>Mobilities: Destabilized work structures</td>
<td>-Data reporting, communication and logistic demand request bypassed existing organizational hierarchies</td>
<td>HSAs keen to maintain new practices and the mobile phones that support their work</td>
</tr>
<tr>
<td>Work made visible/invisible</td>
<td>Visibility: Various work aspects made visible to different actors in the health system organization</td>
<td>-Amount of work in the field recorder in the organization database. -Frequent supervision and control from supervisors</td>
<td>-Good visibility creates the sustained use of mHealth systems- -Bad visibility related to control creates tension and a compromise to continue the new activities that are made visible to supervisors.</td>
</tr>
<tr>
<td>New expressions of agency</td>
<td>Power: changes in power relations as work changes with mHealth system use.</td>
<td>-Better data storage and restoration to organize follow-up activities. -Forgoing paper tools and choosing to use a more efficient mHealth system in care work.</td>
<td>-Space for CHWs to choose the tasks, tools and reinvent work in a way that fits them.</td>
</tr>
<tr>
<td>New ways of doing work</td>
<td>Knowledge: Learning new ways of doing CHW with mHealth systems</td>
<td>-Care practices using a hybrid of the mHealth system and paper forms due to infrastructural issues.</td>
<td>-New work practices of care, communication etc. lack supporting structures to sustain them. This is beyond local sustainability efforts.</td>
</tr>
</tbody>
</table>
two (Decision Support case), I first examined my field notes to understand the work of HSAs and its organization. I then revised my preconceptions about structures to indicate that they are rather mobile and not stable. During my field work, I also read literature, developed themes around my concepts and I had discussions with colleagues, supervisors, feedback from reviewers and presentations at conferences to refine my concepts. In addition, more constructs were developed from the data. For example, the conceptualization of mHealth as a medium through which practices are performed. Overall, theory was a sensitizing devise and a vocabulary as I sought meaning in the research context and it supported the construction of my arguments.

5.8.1. In-case analysis and cross-case analysis during data analysis.
With a multiple case study, it is possible to analyze data within a case and between the case analyses and make a cross-case analysis (Benbasat, Goldstein, & Mead, 1987; Gustafsson, n.d.). The two cases were compared because I wanted to see if there were any important influences in their similarities and differences. This resulted into paper one that describes work transformations and accruing levels of work identity change in both cases. This cross-case analysis was employed to uncover patterns of technology mediated work transformations in the two contexts. However, due to the partial failure of the case in Uganda, I continued with the case in Malawi which was later analyzed separately resulting in papers (two, three, four and five).

While I worked with the cases through various theoretical accounts, it become apparent that various aspects of the work practice were transformed through technology mediation. For example, paper one details work activity changes for various practices in both cases. Paper two specifically points out work practices and how they changed while implicating the changes in the destabilization of work structures in Malawi. The Decision support system case also indicates destabilized work practice structures, the creation of visible work practices, the creation of new knowledge structures and power relations in work. My research was driven by a curiosity around mHealth implementations in different contexts which seemed to fail in many contexts of developing countries. I tried to understand the micro-level activities in which mHealth systems are entangled and how the technology’s interaction with these activities implicates broader organizational consequences like sustainability. I made a data display and
then organized my findings in the papers, focusing them on my key themes and categories that helped me to make sense of the data. The table below illustrates this analysis.

**Table 6: Cross-case analysis**

<table>
<thead>
<tr>
<th>Key findings in the papers</th>
<th>SMS case</th>
<th>Decision Support case</th>
</tr>
</thead>
</table>
| Paper 1: Changing work identities and activities | -Example of new reporting formats requiring both paper and mHealth systems.  
-Feedback flow reversed to flow from the top as well. | -Similarly, new reporting formats with paper forms and the mHealth system.  
-Care giving mediated through the mHealth system.  
-Frequent supervision. |
| Paper 2: Destabilized work structures            | -Example of work interactions especially related to consultations no longer dependent on home visits and physical co-presence. | -Example of work interactions bypassing immediate supervisors as HSAs autonomously organize their own work. |
| Paper 3: Visibility of work activities           | -Online reporting similarly reveals work effort in the field.             | -Online reporting reveals work effort in the field.                                    |
| Paper 4: Altered work power relations            | -VHTs got some agency to autonomously arrange work interactions especially related to consultations through mobile phone communication. | -Space for agency to navigate work activities in fitting ways. Example of replacing paper forms with mHealth systems. |
| Paper 5: Altered work knowledge structures       | -Emergence of work activities based on evidence from collected data for example, community education. | Creation of new ways of knowing in care giving and preventive work based on the dependence on Health system protocols for example. |

The findings in the papers illustrated the various aspects of work that get transformed when technologies start to mediate the community health work practice. I looked at the different categories in work transformation through theoretical concepts from Giddens (1984) work such as, structures, agency, reflexivity, contradictions and conflict. I also introduced the concepts of a medium (Lanzara, 2009) and affordances (Gibson, 1979) to help me understand the role of the technology in these transformations. I also viewed my findings in relation to existing work on ICT4D sustainability.

**5.9. Reflections and limitations of the research methodology**

**5.9.1. Ethical considerations**

Although my research was approved by local research authorities and the Norwegian Centre for Research Data (NSD), there were various ethical considerations during the research.
process that I still had to consider. Interviewing participants required their informed consent. I made sure that I developed a consent form stating my research aim as seeking to understand the work practice of CHWs and how they experience mHealth systems. This was done so that the participants felt safe and comfortable to share their responses with me. I also stated to keep their identity, positions and details confidential and that they would terminate the interview without any explanations if they wanted to. In case of agreement to participate in the study interviews, they were allowed to ask me questions. I also asked for permission to take pictures and assured respondents that I would alter the photos to hide their identity.

During observations of CHWs attending to patients in their homes or in the community village clinics, I had to consider that these interactions between patients and CHWs are confidential and my presence there would be interpreted as intrusive. For home and village clinic visits in both cases, I planned with the CHWs a few days before they happened and the CHW identified which places we would go to. S/he introduced me to the household, orally told them the purpose of my research and asked the patients if they approved of me being present. If they consented, then I was invited to join the home visit where I further orally assured the patients of confidentiality and my aim for being present. In most cases, the patients were very welcoming in both countries and seemed to want to share with me their health challenges beyond my research. For the observations at the village clinics in Malawi, the HSAs still introduced me to patients while I was waiting outside the structure. I was always invited in with my translator to a rather welcoming and pleasantly curious group of people. I understood why Malawi is called the “warm heart of Africa”. During both interviews and observations, I attempted to blend in by observing a descent dress code. My translator introduced me to the ‘chitenge’ (a long shawl-like cloth to wrap around my lower body) for modest dressing. This is an important issue in the villages because exposing one’s legs is considered indecent. I made sure that I did not make the respondents uncomfortable.

5.9.2. Limitations of the study: my focus on CHWs
In this thesis, the focus of the data was very much towards understanding work practice and transformations that happen when mHealth systems are introduced in the work of CHWS. This choice was mainly based on my research aim. In the work transformations I have identified important issues related to local sustainability. Even though I acknowledge that this local sustainability must be matched by macro-level sustainability at the MoH or policy making
level, the material in this thesis does not extensively cover data coming from the macro-level of the health system organization. I acknowledge that understanding this side of the equation is important and I offered some insight into what is required to sustain mHealth systems at the broader structural level. Existing literature has however relatively covered concerns regarding organizational issues around ICT4D sustainability for instance. While I did not review the MoH directly, insights from the micro-level helped me inform what was required at the macro-level. For example, what CHWs said about lacking in terms of technical support, indicated a need for training and technical assistance from technology providers and a more organized system delivery from the MoH. I see that including the MoH’s voice would help to clarify how a link to sustainability can be integrated in the equation. At the same time, I have realized that sustainability cannot only be driven by the macro level, but the micro-level—where everyday activities occur, can also inform this sustainability.

5.10. Generalizability and validity of the research
Generalizability of research accounts in specific settings refers to their ability to become valuable in other settings (Walsham, 1995). The issue of generalizability of interpretive case studies has raised concerns especially whether a single case or several cases can assure generalizability (Walsham, 1995; 2006). Concerns around whether the number of cases under study assures generalizability, I argue can be biased towards more positivist research that is concerned with statistical generalizability (Lee and Baskerville, 2003). Interpretivist research on the other hand can be generalizable based on its analytical accounts. Walsham (1995; 2006) has for example, cited four ways through which interpretive case studies can be made generalizable; through developing concepts, generating theories, making specific implications and giving rich insights. I argue that I generalize my research not based on the number of cases that I studied but rather based on the insightful findings and constructions that I present. My findings mainly contribute to making implications and giving detailed insights especially on revisiting the micro and macro arrangements that sustain mHealth systems. My findings can be drawn on in settings where new mHealth systems are developed. However, I cannot argue that the same findings can be transferable to a developed context for example with more democratic practices, wealthier countries, smaller populations and with better access to health services.
I also reflected on the validity of this study. Interpretive research is subjective with a researcher presenting her own interpretation of events. I acknowledge that it is possible for this study to be different to different researchers. The relationships developed with participants can influence what and how much they reveal (Kaphan and Maxwell, 2005). For example, during the training of HSAs in Malawi, some initially perceived me to be some sort of supervisor coming from the MoH. I did not want that to limit their interactions, what they shared with me or how they acted in my presence. I also did not want my background and personal biases to influence the research and my interpretation of events. So, I ensured validity through paying close attention to the context, observing what participants did and how they interacted with the mHealth systems, I sought participants meanings of actions and triangulated my data collection methods so that I would not miss any important data.
CHAPTER 6: Findings

The thesis draws on five papers that have been published or accepted for publication in journals, accepted and presented at a conference or submitted to a journal. The papers were co-authored with different people, are built on two cases and address the research questions and aim in chapter one. Papers one, two, three and four address work transformations and paper five takes a structuration theory perspective to link work transformations to macro structures that redress their sustainability and the sustainability of mHealth systems that support them. In this chapter, each paper is presented briefly to reflect on how each individual paper contributes to the overarching research aim and develop an understanding of sustainability of mHealth systems in developing countries. The papers are presented in the order of which they were written reflecting different stages of progress in my PhD process.

6.1. Papers

Paper I

Namatovu, E. and Sahay, S. (2016) ICTs and Health in Developing Countries: Understanding the role of Identity. Information Systems Journal (under revision)

Purpose- Mobile health system initiatives have become part of many developing countries Health systems reform. As these reforms unfold, CHWs at the frontline of giving primary healthcare to populations, take on the key brunt of these ICT efforts. The ICT initiatives tend not to focus enough on understanding their work practices and relation with technology. The ICT reforms are often supply driven with lesser focus on the human aspect of users. This paper focuses on understanding the work world of Community health workers, the changes in their work implicated in mHealth systems use and strengthening a human-centered focus to ICT design and use. The paper reports on two case studies of mobile health systems implemented in Uganda and Malawi.

Research approach- This is a comparative case analysis of two mHealth projects conducted in 2015 (March and April) in Uganda and Malawi in 2015 (September and October). The SMS case in Uganda was developed to support weekly SMS reporting on maternal and infant mortality indicators. The Decision Support case was developed to support patient diagnosis in the care practices of treating and educating patients. Although both cases have similar work activities, there are differences in work compensation and structure, artefacts and content of their application. CHWs, their supervisors and members of the community in both Uganda and
Malawi were interviewed about their experiences while using the mHealth system and about their work. In focus group discussions in both countries, participants shared their experiences with using their mHealth systems, their work and networks. We also studied data derived from observations of work interactions with community members during drug distribution, caring for children and report making in both cases. Some informal discussions were made during observations. We paid close attention to understanding CHWs’ work practice transformations and experiences with health system use. Through the lens of modernity, we highlighted work transformations with technology use and analyzed their implications on work identity.

**Findings** - The paper addresses RQ1: *What is the nature of mHealth systems mediated work transformations of the community health work practice?* The study found a range of work transformations associated with mHealth system use in both countries. For example, new formats of data reporting involving a combination of paper and mHealth forms evolved. This was especially an initiative by CHWs that chose to use the mHealth systems and duplicate paper forms required by the MoH in Malawi. Work interactions involving work mobilization, coordination, collaborations among others were made virtual and no longer dependent on the word of mouth and physical places of interaction. There was an emergence of increased surveillance in work due to work becoming visible with more frequent data reporting through mHealth systems in both cases. Care practices in Malawi become completely reliant on the mHealth system replacing the paper forms. New practices emerged around the mHealth system for example, the provision of pregnancy kits to expectant mothers and community education services based on collected data in Uganda. Consultation work with the community and colleagues was extended beyond worktime in both cases. The table below illustrates some of the transformation in specific practices.

**Table 7: Examples of practices and how they were reinvented**

<table>
<thead>
<tr>
<th>Work practice</th>
<th>Reinventions in the practice</th>
<th>Reinventions in the system</th>
<th>New practices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reporting</td>
<td>Hybrid between paper and mHealth systems dependent on power, costs and network connectivity</td>
<td>Hybrid between paper and mHealth systems dependent on power, costs and network connectivity</td>
<td>VHTs expressed a need to engage in family planning reporting but could not be</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SMS case</td>
<td>Decision Support case</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decision support case</td>
<td>SMS case</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Decision Support case</td>
<td>Decision Support case</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SMS case</td>
<td></td>
</tr>
</tbody>
</table>

85
<table>
<thead>
<tr>
<th>Consultation done at health facilities, homes and village clinics</th>
<th>More phone interactions to consult with medical personnel, colleagues or receive consultations from the community. Extensively limited by cost, poor network and power connectivity</th>
<th>More frequent and richer interactions with medical personnel, community members and colleagues but challenged by costs and lack of electricity</th>
<th>Feedback from supervisors reignedited</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consultation</td>
<td>More phone interactions to consult with medical personnel, colleagues or receive consultations from the community. Extensively limited by cost, poor network and power connectivity</td>
<td>More frequent and richer interactions with medical personnel, community members and colleagues but challenged by costs and lack of electricity</td>
<td>Feedback from supervisors reignedited</td>
</tr>
<tr>
<td>Communication</td>
<td>Increased feedback from supervisors</td>
<td>Prompted feedback from supervisors</td>
<td>WhatsApp group created among colleagues to consult each other</td>
</tr>
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<td>WhatsApp group created among colleagues to consult each other</td>
</tr>
<tr>
<td>Care</td>
<td>Evidence based solutions.</td>
<td>Replaced paper guidelines with mHealth system in Malawi but due to poor electricity connection HSAs went back to using paper forms often</td>
<td>Decision support system revised to accommodate malaria diagnosis, but this was at the beginning of the pilot.</td>
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</tr>
<tr>
<td>Mobilization, collaboration and more autonomy</td>
<td>More individual autonomy and more autonomy to manage workflows that involve</td>
<td>More autonomy to manage workflows that involve</td>
<td>WhatsApp group for colleagues to mobilize</td>
</tr>
<tr>
<td>Mobilization, collaboration and more autonomy</td>
<td>More individual autonomy and more autonomy to manage workflows that involve</td>
<td>More autonomy to manage workflows that involve</td>
<td>WhatsApp group for colleagues to mobilize</td>
</tr>
</tbody>
</table>
coordination work potential to reach out to colleagues. collaborations without going through bureaucratic processes. collaborative work.

Supervision Increased surveillance from supervisors Increased surveillance from supervisors Less field trips for supervisors who can see data in the database

The transformations in existing work practices and emergence of new ones with mHealth system use had various implications which address RQ 2: How do we sustain work transformations and the mHealth systems that support them? For example, there were similar implications on CHWs' work identity in the two cases pointing to a growing sense of work professionalism in their non-professional work context. This prompted CHWs to locally continue using the mHealth systems and those work practices that supported their sense of self. As CHWs developed trust in the abstract system of the mobile phone, using it to consult, communicate in their work networks, make reports and attend to patients, these work transformations resulted into some reflexive processes that impacted work identities. This emerged from CHWs becoming efficient and competent in their work and their ability to address real health problems. As work shifts and expressions of professionalism in work grew, so did commitment and persistence towards mHealth system use.

Notably, reflexive tendencies to revise work and the self were more prominent in Malawi where the smart phone artefacts allowed more functionality and HSAs had more support in terms of monthly credit allowances to use their mHealth systems. In Uganda, costs and infrastructural challenges inhibited extensive use of the mHealth system. Work transformations were not complete and were less dynamic with simpler basic phones. However, as work transformations emerged, there were also echoes of tension especially around increased surveillance from supervisors through the mHealth systems. New formats in care giving and data reporting also increased workload which CHWs were not enthusiastic about.

Research implications- Giddens' themes in his modernity theory helped the study to bring forward an understanding of work transformations due to technology use and its intricate relationship with the work identity of CHWs. Specifically, it highlights how this relationship
instigates reflexivity in terms of redefining meanings about work and self. However, different from earlier studies (Walsham, 1998) and Alvarez (2008), the study shows positive reflections in identity indicating a sense of growth hence enabling technology use. Like Lamb and Davidson (2005), it suggests positive implications of technology use on work identity accruing from emerging efficiency and competence in work. Western studies on the dynamics of technology and work-related identity of users have often dominated IS studies. This focus limits observation of contextual constraints like infrastructural shortages which in this case altered reflexive tendencies in work and the self in both cases.

**Practical implications**- The paper gives some insights to practitioners in guiding technological change in community health work. We agree with literature that argues that technology use that supports and develops existing work practices reinforces work identities and users attempt to maintain it. The findings are crucial for addressing issues related to the management of CHWs considering technology introduction, design and use relevant to this work practice.

**Contribution to overarching research aim**- The paper conceptualizes work practices as they undergo transformations through technology use. The paper highlights the importance of detailing work transformations and the reflexivity that workers and end-users of technology undertake to redefine their positions, work identities and work in response. It highlights that work transformations and the mHealth system can be adopted and sustained in the CHW practice if they support and reinforce work and work identities.

**Paper II**


**Purpose**- Technological innovations in healthcare instigate various ways for users to reconstruct and restrict their work. Although mHealth systems are introduced with emphasis on their potential, we do not fully understand their interaction with the work practices of CHWs. This paper reports from a case study on the implementation of mHealth systems in community health work. We investigate to understand how interactions with technology can undermine traditional forms of work stability in this health work context.
Research approach- The paper borrowed ideas from the rhizomatic approach to uncover the various networks that build up the community health work practice. This was to understand how this work is structured and built. Data collection methods involved semi-structured interviews to understand how the community health work practice is organized, understand how things come together, the logic of how CHWs work and identify the various micro-elements in the nodes and consequences of their interactions. Data was also derived from field observations of CHWs in their catchment areas and at the health facility.

Findings- This paper mainly addresses RQ1: *What is the nature of mHealth systems mediated work transformations of the community health work practice?* The analysis shows how normative work interactions are destabilized with technology mediation in community health work. The various work practices; care, data reporting, communication, coordination, collaboration and supervision all had undertones of being reinvented. For example, separately existing programs were joined which increased HSAs’ responsibilities. Care practices were mediated by the mHealth system that replaced paper forms. The data practice evolved into new reporting formats of both paper and mHealth system. Communication practices were made virtual. HSAs took on more upgraded work of treating patients in the field due to enabled consultations with medical staff, and supervision required less travel to the field due to work becoming visible in the organization’s database.

The findings show that the normative work order was changed through technology enabled affordances. These shifts destabilized existing work structures. For example, logistic demands were made through SMS directly to the DHO eluding previous hierarchical structures by bypassing the HSA coordinator and the health facility In-charge. Virtual communication to mobilize, consult and collaborate in work also bypassed the HSA coordinator previously in charge of organizing these activities. However, we also found hints of tension as transformations occurred. For example, double reporting created a bigger workload for these lowly compensated workers. Increased surveillance forced HSAs to work more in order to make their productivity visible to their supervisors.

Research implications- We make three contributions to the literature on IT and change. First, we expose how technology use in a work practice undermines the social order of work through facilitating transformations that destabilize existing structures. We delicately account for both social and technology’s agency in work transformation eluding a sole focus on human actions.
as in Giddens view of structure and agency that underplays the materiality in work transformations. The paper reflects on the role of technology affordances enabling new work practices to emerge. Second, we provide insights into utilizing a historical perspective rather than the here and now of a practice to address pre-existing social structures and how they influence technology use. Third, we give thick descriptions of how existing structures are made unstable through transformations in work as work is mediated by the mHealth system.

Practical implications- The paper offers insights to practitioners on the implementation and management of mHealth systems. Community health work mediated through a mobile health system undergoes changes in social order and work relations which require new skills to manage and maintain.

Contribution to overarching research aim: The paper contributes to the overarching research aim by conceptualizing new orders that emerge in a work practice when normative work orders are destabilized with new technology use. It further highlights that work structures are pliable and new structures can emerge from existing structures as technology users reinvent their work. It is argued that sustainability develops from the local improvisations around the technology system that alter existing structures. However, tensions compromise the maintenance of new practices and the mHealth systems.

Paper III


Purpose- For work that is place dependent, technology opens new spaces for visibility. The paper aimed to understand the interaction between technology use and the visibility of community health work and the implications of this. As mHealth systems rapidly become a part of the work of CHWs, it is important that unknown implications are catered for. The paper reports a case study from Malawi, where we investigate how mHealth system implementation and use influences the dynamics of work visibility and accruing implications.

Research approach- The interpretive case study was conducted in Malawi. HSAs and people in close connection with their work such as, health facility staff and community members were
interviewed. They were interviewed about the everyday work of HSAs, where it is conducted, their work interactions and experiences with using the mobile health systems. We also examined data derived from observations and informal discussions.

**Findings**- This paper mainly addresses *RQ2: How do we sustain work transformations and the mHealth systems that support them?* It identified different work aspects that were made visible to different players in the CHW practice and the analysis draws on these to relate them to the sustainability of the mHealth system and the work practices. The analysis shows how when the mHealth system is implemented and used, local improvisations emerge to facilitate work collaboration, coordination, and organization. HSAs’ social interactions around these activities become dependent on mobile phone communication for example through WhatsApp. These activities were also no longer dependent on physical places but become visible to various actors in the health system organization. The visibility of these new work reinventions for example facilitated knowledge sharing and work coherence among HSAs distributed across different areas. HSAs echoed locally maintaining supportive work practices made visible amongst colleagues through the mHealth system. Visibility that created HSAs’ recognition among community members, health personnel and supervisors encouraged the continued use of the mHealth system and the work it supported. HSAs also manipulated this visibility to show their work productivity to supervisors who in turn stiffened surveillance which created tension. However, with standardized care procedures in the mHealth system, tacit knowledge acquired through experience became invisible.

**Research implications**- The analysis of work activities shows that technology disembedds locally specific social relations to different space and time contexts which implicates their visibility. We show that actors strive, both for change to counter tensions from the emergence of visible work and they also retain some work practices for stability and situatedness. For example, although care giving work is mediated by the mHealth system, these practices are still held in physical places of the home or the village clinic.

**Practical implications**- The paper illustrates the importance of understanding the implications on work visibility when work is moved from physical to technological places. The paper points to both opportunities and challenges or tensions of making work visible aiming for an understanding of technology users and the work context. This calls for considerations of appropriate technology representations of work.
Contribution to overarching research aim- The paper takes a step towards identifying various work activities and aspects that are redefined as CHWs use the mHealth system. Some of the reinvented work activities become visible to different levels in the health system including the community, fellow HSAs, health personnel and supervisors higher up in the hierarchy. Supervisory work transformations are especially maintained by supervisors with more power to control HSAs work that is made visible to the health system. Sustainability of the mHealth is also rooted in those work transformations that are made visible and reinforce and build CHWs work and their sense of work identity.

Paper IV

Namatovu, E. (2017) ICTs, Community Health Workers and the Transformation of Community based Healthcare Power Relations. (Submitted to the Journal of Information Technology for Development)

Purpose- Technology initiatives in health aim to facilitate and reform healthcare provision. However, the role of ICTs in transforming development and particularly healthcare provision is not very clear. The paper aims to understand the power dynamics at play in community health work as processes that facilitate healthcare provision with ICTs. The paper reports from a mobile health system designed to aid decision-making for health surveillance assistants in rural Malawi as they provide healthcare to villagers. It investigates the interaction between the mobile health system and the power relations in HSA’s work to uncover how agency unfolds to provide healthcare.

Research approach- The case study of the mHealth system was conducted in 2015 and 2016. HSAs and people closely related to their work; supervisors, community members and professional health personnel were interviewed to understand HSAs’ work, its structural organization and interpretations around ICT use among HSAs. Planning meetings and healthcare activities in the community were observed in addition to informal discussions to get a better understanding of their work practice, existing power relations and how they influence the agency of HSAs in their provision of healthcare.

Findings- This paper mainly addresses RQ 2: How do we sustain work transformations and the mHealth systems that support them? It points to the agency of CHWs through various power relations to choose what is important to them and therefore what to maintain in their work
as they use the mHealth system. The study finds that HSAs’ agency to provide healthcare using the mHealth system is influenced by three power relations existing in the health system, among colleagues and the community. Within the health system, HSAs can choose for their care activities, to rely on relevant tools like the mHealth system to facilitate patient analysis and diagnosis in the field while forgoing those paper forms invisible to the MoH. Only those paper forms visible to the MoH are maintained.

They can also maintain their work knowledge in the technology artefact especially considering that they receive limited training to renew work knowledge. HSAs learn to retrieve information in the mHealth system for other activities like following up patients in the field. The logistics component enables HSAs to bypass lower organizational hierarchies to demand for logistics directly from the DHO, instigate feedback that was previously rare and engage directly with supervisors further up in the organizational hierarchy. Surveillance also increases with the mHealth system through data reporting prompting HSAs to increase their work efforts. In the community, motivating community participation is highly driven by the community’s trust in the sophisticated new smart phones although it previously depended on community members like village chiefs. However, some activities like the first antenatal care service through the mHealth system are limited by existing cultural dynamics. Among colleagues, HSAs learn to collaborate while forgoing main supervisors.

Research implications- The analysis in this paper shows that HSAs’ agency while using the mHealth system is enabled or disrupted by power relations in the work context to undertake or transform work activities while providing healthcare services. Through their agency, they transform work practices around the mHealth system to fit the technology in their work. However, in doing so, HSAs can accumulate some tensions in the field like cultural constraints. HSAs agency to maintain the mHealth system and accruing practices can also be met with tension from the structural organization of their work that requires them to sustain the use of paper forms. The paper contributes to the ICT4D field by more broadly detailing power relations as processes leading up to better healthcare provision through enabling HSAs agency.

Practical implications- The paper points to understanding the intricate contextual details where ICTs are implemented. Cultural power dynamics and norms as transforming processes of development render both ICT4D and people powerless. They should be considered during
ICT4D design, implementation and use. Second, the paper offers insights in managing intended and non-intended outcomes of ICT4D initiatives such as ensuing practical workloads when work is coupled with electronic representations from the automatic recording of work.

**Contribution to overarching research aim**- This paper contributes to the overall research aim by addressing intricate ways in which end users through their agency renegotiate spaces for providing healthcare services in their work. The paper highlights the role of human agency in the use of a mobile health system to facilitate empowering new ways of primary healthcare provision. The sustainability of the mHealth system and the emergent work transformations are dependent upon their adoption by HSAs when they are considered able to support and facilitate work. However, this sustainability is compromised if the higher structural systems in the health organization do not support it. The next paper accounts for macro level considerations to conceptualize sustainability by linking micro level improvisations to macro-level structural dynamics of sustainability.

**Paper V**


**Purpose**- There is considerable bias in information systems research towards the influence of structure on practice while explaining work practice transformations related with IT. Although acknowledged, it is not empirically established how practices shape structures especially since changes in structures are hard to discern and unfold over a long time. This paper reports from a case of an implemented mobile health system in the work of community health workers. We investigate how knowledge practice changes can influence structures to sustain the IT innovation.

**Research approach**- The case study was conducted in Malawi in 2015 and 2016. Health Surveillance Assistants, their supervisors and health personnel were interviewed about how HSAs knowledge practices were organized and performed. We also examined HSA group accounts of knowledge structures and their shared practices. We used the lens of structures and agency, to understand how HSAs reflexively change their knowledge work practices mediated through technology.
**Findings**- This paper responds to both research questions. The analysis shows how through using the mobile health system, HSAs restructure their knowledge practices in ways they deem fit. It highlights how they create new practices situated in their work context to accommodate the new IT. For example, they combine both paper and system guidelines in care giving work to fit their poor infrastructural context. They use stored data in the mHealth system to support other activities like following up patients. They reinvent their reporting formants to include mHealth system capture in the field and follow it up with duplications on paper forms that are submitted to the MoH. They create a WhatsApp group to communicate and organize mobilization and collaboration activities that bypass immediate supervisors. They reinvent the mHealth system to capture their knowledge needs such as by adding malaria assessment to the system.

The new practices happening at the micro level in the work practices of the HSAs were found to lack supporting structures to sustain them and the mHealth system supporting them. The study identified; infrastructural, training, reporting and knowledge learning structures as crucial to supporting and sustaining emerging practices and the mHealth system in HSAs’ work. Reporting structures should ensure feedback flow between the micro and macro levels, technical support to ensure online reporting and policies for data interoperability between mHealth systems and the national HIS. Infrastructural structures such as electricity and improved network connections are supposed to support mHealth system use and accruing practices of online data reporting, mHealth system mediated care giving and mobile phone-based consultations or communication. Training structures to ensure the demand for new knowledge and skills related to mHealth system use are met. Knowledge learning structures should ensure that knowledge in the new practices is made visible to the rest of the health system organization for evaluation.

The identified structures also need practices to continuously renew them to remain relevant. For example, feedback practices especially from both CHWs and their supervisors and data checks, data use are essential in strengthening reporting structures. Feedback practices can also strengthen knowledge learning and sharing structures. Consistent and periodic training from supervisors strengthens training structures. Allocated policies and budgetary reviews can support infrastructural structures.
Research implications- We make two contributions to IS research. First, we agree with researchers who argue that practices are also shaped by the material mediating influences of the mediums through which they are performed. We show that knowledge practices previously only dependent on the medium of paper forms are transformed when ITs are introduced. Secondly, we have argued for an agency-structure analysis to emphasize the reflexivity of social agents and its implications on broader social structures in organizations. In this way we illustrated how knowledge practices can influence structures to sustain and support emerging practices and ITs.

Practical implications- The paper points to the importance of understanding various local improvisations in sustaining their emergent practices with technology use. By understanding that technology initiatives are by design social interventions, then it is important that they have new rules and resources to function.

Contribution to overarching research aim- The paper contributes to the overall research aim by developing the key theoretical contribution to this thesis through arguing for the exploration of an agency-structure relationship in work practices facilitated by technology mediation. In this perspective, the paper considers that sustainability of a novel IT system is entangled in the work transformations emerging around its use. It highlights the reflexivity of human agents in their knowledgeable work as they engage with the mobile health system to create new practices and how these practices can mold structures to sustain them and the IT initiatives.

6.2. Synthesizing the findings.
The five papers describe both work practice transformations and the agency of individual CHWs to accommodate or displace these changes as they engage with a new technology to mediate their work. The studied cases illustrated that community health work is guided by structures that mold the practice. They constitute rules and resources that for example guide care giving practices, reporting practices, regulate prevention practices, guide collaborative work among others. The mHealth systems are developed to guide some practices of community health work; reporting in Uganda and care giving in Malawi.

The papers show that community health workers are knowledgeable agents in their work. As they use the mHealth systems, the five papers elaborate that they create and innovate new
ways of working that spill across their practice. Papers, one, two, four, and five describe the normative order of work detailing how various practices of care giving, data reporting, among others were previously organized. They also detail how these work activities are transformed when technology mediates CHWs’ work practice. For example, CHWs reinvent work activities, to create new formats of reporting involving both paper and the mHealth systems. They create virtual spaces for their work interactions to facilitate collaboration and mobilization activities that bypass immediate supervisors. They utilize data stored in the mHealth system to facilitate other activities like follow-up exercises. Work consultations are stretched beyond work time although this increases workload. They replace paper tools with the mHealth system and occasionally rely on both to compensate for poor infrastructures.

New activities also emerge through the mHealth systems. For example, revamped feedback between CHWs and their superiors. Supervisors also increase their surveillance in CHWs’ work due to visible activities as paper three noted. So, through their agency as they use the mHealth system, they renegotiate their power to reinvent practices that support their work and build on the mHealth system to meet their needs. These transformations in work are also facilitated through the material aspects of the technology as a medium with affordances that enable CHWs to for example change their interaction and communication patterns or alter their collaboration and mobilization activities by forgoing supervisors. The timer on the phone is utilized to assess breathing in infants and children while giving care. This is illustrated in papers one, two and five. The work transformations destabilize existing work structures.

As the technology mediates CHWs’ work, new practices emerge at the micro work practice level when CHWs attempt to fit the new mHealth systems into work contexts. The papers illustrated the various ways through which the agency of CHWs takes shape in utilizing mHealth systems. Agents are also faced with different opportunities and challenges based especially on limitations in their overall work context. These are mostly related to costs, poor infrastructure and tension rising from increased surveillance. Despite limitations, paper one for instance shows a commitment by CHWs to continue using the mHealth systems through borrowing mobile phones to continue sending texts, paying for battery charging and airtime credit. This is so that CHWs can maintain or sustain the mHealth systems along with the work transformations that support their work.
The research found that sustainability is ambiguous, and it refers to different things to different people. The literature has shown that there are questions regarding what should be sustained; the IT artefact, the work practices supported by the IT artefact, or the whole project in which the ICT4D project is embedded. As the papers indicate, CHWs reinvent their practices around mHealth systems and adopt both the practices and the system in their practice if these support their work. Therefore, to the CHW, the mHealth system, the work practices and work transformations it supports to facilitate his/her work, should be sustained. In the opening vignette, we learn a CHW’s effort to maintain the mHealth system through directly paying for airtime credit on her own. In paper one, CHWs overcome their infrastructural barriers by walking to health centers to charge their mobile handset batteries at health centers for instance. However, CHW’s efforts to maintain or sustain the mHealth and emergent work practice transformations, cannot be facilitated only by micro level endeavors. There is a need to link these micro level activities to wider macro-organizational structures that can sustain them, if the practices to influence these structures are in place. Paper five has made this link by identifying efforts at the micro-level to redefine work practices around the mHealth system and appropriate macro-level structures in the health system organization that can support and sustain them. These structures should support and maintain the adoption of the system in a work practice and its overall integration into the broader organizational structure. For example, structures of infrastructure, training, feedback, reporting, and communication were identified in paper five as essential in supporting the mHealth systems, the practices they support and the emergent practices around these technology systems. This link between the micro and macro elements is relied on to understand how we can redress the challenge of sustainability.

The findings help to address the research aim of studying how work practices are implicated when mediated by new technologies and how users of those technologies respond and reinvent their work practice to fit emerging work transformations and the technology into their work. From these transformations we get implications for sustaining both work practices and the mHealth systems. The table below outlines how the findings in the papers relate to the research questions.
<table>
<thead>
<tr>
<th>Papers</th>
<th>RQ1: What is the nature of mHealth systems mediated work transformations of the community health work practice?</th>
<th>RQ2: How do we sustain work transformations and the mHealth systems that support them?</th>
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<tr>
<td>Paper 1: “ICTs and Health in Developing Countries: Understanding the role of Identity.”</td>
<td>- The paper describes how work relations and interactions are altered when CHWs transfer them to virtual spaces where they bypass immediate supervisors to organize, collaborate and mobilize their work activities. - Data reporting gets a new online format when its mediated through mHealth systems, but traditional formats exist alongside the new ones due to infrastructural and institutional constraints. - The paper illustrates the emergence of new work practices such as; community sensitization activities in response to reported data through mHealth system. Surveillance, follow up activities and feedback are also revived with mHealth data. - The paper also shows that these transformations are limited by cost, lack of electricity prompting CHWS to return to old practices.</td>
<td>- The paper shows how CHWs revise their work and their sense of self as they try to fit the mHealth system into their context. - The study illustrates how CHWs are inclined to the persistent use of the mHealth systems and emerging work transformations if they support work efficiency and competence and reinforce their work identities. - Local improvisations such as buying own airtime, using solar chargers are implicated in locally maintaining mHealth systems and the work practices they support.</td>
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<tr>
<td>Paper 2: “Mobilities of the Community Health Work Practice: Mobile Health System Mediated Work”</td>
<td>- The paper describes disruptions of normative structural orders of work through work transformations when CHWs use the mHealth system. - It illustrates work transformations for example when new reporting formats involving a hybrid of paper and mHealth system-based reporting emerge. Two programs are also combined to give HSAs more responsibilities in clinical work. - It shows how HSAs utilize functionalities on their mobile phones to support their work. For example, the phone’s torch supports care and treatment activities in the night and the phone’s timer supports assessing children’s breathing. The WhatsApp functionality is used to ease communication which bypasses supervisors. - The paper therefore describes how social agency eludes structural determinism by utilizing technology affordances to collectively push work interests including emergent work practices.</td>
<td>- The paper shows that the mobile health system’s sustainability is embedded in the local improvisations and reinventions in the work practices that destabilize existing work structures.</td>
</tr>
<tr>
<td>Paper 3: “Bringing Visibility to Community Health work with MHealth Systems: A Case of Malawi”</td>
<td>- The paper highlights how previously field specific work become visible to the rest of the health system organization. For example, work interactions to coordinate, organize and collaborate in work are revised and conducted over the phone. They no longer rely on physical interactions in the health facilities and the village clinic. - It shows the emergence of practices in response to the new visibility. E.g. feedback</td>
<td>- HSAs rearrange work around the mHealth system to align it with the health system organization. e.g. data reporting. - Practices such as surveillance that strengthen supervisory and control structures are maintained by supervisors to monitor HSA’s work efforts - Work activities like care giving make HSA’s knowledge visible to communities prompting redefinitions of self with growing professionalism around the use of the sophisticated mHealth system and mobile phone in local communities. This is linked to the commitment and persistent use of the mHealth in HSAs’ work.</td>
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<tr>
<td>Paper 4: “ICTs, Community Health Workers and the Transformation of Community based Healthcare Power Relations”</td>
<td>- The paper illustrates how the mHealth system enables spaces for HSAs to renegotiate and redefine healthcare activities through their agency. For example, choosing to provide care activities on the mHealth system while disregarding paper forms. Taking over social interactions that facilitate collaboration and mobilizing work activities from their coordinators. - There are existing cultural norms in communities that constrain CHW’s agency to reinvent some healthcare activities through the mHealth system</td>
<td>- The paper shows HSAs having agency to choose to retain new work practices that support their work in the field. E.g. follow up exercises, logistic demand, feedback that affirms work positions, faster and efficient collaboration, and mobilization activities. - Work practice transformations that are made visible to superiors through the mHealth system are maintained to illustrate work effort e.g. care giving, follow up exercises - The paper illustrates HSAs agency to retain and adopt using the mHealth system in their work practices in the field and disregard systems they consider inhibiting their work. For example, HSAs replaced paper forms with the mHealth system in the field.</td>
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</table>
| Paper 5: “Creating Knowledge Structures to Sustain ICT Interventions” | - HSAs keep the mHealth system in their work because it is associated with community support and growth in professionalism.  
- The paper describes how different knowledge practices are destabilized to create new knowledge work practices when HSAs reflexively redefine their work to fit their context.  
- It illustrates how HSAs creatively adapt and redesign the mHealth system to capture local needs like malaria diagnosis.  
- HSAs combine or alternate the use of existing paper forms and the mHealth system in their work due to poor electricity coverage.  
- There are limited existing structures and practices to support and sustain work transformations and new mHealth systems into the wider health system organization.  
- The paper identifies structures through which emerging technology mediated practices can be absorbed into the wider health system organization. Structures of; reporting, training, communication, knowledge sharing and learning, supervising, feedback.  
- Various practices must be in place to influence structures that sustain work transformations. E.g. practices of; feedback, data checks, data use, training. |

In the next chapter, seven, I synthesize and discuss my findings in relation to the literature and theoretical perspective presented in chapters two and three.
Chapter 7: Analysis and Discussion
This chapter contains my analysis and discussion. I elaborate my findings in the five papers presented in the thesis while drawing on my theoretical framing and the existing literature in ICT4D. Section 7.1 presents as an alternative the conceptualization of sustainability as entangled in the local work practices the ICTs support. Section 7.2. stretches the arguments in section 7.1 to identify structures at the broader organizational level that should be present to support and sustain locally relevant work practices and the mHealth systems. It goes ahead to discuss the theoretical and practical oriented contributions and recommendations from this research in sections 7.3 and 7.4 respectively. My contributions in this chapter are directed towards understanding how health providers, health workers and authorities can facilitate the sustainability of mHealth initiatives in developing country contexts.

7.1. The sustainability of mHealth systems is entangled in local work practices and accruing work transformations they support
ICT4D initiatives embed ICTs in many contexts to mediate activities in the pursuit of various development goals. The thesis has shown the use of mHealth systems to mediate the delivery of maternal and child health activities among CHWs. In both cases, mobile based solutions are built with demands, commands, guidelines to mediate different practices in maternal and child healthcare. In Malawi, HSAs’ actions in care giving, educating expectant mothers and reporting data were mediated by the protocols built in the mHealth system. Paper one showed that in Uganda, the SMS functionality mediated data reporting. Feedback messages and reminder notifications ensured that VHTs reported data within deadlines. Like Walsham (1993, 2002), I have related these built-in demands, assumptions, options to the modalities that agents draw on in their practices to either reinforce or change existing structures. They embody knowledge to purse action, facilities to allocate resources and norms to regulate action.

The sustainability of mHealth systems is not guaranteed simply because they embody modalities that mediate CHWs practices. As echoed by other researchers (see: Aanestad et al, 2014; Henfriedsson and Bygstad, 2013; Karasti, 2001), I argue, that the sustainability of mHealth systems starts with an understanding of how these ICTs stay relevant and meet their users’ work needs. The two cases show that for CHWs, when the mHealth systems that mediate their practices support their work, they in turn take initiative to locally maintain these
technologies and the practices they mediate. In Uganda for example, data collection resulted in more evidence-based decision making which initiated services such as the provision of pregnancy kits to expectant mothers. These created more effectiveness in maternal and child healthcare delivery. Papers one and three implicated this effectiveness in affirming community recognition and supporting work identities associated with professionalism among CHWs. VHTs in turn improvised to maintain SMS data reporting by borrowing phones, paying to charge their batteries to locally maintain both the mHealth system and the new practices that they considered important. Carol from the vignette in the introductory chapter, resounds these arguments for continuing to use the mHealth system. For Carol and other VHTs, the mHealth system enabled the identification of relevant services for maternal and infant healthcare based on reported data. This not only matched her work but also supported and improved it. In addition, reported data prompted her collaboration with superiors from the District Health Office to deliver healthcare in the villages. This was accompanied with a sense of recognition in both her work and position by the communities and her superiors. In Malawi, this was similarly expressed as good visibility and activities mediated by the mHealth system that prompted the community’s and supervisors’ recognition were supported by HSAs.

In addition, the nature of work transformations associated with changes in practice as technologies are appropriated are also important in informing sustainability. Similar to Orlikowski’s (1996) observation, some changes in work were deliberate as intended by the technology design and others were emergent without prior intentions. In Malawi, HSAs begun to use the mHealth system in care giving and consequently received frequent monitoring from supervisors that could see their daily work achievements. This contrasted with earlier existing monthly paper reports. The mHealth system created a potential for supervisors to exercise more power and control by enhancing the visibility of CHW’s work. In Uganda, VHTs engaged in SMS reporting as intended but these reports prompted new collaborations in work with superiors from the DHO. In the transformations, CHWs also through their agency reflexively and actively altered their work and the mHealth systems. This is illustrated in papers one, two and five. The work transformations were in the form of innovations, improvisations and alterations. For example, Papers one, four and five showed that in Malawi, HSAs realized that with the mHealth system, they could demand for a malaria diagnosis feature to be added in the system. This was to curb HSAs’ inability to effectively diagnose malaria. They also looked
beyond the modalities in the mHealth system and relied on the affordances of the mobile phones to innovate new ways of working. For example, they created a WhatsApp group that afforded them a quicker and more efficient way to communicate, consult and collaborate with colleagues. Improvisations included CHWs in both cases sometimes making consultations over the phone with health professionals and amongst peers. In Malawi, work alterations included bypassing previous hierarchies to order for logistics. HSAs made adjustments like replacing paper forms with the mHealth system in care giving work while also going back and forth between the two depending on for instance the availability of electricity. Data reporting was also rearranged, with the mHealth system used first to capture data that was later copied to paper forms. Some of these transformations inform sustainability through showing the agency of CHWs in appropriating mHealth systems in their work practice and actively being involved in the change process especially with intentions of supporting their work. Carol and others’ efforts to maintain the mHealth system, SMS reporting and new practices like educating communities and collaborations with supervisors, show human intent, an important basis for ICT4D sustainability (Toyama, 2011). Carol and other CHWs aim to reach primary healthcare to mothers, infants and their communities. As the new mHealth systems support this work, they adjust their work, demand for adjustments in the systems and improvise to locally accommodate and sustain them.

Note therefore, initial considerations of how work gets done and the integration of these understandings in the design of mHealth systems are essential in the successful use of technologies (Karasti, 2001). When mHealth systems are implemented however, it does not mean that existing work practices or the technologies will remain stable (Ciborra, 1997; Forman et al, 2014; Nicolini, 2012). They drift due to various micro-events that occur and therefore their design should be flexible. Like previous studies (see Zuboff, 2001; Orlikowski, 2010), this thesis found that CHWs attempt to change their work practices and the mHealth systems. And not all work transformations are supported or considered supportive of CHWs’ work as the thesis shows some conflicts and contradictions. For example, paper one, three and five showed that online reporting increased workload due to double reporting. Frequent supervision created agitation and tension among CHWs. These tensions created a lot of circumspection around continuing those practices.
The work changes were rooted in the local contextual features such as infrastructures, work activities that CHWs engaged in and the demand for specific work procedures. The changes emerged especially through the ways in which the CHWs fashioned their use of the technology in their situated actions. The changes were delicate, often impaired by the work context characterized with lack of electricity, costs, and wide geographical spread among others. This created a back and forth movement between the new practices and existing ones. This slowed the complete unfolding of work transformations and reflexive processes as well. By reflecting on their local practice, CHWs, like knowledgeable agents (Giddens, 1984) monitor their actions and those of others to either reproduce existing practices and structures or create new ones. This is reflected in papers 1-5 as a response to research question one. In these actions of maintaining or reinventing their work practices and the mHealth system, CHWs try to continually adapt the mHealth system through these changes. This was mainly an effort on their part to accommodate the mHealth systems in their work context which Jacucci et al (2006) relate to local sustainability. Notably, although the transformations in the two cases were quite similar, their intensity was different. Paper one showed a more reflexive tendency in Malawi where HSAs received monthly credit top-up and smart phones with more functionalities compared to the basic phones in Uganda. In Malawi, the smart phones enabled the utilization of applications like WhatsApp to increase lateral communication and teamwork among colleagues that are widely dispersed. This was not possible on the basic phones in Uganda.

The essence, I believe is in recognizing that technology users can take initiative to either use or reject new technologies regardless of what hierarchy they occupy in a health system organization. Changes in practice are an unstable way of coping and adjusting with the new technologies as experienced in everyday practices (Ciborra, 1997). These transformations in work around a technology system and in the technology system itself have been cited as essential in understanding the adoption and success of technologies in work practices (Aannestad et al, 2014). It is in these transformations that we can understand how human agents try to adjust, identify needs and priorities, cope to accommodate or reject new practices and technologies in the workflow of their everyday lives (Ciborra, 1997). Where there are no tensions, actors tend to let practices continue, favoring practice reproduction.
which reinforces organizational structures that support and sustain the practices and mHealth systems that support them.

I argue therefore that work transformations that back the work of CHWs and the technologies that support them should be sustained. The sustainability of mHealth systems and the work practices they support should take root in Carol’s and other CHWs’ efforts especially those grounded in their everyday work lives and are considered important. In response to research questions two, paper four for example shows how through using mHealth systems, CHWs gain power to schedule work activities that involve mobilizing and collaborating with others and coordinating work through their new mobile phones while bypassing their supervisors. And for such new work activities that support work, CHWs attempt to maintain and continue them. They improvised to use solar chargers to charge their phone batteries in the Decision Support case. The aim of the proposed framework in the thesis was to understand the relationship between work practices and the technologies that mediate them. As the findings in the two cases show, CHWs choose how to appropriate technologies, and in so doing create changes and take initiative to locally sustain those practices mediated by the technology that support their work. These practices not only supported their work but, in some cases, garnered their supervisors’ and communities’ support hence creating a sense of work and position affirmation. Good visibility (Lehmann and Sanders, 2007) in paper three was found to foster practice reproduction among CHWs especially since they are often weakly recognized by their governments and communities (Kok and Muula, 2013; Braun et al, 2013).

ICT4D research should therefore be keener to uncover work practices and accruing transitions at the micro level basis of the health system organization where technologies are used to inform sustainability. ICT4D initiatives and especially mHealth solutions are primarily supply-side driven (Kleine and Unwin, 2009) yet ICT4D research on sustainability in developing contexts tends to abstract ICT users at a broader organizational level like a MoH (see Kimaro and Nhamposa, 2005). ICT4D studies at the level of technology use tend to focus on understanding how technology contributes to development and the consequences of technology (Heeks, 2014) and not specifically on the work and organizational interactions necessary for accomplishing technology implications (Aanestad et al, 2014). In work practices, I have argued we can understand local sustainability efforts. I have diverted from typical reflections on higher abstractions in the health system organization to intricately uncover local
social practices around mHealth systems. My approach illuminates those aspects about CHWs’ work and the mHealth system that are important for their work and they are willing to sustain locally. It is important therefore for mHealth system strategies to have plans but to also be quite general to accommodate deviations. And mHealth systems should also be flexible to evolve with new improvisations and many unexpected outcomes. It is these transformations especially those that support work, that are linked to the sustained demand of HIS and their scaling (Aanestad et al, 2014). It shows that mHealth system scaling and sustainability is not simply about technology roll-out but is a complex phenomenon that should also account for embedded work practices.

7.2. Work practice transformations should be linked to broader organizational structures for sustainability.

Heeks (2008) noted that ICT4D initiatives fail when introduced to local communities in a top down manner that views technologies as only a means to an end. There should therefore be a form of interaction between the top and bottom to inform the success of ICT4D initiatives. While revising the ICT4D concept, Heeks (2008) went ahead to show a shift from top-down approaches to a focus on concerns around sustainability, adoption, evaluation and the scaling of ICT4D projects. This focus refutes passive adoption and sees people as capable of adapting ICTs to fit their objectives and goals. This has been illuminated in the thesis and the papers have shown in both cases, that like all knowledgeable actors (Giddens, 1984; Schmidt, 2014), CHWs are capable of innovating, reinventing, improvising and making adjustments in both their work practices and the technology, to align it to their work flow or goals. In the Decision Support case, CHWs decided to replace paper forms with the mHealth system to mediate their care practices involving treating and educating patients. When infrastructural barriers challenged mHealth use, they learned to go back and forth between the papers and the mHealth systems. At the same time, they demanded for adding a malaria diagnosis functionality to improve malaria diagnosis. I however learned that most of the feedback from CHWs to develop and change the mHealth system according to their needs was at the beginning of the projects. Demands in Malawi were later not responded to and in the SMS case, technical support was limited and new developments to use the basic phones in VHTs’ work could not be captured. The findings also showed in both cases that CHWs utilized the technology affordances to support their communication, consultation and coordination work activities. Overall, in the two cases, the mobile phone handsets enabled a space of
empowerment where CHWs could revise their work and manipulate the mHealth system for local adaptations and adoption.

As I respond to research question two, I see that the practices and the work transformations resulting from reflexive social agents can have implications for broader social structures (Ellway and Walsham, 2015). Like Feldman and Pentland (2003), Karasti et al (2010), Orlikowski and Yates (2002) note about the relation between practices and structures, in my proposed framework, it is argued that if the new practices associated with the technology persist and become routinized patterns, they reinforce new structures to support and sustain them over time and space. Therefore, without an understanding of how practices unveil alongside technology use, we cannot fully inform organization structures at the macro-level. There are gaps and demands we can identify in work transformations that support CHWs’ work to inform broader organizing structures. However, the relationship between users’ actions and resultant institutional changes has been elusive to theorize and empirically explore (Ferraro et al, 2015). HIS related studies on work activities (see: Chawanii et al, 2014; Kimaro et al, 2005) around technology in healthcare come close to filling this conceptual gap by paying attention to the intricate details of everyday work practices but need to move beyond the micro or work level and develop understandings of how they can be captured into broader organizational systems (Monteiro et al, 2013; Firtzpatrick and Ellingsen, 2012; Haried et al, 2017). Some of this research often draws implications for HIS system design and how practices can change to accommodate technologies (Firtzpatrick and Ellingsen, 2012) which is important. It is also important to understand that new HIS like mHealth systems are a part of the broader organizational system where they should be aligned and integrated especially now that developing countries are trying to move towards large-scale integrated HIS. I reflect on how mHealth projects can have impacts on HIS more broadly by understanding the implications of work transformations for ICT sustainability. In so doing, I observed that as CHWs endeavored to change and reinvent their work and the mHealth systems at their own terms, so they could fit their work, these transformations created new practices that did not have supporting structures in the health system organization to sustain their existence or the mHealth systems institutionally. Note that structures have no material existence but are actualized in practice (Giddens, 1984). The health system organizational structures I refer to
are the material and symbolic representations and properties of structures that exist in the CHWs’ minds as rules and resources for their practice.

I argue that if supporting structures are present, they should enable spaces for local improvisations to thrive. And as new practices emerge, structures should also be updated to adapt to the changes grounded in local adaptation and adoption or else they get misaligned with the work they organize (Barley and Kunda, 2001) leading to dynamic tensions. Paper five made the link in the thesis between the micro practices of CHWs and the macro structures that should be in place to sustain both practices and the mHealth systems. It identified four structures important for sustaining work practices and transformations identified in the thesis and the mHealth systems that mediate them as: structures of knowledge learning and sharing, reporting, training and infrastructure. These structures are not exhaustive but were identified in relation to the work transformations in the thesis. It is in these structures that micro-level activities can be aligned and balanced with the macro-level structures that guide and sustain both the practices and the mHealth systems (Norris et al, 2009).

Knowledge learning and sharing structures are related to making visible emerging practices in the field to the rest of the health system organization. They can ensure that new innovations, local adaptations and dynamics in the work context are shared across the health system organization through feedback loops and timely supervision. This enables identifying required skills, tensions, resources and revisions necessary for the mHealth systems and associated practices to survive over time. For example, new innovations constantly need technical support to be integrated in mHealth systems. Increased surveillance created tension among CHWS who felt more control from supervisors hence compromising new online reporting practices. Feedback loops should make it possible for organizing institutions to be aware of such tensions so as to learn from them and manage them accordingly. Sustainability here is linked to the attention given to local adaptations and developing ways to understand how to manage them in the wider HIS.

The reporting structures are associated with guiding channels of information flow from the communities to the higher authorities and back while reflecting the content of what flows and by what media. The mHealth systems created new reporting formats where traditional paper reporting co-existed parallel to online reporting. Traditional reporting structures need to be revised to create formal online reporting structures that can additionally avail policies for
sustainability to ensure that new online reported data is protected, transparent and interoperable with existing national HIS. In addition, they should support feedback between the CHWs and the higher levels to enhance learning from local contexts and catch up with the speed at which CHWs send data on their phones.

Training structures relate to the availability of training resources such as competent trainers, budgets and policies to impart training to renew CHWs skills as they use both the paper and mHealth system media to mediate their work. Training of CHWs is often inadequate and not reflective of the changes in their work practices. The findings have shown that CHWs traverse between paper forms and the mHealth systems depending on infrastructural issues in their local context. Enabling structures of training should therefore be established to support the use of both media where CHWs can take advantage of the media that suits them best at a particular time. For example, training should be enhanced for those guidelines that are only paper based especially considering that CHWs reported forgetting to ask some questions during disease diagnosis. The mHealth systems should be upgraded to continuously include existing paper guidelines and also new ones. Training support can also be enhanced online due to the CHWs’ comfort with using phones in Malawi. Peer to peer support can be done through WhatsApp. The work practices of CHWs need to be nurtured without the MoH completely dictating them. Training should therefore be sensitive to the experiences of CHWs and sustainability can be attained when local improvisations are allowed to thrive (Sanner 2017).

And, infrastructural structures are related to infrastructural aspects such as, electricity supply and physical distances. CHW’s understanding of the lack of electricity in their areas kept them aware that they cannot constantly use their phones, hence falling back to paper protocols. Physical distances are long between villages and health facilities and CHWs sometimes resorted to phone consultations for instance. In Uganda VHTs continue using SMS data reporting because it supports evidence-based decision-making while in Malawi, the mHealth system’s efficiency led HSAs to rely on it in their various practices of care giving, reporting, consulting among others. Due to the lack of electricity, CHWs resort to cheaper electricity options like solar power to charge their phones to sustain mHealth system use. The support mHealth systems afford to CHWs in their work should be matched with supporting infrastructural structures to sustain their use and local improvisations around them. This can
be enabling structures in the countries to support rural electrification through significant budget allocations. If solar power is considered a feasible alternative, considering CHWs’ dependence on solar power, then policies and budgets maybe put in place to supply solar electricity. The existence of these infrastructural structures allows for mHealth system use and its associated practices to continue if CHWs regard them important in their work.

Without an arena to learn what is going on and needed at the micro-level, implementors of mHealth systems are prone to missing cues important to sustain mHealth systems and the practices they support. There should thus be some negotiation in aligning micro-activities and technological capabilities with broader organizational structures. Identified structures to support new work transformations and the technologies also need to be continuously renewed by related practices to remain relevant. For example, paper five also showed that practices of data checks by the MoH can emphasize the integration between online and paper reporting to support new reporting structures. This is what (Giddens, 1984, Orlikowski, 2000) refer to as both practices and structures evolving in a mutually constitutive manner.

For ICT4D initiatives that are often centrally driven (Uwin and Klein, 2009, Sahay and Lewis, 2010), it is important to learn that they can be sustained through addressing local social practices of the technology users and linking them to broader organizational structures. Giddens’ account of agency and structure (1984) offered a useful theoretical account of the micro practices and how they are interlinked to macro-processes or how agency can affect existing structures. These accounts are limited in the ICT literature that investigates work practices in healthcare work (Firtzpatrick and Ellingsen, 2012). The papers in this thesis give a rich account to understand the situated practice in primary healthcare work from the CHWs’ perspective and the way everything is brought into play including the changes in this work context. In addition, these work transformations are related to corresponding broader structures considered essential to their sustainability and the mHealth systems that support them. Consequently, the thesis broadens the scope of ICT4D research by simultaneously addressing the broader organizational and institutional issues of HIS sustainability (Orlikowski and Barley, 2001) in which mHealth systems are implicated.
7.3. Implications and contributions to theory: Explicit elaboration of the empirical and theoretical use of a practice theory

As I respond to the two research questions addressed in this thesis, I contribute to practice theory by elaborating the ‘what’ and ‘how’ of using practice theory (Feldman & Orlikowski, 2011). The ‘what’ is the empirical approach to practice that foregrounds the centrality of people’s actions to organizational outcomes and recognizes the importance of practices in ongoing organizational operations. I have made an empirical contribution by focusing and understanding the everyday activities of CHWs in both their routines and improvised forms as they use mHealth systems. In paper one and five, I have detailed care, reporting, communication practices among others. I went beyond understanding the execution of activities to exploring how and why CHWs planned, handled contingencies and made changes in their practice. To understand this, I also had to understand the broader context that shapes the practice as recommended by Nicolini (2012) and Labatut et al (2012). That is, the historical, economic, infrastructural and socio-political factors at play. In his conceptualization of practice as the site of knowing, Nicolini (2010) states the importance of recognizing that the context (historical, social and cultural) in which practices are situated is not passive. This brings a deeper understanding of why some practices through the mHealth systems were maintained by CHWs and others were not. For example, paper five narrates that CHWs navigate through both paper and the mHealth system in their care practices due to contextual challenges related to poor infrastructures and a lack of electricity supply.

Early ICT4D research was not far from positivist tendencies, neglecting the social context in which ICTs were implemented (Cardoso and Ramos, 2012; Orlikowski and Baroudi, 1991) and assuming that technology would bring about intended changes. Orlikowski, (2000) for example refuted this to show that technologies are not independent of the social world they are a part of and they can be used in unforeseen ways creating unpredicted changes sometimes different from expected changes. For example, research has relentlessly foregrounded the potential of mobile solutions (see: Busiku, 2014; Kiberu et al, 2014; Blaya et al, 2010) especially because they reach remote areas and compensate for infrastructural shortages in developing countries. This research has however been criticized for a neglect of the social world in which these ICTs are implicated (Walsham et al, 2007; Avgerou, 2008). Heeks (2006) referred to it as the design-reality gap attributed to many failures in ICT4D initiatives. Heeks (2006a) referred to ICT4D as more biased to action and not knowledge and
therefore merely descriptive and not analytical. The community health work practice is underexplored even though CHWs serve the world’s marginalized populations. There has been limited attention towards the potential of local sustainability from groups such as CHWs at the lowest level of the health system organization (Jacucci et al, 2006). I illuminate the practice in the context of two developing countries of Uganda and Malawi. I go beyond mere detailed descriptions of the community health work practice, a challenge for several studies of ICTs and work practices (Monteiro et al, 2013; Fitzpatrick and Ellingsen, 2012) to elucidate how mHealth systems are implicated in the concomitant work transformations and I link these to broader organizational concerns of sustainability.

The ‘how’ of conducting practice theory is the theoretical approach undertaken (Feldman & Orlikowski, 2011). I leaned on Gidden’s structuration theory to sensitize my understanding of how CHW practices operate, how they are produced, reinforced or changed. The emphasis of this theory on the interplay between structure and agency helped me to understand the dynamics of how changes at the micro-level of practice are linked to broader structures of sustainability for work practices, accruing transformations and the mHealth systems that support them. The challenge however is that structuration theory has an insufficient focus on technology (Nicolini, 2012) even though as a meta theory it illustrates how the social world unfolds in practice. Practice scholars have indeed acknowledged that practice is bound up in material forms such as infrastructures, spaces and artifacts through which humans act (Nicolini, 2010; Orlikowski, 2006). Some practice theories like actor network theory (ANT) have accounted for this materiality. ANT has however received criticism for its symmetrical treatment of technology and human agents which Verbeek (2016) has for example argued fails to address the process of technology mediation from the perspectives and interpretations of human agents. I therefore had to conceptualize and carefully consider the material aspect of the technology, to show how it unfolds and is implicated in the practices of CHWs that influence sustainability.

7.3.1. Practice theory and the technology artefact
The work practices and work transformations occurring in both cases are not only characterized or brought on by human agency. To paraphrase Orlikowski (2006), practices are also materially entangled. They transpire through the mediatory work of nonhuman elements (Nicolini, 2010). Practices are influenced by the properties of the technology that enable
capabilities as human agents draw on them in the structuration process in their practices (Giddens and Pierson, 1998). The two cases have shown that the mHealth systems are a part of the context that shapes work practices. For example, in paper one, the mobile phones induced more frequent communication and feedback through SMS, WhatsApp and their calling functionalities. This connectivity was aligned with work interests to have more frequent interactions amongst CHWs, consultations with health personnel and organizing follow-up activities with community members. In both cases community members in turn can conduct consultations because of the increased connectivity afforded through the mobile phones.

Some transformations emerge as CHWs draw on the modalities built into the mHealth systems as demands and protocols to mediate their practice. For example, replacing paper forms with the mHealth systems in care giving work in Malawi was based on the efficiency of the technology in comparison to the papers. Besides the modalities, CHWs extend their interpretations of the mHealth system to the affordances of the mobile phones that are implicated in some work transformations. Some transformations are enabled by functional affordances because they are based on the material properties (Thapa and Sein, 2017) of the mobile phones. Paper one described how collected data in the SMS case also prompted the emergence of new services like the delivery of pregnancy kits to promote maternal and infant health. These new work activities were socially constructed based on the needs and goals of CHWs to curb maternal and infant mortality in their villages. People can harness technologies to achieve their goals especially through the affordances allowed by the technology (Norman, 1999; Thapa and Sein, 2017). It was therefore important that I did not assume a fundamental separation between technology and the social as I studied the community health work practice. It was important to understand how CHWs interpret the mHealth systems that mediate their work and how they engage with them in their practices.

Most of these changes were not planned but were triggered by CHWs discovering and seizing opportunities from the capabilities of their new acquired mobile phone handsets while conducting their practices. In the Decision Support Case, the redesign of the mHealth system was closely related to real use when CHWs identified potential trajectories they could take with the new technologies. For example, CHWs identified the need to incorporate malaria diagnosis in the mHealth system to improve patient treatment. Therefore, the mHealth system as a medium is unstable because it requires to integrate various emerging needs of
CHWs. For this, the technology should be flexible to evolve with emergent needs and in so doing, it adapts better to the local context by providing a space for local improvisations (Maruster et al, 2008; Sanner, 2017). The mHealth system as a medium in the Decision Support case was also dynamic in the sense that it facilitated unexpected outcomes such as, surveillance. This raised concerns among CHWs for being under the constant control of supervisors. These concerns raise tensions as similarly found by Mukherjee (2015) and Zuboff (1988). It can therefore be noted that the mHealth systems were not dormant and possessed their own logic of growth. It was not only the human agents that constructed around the technologies to align them with their goals. The mHealth systems become a basis for shaping some work activities through their capabilities, modalities, functionalities and perceived affordances.

I also learned that the emergent changes in both work and the mHealth systems were continuous, often supported by the CHWs but were restricted by contextual challenges. For example, poor infrastructure like power shortage, costs in both cases and limited technical support especially in the SMS case. This implied therefore that as mediums for practice, the mHealth systems in the two case contexts were fragile. This explains why CHWs went back and forth between the paper forms and the mHealth systems. Therefore, even with the evidenced transformations in the CHW practice to embed the mHealth systems into their workflow, some aspects in the work context required fixing. Infrastructural, cost and technical issues were above CHW’s ability to address. These challenges should be addressed in the broader organizational structures as I indicate in the previous section. ICT4D initiatives continue to be engulfed in the same contextual challenges that have accounted for their unsustainability (Walsham et al, 2007; Avgerou, 2008) without necessarily taking lessons from previous initiatives.

To cope with the dynamics that exist in this work context, this thesis like other scholars (Nicolini, 2010; Orlikowski, 2006, 2007) accounts for the role of technology without naively assuming only the role of human agents over the technologies in work transformations. This is what Orlikowski (2007) referred to as sociomateriality when she recognized that research needed to acknowledge the materiality in everyday organizational life or practices. I have assumed technology to be involved in the modalities that link social action and structures where actors draw on the interpretive schemes, facilities and norms embodied in the mHealth
system to reinforce or change existing work structures. I embed these modalities into the notion of affordances to capture whole materiality of the mobile phone without limiting its materiality to the demands built in the system to facilitate the CHW practice. Structuration theory is here, extended to capture the material aspects of the technology as people act around and draw on the technology systems in their practices. Structuration theory lays emphasis on the role of human agents in social action and does not account for material aspects in practices. Giddens’ later commentary seems to revise this (Giddens and Pierson, 1998) by suggesting that technology is implicated in human action and people do things in relation to material artefacts. This interaction is important for social practice and considering Giddens’ neglect of it, I conceptualized and developed a theoretical account of the mHealth systems as mediums with affordances. I show how the mHealth systems define potential for action as they mediate practice. Like other material resources, technology can be implicated in the structuration process to shape social practices (Jones and Karsten, 2008). My account has shown what has so far been possible around and through the mHealth systems/mobile phones in the work practices and context of CHWs.

This thesis has thus shown a consideration for socio-technical agency and how technology helps human agents interpret their practices (Verbeek, 2016) to understand all transformations that occur in work, where some are chaotic and others disruptive (Avgerou, 2010; Ciborra, 1997). These transformations give attention to various facets in the context, bringing to light those aspects that need attention. They help us to understand more open evolutionary strategies to accumulate learning, resources and technological modifications at the work level that are relevant for maintaining the technology. Ciborra (1997) refers to these as cultivation strategies that consider the role of the technology and the context in teaching us how we can learn from the tensions, changes and misfits when technology is introduced in organizational settings.

- **7.4. Implications for Practice:** mHealth sustainability is influenced by linking important micro and macro level elements in the health system organization. Introducing technologies without making organizational changes results in significant failures as any benefits from the new technologies cannot be absorbed in existing practices and organizational structures if changes are not made (Brynjolfsson and Hitt, 2000). This is unfortunately the case in many developing countries where most changes that happen are
those that are instigated at the top or by foreign donors that for example introduce their own institutionalized practices of reporting. These are often far from existing practices or without any local support both at the national and local levels. By answering the two research questions, this thesis brings to light the dynamics between micro and macro aspects that influence the long-term sustainability of mHealth systems. I argue that these are important in guiding policy to support mHealth systems in developing contexts.

The main argument here is to allow for policies that accommodate active local improvisations and innovations that capture local needs and take lessons from those improvisations to in turn inform policy regimes at the broader organizational level on how to support sustainable mHealth initiatives. If there is a group of health workers, that can co-master community complexity given the appropriate support, it is CHWs (Palazuelos et al, 2018). And if mHealth systems are implemented to support equitable health service delivery as called for in the Alma Ata declaration of 1978, then improvisations to support primary healthcare work through these technologies should not go unnoticed. Although the vertical programs supported through mHealth systems would prove the contrary. I think this is an environment for learning from past mistakes since ICT4D initiatives have been preoccupied with the same problems resulting from top-down and supply driven approaches (Kleine and Uwin, 2009) especially in developing countries.

Work transformations and even accruing tensions possess the potential to enable us to learn about missing elements, understand local necessities and needs that can be cultivated to support mHealth systems in the local contexts where they are embedded without impositions by a development team from a different context. Papers one and five for example have shown how CHWs in Malawi improvise to use solar chargers to maintain mHealth system use. This can inform public policy and budgets for rural electrification. This is expensive but CHWs in the Decision Support case use solar power as a cheaper solution in their rural work context. This might require policy to supply solar electrification on a more systematic basis to enable continued use of mHealth systems. Also, based on the insufficient training, there should be policies to impart continued training to renew knowledge skills for CHWS in using paper and mHealth system guidelines in their work. New policies are required to ensure that data reported by third-party players is well protected, transparent and interoperable with the national HIS. Therefore, mHealth systems cannot simply be rolled out as standardized
solutions to be used upon deployment. Even in poor contexts, innovations are capable of emerging (Kahn, 2008). There are various changes that happen around and in technologies and these should be evaluated, adjusted and maintained when deemed fit. Scaling of such systems will thus be influenced by their demand. Allowing for local improvisations therefore creates an understanding for locally relevant solutions that can guide policy to support self-reliance and strengthen local sustainability. And as local transformations occur, similar modifications are required in the health system organization to adapt the changes into broader organizational structures to maintain them.

The implementation of ICT initiatives has almost always been centrally organized based on rationalizations like having control over these costly technological projects in healthcare. This has so far proven futile. Balancing the micro and macro aspects should be essential in taking this control away from approaches that are often supply driven and giving some control to the users of the technologies. mHealth systems are already based on established, although not exclusively, mobile technologies prominent in the developing world. Mobile phones are cheaper compared to other technologies and as the cases have shown, although costly, CHWs incur some costs to maintain them. It would be easy to assume that they would be successful but as research accounts have shown, it is not always the case with these established technologies. I agree with Hosman and Fife (2012) therefore, that technology sustainability requires the long-term investment on the part of governments and all stakeholders including the lowest cadre of health workers in the health system organization such as CHWs.
Chapter 8: Concluding remarks and recommendations for future research

In this chapter, I present my concluding remarks and identify avenues for future research.

8.1 Answering the Research questions

Research question 1: What is the nature of mHealth systems mediated work transformations of the community health work practice?

The research question is answered based on the framework presented in chapter three. My goal in this thesis was to understand how work transformations related to the introduction of mHealth systems in the work practice of CHWs can help us to understand their sustainability. To summarize, first, in the framework, I referred to work practices as purposeful activities regulated by structures. The changes in work practices are what I conceptualized as work transformations. The thesis has presented an interpretive study of the social and technical changes in work practices that evolved around the introduction of mHealth systems in community health work. The two cases detailed accounts of the work practices of CHWs. In this work, mHealth systems are implemented especially through top-down approaches either through the institution of the MoH or other organizations. I found that the introduction of mHealth systems was followed by radical work transformations implicated by both social and technical processes. Some changes were planned according to the design of the mHealth systems, for instance SMS data reporting in Uganda, while others like increased surveillance and engagement with supervisors were emergent. The thesis has also shown the role of human agency and reflexivity where CHWs actively changed their work as they used the mHealth systems. CHWs actively initiated work transformations by innovating, improvising and altering their work while appropriating mHealth systems as mediators of their practices in their work contexts. Through innovating, they demanded novel changes such as the addition of a malaria diagnosis section in the mHealth system. Through alterations, they changed data reporting by entirely relying on the mHealth systems to capture daily data and later copying that data into paper forms that are submitted every month. Through improvisations, CHWs learned to sometimes consult and make inquiries amongst each other on their phones or through WhatsApp while forgoing supervisors. In addition, the thesis also recognized the technological role in the work transformations. The modalities embedded in the mHealth systems mediated data reporting, care giving work, and educating patients for
instance. CHWs drew on these modalities to follow the demands built in the systems to either reproduce or change their practices. Data collection went from only using paper forms to using a hybrid between paper forms and the mHealth systems. CHWs chose to use the mHealth system first and later copied data into the paper forms. CHWs additionally drew on the affordances of the mobile phones to create changes in their work. For example, creating a WhatsApp group in Malawi, afforded CHWs more lateral communication amongst colleagues while bypassing supervisors.

**Research question 2: How do we sustain work transformations and the mHealth systems that support them?**

This research question is both theoretical and practical in nature and is answered through the framework in chapter 3. The framework conceptualizes the main building blocks in the thesis. That is, it theorizes work practices and transformations and the role technology plays in mediating them. It recognizes the role of the technology and human agency in the practices and their transformations. The framework argues that work transformations can influence sustainability by informing broader organizational structures, but this process is embedded in tensions and negotiations. I draw implications from the work practices and transformations described by research question one to inform mHealth sustainability. I described sustainability to include the work practices and work transformations supported by the mHealth system and their supporting structures. As work transformations ensue alongside mHealth system appropriation in the community health work practice, CHWs initiate various attempts to locally adapt, adopt and sustain the mHealth systems and the work changes that support their work. The practices that support community health work and are mediated by the mHealth systems, are locally favored and I have argued that when they are routinized, they change existing structures. However, efforts to locally sustain the mHealth systems and the practices they support are not sufficient and thus require matching broader organizational structures to sustain them.

The thesis linked the work transformations that support CHWs’ work to four structures that should be in place to sustain them. Innovations in work transformations require knowledge learning and sharing structures to capture them from the micro level of practice to fit with the broader HIS. Work alterations like new online reporting formats need reporting structures to manage and sustain them in the national HIS. Work improvisations like consulting colleagues
through their WhatsApp groups require training structures to for instance maintain peer to peer support. Overall, all work transformations through the mHealth systems that support the work of CHWs need infrastructural structures to support their continued existence. The structures are crucial for sustaining both work practice and the mHealth systems that mediate them over time and space. Note that the structures are flexible as they can change when practices change and vice versa. However, it is not straightforward that work transformations can be implicated in organizational structures because they can be engulfed in conflicts between the macro structural level and the micro level where practices occur. For instance, the local adoption of mHealth systems can still be faced with tensions especially where CHWs are threatened by emergent changes from technology use such as increased workload, surveillance and control. Although superiors drive these changes, CHWs are mainly agitated by them and devise ways to avoid the controlling eye of their supervisor through the mHealth systems.

As I respond to the research questions, the thesis contributes to ICT4D research by describing the sustainability of mHealth systems as entangled in context specific micro events and dimensions of the local contexts in which they are implemented. The thesis argues that work transformations are essential in opening spaces for understanding local improvisations, alterations and innovations. These are requirements for reinterpreting work practices to fit or reject the technology in CHWs’ work and reinterpreting the mHealth systems to innovate better ways of using them in the work context. It is these local improvisations that can explain crucial aspects around the local adaptation, adoption and sustainability of an ICT4D initiative. These are essential in the survival of the ICT4D initiatives based on technology users’ efforts.

Another contribution is made through taking detailed accounts of the work practices and the work transformations related to the introduction of the mHealth systems in community health work. The thesis looks beyond describing these small group work interactions to linking them to broader health system organizational concerns of HIS sustainability through identifying supporting structures. That is, the structures of reporting, infrastructure, training and knowledge sharing and learning. By theoretically and empirically exploring and linking the micro work transformations and required corresponding organizational structures, the thesis explains how local work transformations and mHealth systems can be aligned and integrated into the broader health system organization where they are a part of a larger network of HIS.
In response to research question two, a claim is forwarded that work transformations and their supporting mHealth systems should therefore be matched with flexible structural adaptations that negotiate a balance between the needs of the local and broader organizational system needs.

Another main theme of the thesis has been to explicitly highlight the empirical and theoretical accounts of practice theory. It detailed the work practices of CHWs and accruing work transformations upon mHealth system use. These transformations are woven to capture the context in which they occur and the technological properties that are implicated in them. This has been related to the affordance characters of the mobile phones as they mediate certain practices of work but enable some activities around them and even through them. Users draw on these affordance characters to either maintain practices or improvise new uses important in their work. As they draw on the mobile phones, work transformations spill across their practice enabled through new uses that are afforded by the technology.

I see that it is possible to downplay other important issues while focusing on a particular one. This work has been interested in understanding work transformations accompanied by mHealth systems use and uncovering them to understand their implications for sustainability. While focusing on this work, a few issues have come to mind. The two cases have shown some form of work changes in terms of improvisations, alterations and even innovations around mHealth systems among CHWs. These were not coordinated. It would be interesting to investigate these work changes and innovations among a coordinated group of CHWs. With the explosive use of mHealth systems in developing contexts, most without recognizable impact even though they are implemented in rural communities where healthcare is provided to the biggest populations of marginalized people, it is important to explore how coordinated work reinventions and innovations around mHealth systems can impact our understanding of healthcare outcomes in the ICT4D field.

The empirical cases I have used here, I regard quite limited in terms of the services they provide, and they illustrate only a small proportion of the wide mHealth and general ICT4D field. There are many ongoing and incoming initiatives, some even more sophisticated than what is currently available. Healthcare services must deal with the dynamics of social-technical transformations. It would be interesting to explicitly consider socio-technical characteristics of these dynamics and particularly capture the technological characteristics like I have
attempted here. This work has offered some conclusions about aligning micro initiatives with macro- processes, but I believe there is abundant room left in exploring this nexus to better understand where bottom-up needs and innovation with technology can meet top-down capabilities.
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Appendices
Appendix 1: Paper 1

Namatovu, E. and Sahay, S. (2016) ICTs and Health in Developing Countries: Understanding the role of Identity. *Information Systems Journal* (under revision)
Appendix 2: Paper 2

Mobilities of the Community Health Work Practice: Mobile Health System Mediated Work

New technologies have been implicated in various forms of mobilities creating new realities and questioning normative categories and order in contexts where they are applied. Our study argues that through understanding technology mobilities, we uniquely bring to light new forms of social phenomena that materialize with interactions between mHealth systems and the work of Community Health workers in Malawi. Through the analysis, we also elaborate the role of both human and non-human actants in work transformations. This is important in managing technological innovations and theorizing electronically supported work practices.

Introduction

We are witnessing an era where information and communication technology innovations have taken center stage in our social activities and work places, spurring intensive transformation processes. As Kling (1996) noted, the introduction of technologies makes work complex, creating various ways for users to reconstruct and restrict their work. Barley (1986) has also cited technologies as enabling many novel practices to
emerge. These transformations are not only due to the influence of technology but also its interplay with social systems and organizational structures. In contemporary healthcare, a range of technological innovations are developed to aid health service provision. In the developing world, mobile technologies offer new opportunities for healthcare delivery even in the remotest regions of those countries.

Community health workers (CHWs) provide simple healthcare to populations in communities often far away from health facilities (Lehmann & Sanders, 2007). They sometimes conduct administrative functions at health facilities. Mobile Health (mHealth) systems are often presented in light of their potential to assist CHWs (Braun et al, 2013; Källander et al, 2013; Agarwal et al, 2015), yet we do not fully fathom their interaction with the work practices of CHWs. There is a need to understand how and what changes emerge.

We use the concept of mobilities which not only refers to human movement but also includes dimensions of human interactions (Urry, 2000; Kakihara & Sørensen, 2002). Scholars like Urry (2000) sought to elaborate how mobilities undermine traditional forms of stability associated with endogenous social structures. Mobilities have especially been of interest to sociologists but they should be important to information systems research as technology has been implicated in the facilitation of various kinds of mobilities. Kakihara and Sørensen (2002) argue that technologies like mobile phones afford various forms of mobilities to human interactions. They expand the concept beyond mere human movement to include three interrelated dimensions of human interactions: spatial, temporal and contextual mobility. This article concerns itself with understanding the mobilities constituted by mHealth systems and how they are implicated in new social order. We study a group of CHWs in Malawi also known as Health Surveillance Assistants (HSAs). Lash and Urry (1996) argue that an understanding of mobilities contributes to an understanding of changes in social relations such as the organization of work. Our study thus focuses on this question: What is the nature of mobilities implicated in mHealth mediated community health work?

We illuminate normative work interactions and use the concept of mobility to understand how social order is influenced in the presence of technology. Referring to Kakihara and Sørensen’s (2002) categorization of mobilities, we further identify social mobility to emerge from our study, thus expanding on their work. We explain the unfolding of human-technology interaction processes with the social context to understand the outcomes of technology use. We believe the study contributes to our understanding of the contextual influence on systems’ use and technology’s role in influencing work. It has important implications for the use and management of mHealth systems.

The article is arranged as follows: in section 2, we discuss our background literature leading up to our theoretical framing. Section three presents our research approach followed by section 4 with our empirical findings. Section 5 indicates our analytical discussion and in section 6, we reflect on the implications of the study. Section 7 presents our conclusions.
Literature Review

Mobilities

Studies of mobility have emerged in globalization studies, geography, and anthropology among others (Sheller, 2011). Technology has been implicated as a means to mobilities (Sheller, 2011; Sheller, 2014; Urry, 2000) questioning our notions of social order and organization. Mobility refers to movement and Kakihara and Sørensen (2001) stretch the concept to suggest three interrelated mobilities that encompass human interactions. That is, spatial, temporal and contextual mobilities (Table 1). Spatial mobility refers to the movement of people, objects, space and symbols like information with geographical independence. This has been credited to invoke complex patterns of human interaction. Temporal mobilities are related to the acceleration of work and saving time, thus creating new temporal orders in the organization of work. These mobilities are related to influencing structural orders and interpretive frameworks for action. Contextual mobilities have also been related with modern technologies especially ICTs. Contexts in which actions occur, organize human interaction. They frame and are framed by the recursive performance of actions and they capture aspects of human interaction such as ‘in what way’, ‘in what particular circumstance’ and ‘towards what actors’. Technologies influence contextuality through affording diversified modalities of interaction. These modalities of interaction can range from unobtrusive to obtrusive depending on how they impose obligations to notice or react. Interactions can also range from ephemeral (where interactions only exist in the flux of unfolding events) to persistent (where interactions leave behind traces for further inspection and discussion).

Table 1: Three dimensions of mobility (Extracted from Kakihara and Sørensen (2002))

<table>
<thead>
<tr>
<th>Dimensions of mobility</th>
<th>Aspects of interaction</th>
<th>Extended perspectives</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Spatiality</strong></td>
<td>- Where</td>
<td>Geographical movement of not just humans but objects, symbols, images, voice, etc.</td>
</tr>
</tbody>
</table>
| **Temporality**        | - When                 | - Clock time vs. Social time  
|                        |                        |   * Objective vs. Subjective  
|                        |                        |   - Monochronicity vs. Polychronicity |
| **Contextuality**      | - In what way          | - Multi modality of interaction  
|                        | - In what circumstance |   - Unobtrusive vs. Obtrusive  
|                        | - Towards which actor(s) |   - Ephemeral vs. Persistent  
|                        |                        |   - Weakly & strongly tied social networks |

Sociological studies have often pointed to social mobility described by Lipset and Bendix (1959; Sheller, 2014) as the process by which individuals move from one
position to another in society. These positions often have specific hierarchical values. These mobilities raise concern of structures, hierarchy and power (Sheller, 2014).

John Urry in his 2000 discussion of ‘mobile sociology’ introduces contending views of structures as unstable. He notes that, “…in certain contexts, order generates chaos.” This according to him is because the social world/system is a social hybrid where several individuals’ iterative actions are subsumed under the notion of structure, ordered and reproduced through continuous interaction. He notes that Giddens gives us an understanding of how structures are drawn on and are an outcome of numerous iterative actions by knowledgeable actors but Gidden’s view insufficiently examines the complex character of the iterative processes composed of various elements- human and non-human and the iterative process of how order (structure) can generate chaos or change, unpredictability and non-linearity (Sheller, 2011). Urry notes that it is through the iterations over time that agents may generate unexpected, unpredictable and chaotic outcomes that revert to structures. To emphasize his assertion, de Certeau (2004, p. 1248) later noted that, “human agency has some leeway to “err” or wander from the lines prescribed by the overarching structure of society”. Human agents can do this by tactfully eluding structural determinism. So how does the repeated action towards structure produce change? Urry introduces the notion of mobilities and flows as being at the heart of many transformations in contemporary society.

Urry (2000) centers his arguments on mobilities that destabilize structures. Mobilities involve the interaction of different and sometimes conflicting linkages between people, technologies and practices across time, space and cultural conditions. The elements in social systems that interact physically and informatively over time do have both positive and negative feedback loops. These mobilities can help understand the iterative process that changes structures. To Giddens, structures are changed by human agency but through the lens of mobilities we can understand the role of both human and non-human actants like technology. We can understand how structures are transformed and what influences the change in community health work. Instead of merely highlighting what changes, we try to understand why it changes in the presence of technology. We use the mobilities lens to understand this.

Technologies have been linked to being channels of mobility and they break the way individuals, groups and society conduct their everyday actions. They add new dimensions to our understanding of the social world (Molz, 2014). We shall in the article seek to understand the community health work practice, illuminating who and what is mobilized or not mobilized and how this influences work practices. In this way we shall understand the changes influenced by both technology and social systems in implicating work practices.

**Research Approach**

Our empirical data is based on the work practices of Health Surveillance Assistants (HSAs) as we seek to understand their everyday mundane work and interaction with mHealth systems. HSAs in Malawi receive 6-8 weeks training and work at the lowest level of healthcare providing primary healthcare services to populations in rural areas.
Organization mHealth (a pseudonym) in 2014 developed a mobile decision support system to aid decision-making for HSAs during assessment of expectant mothers and infants. The project started in 2014 with six HSAs and by the time of the study (September and October 2015), six more were involved.

The system was developed based on existing paper protocols that were incorporated into a mobile phone system to support HSAs in accurately assessing, diagnosing and treating mothers and infants. In the pilot studied, new protocols were introduced and adjusted according to emerging needs that were not in the previous version. For example, the current version includes a provision for malaria testing. There have also been attempts at integrating the system data with the national Health Information System.

The system guides HSAs through a step by step analysis and treatment plan for health conditions like malaria, pneumonia, and malnutrition among others. For example, if the HSA is assessing an infant’s health, he/she has to go through a step by step inquiry and based on the answers entered into the system, a diagnosis or a recommendation for action such as a referral to a health facility is generated.

**Data collection**

The work of Community Health Workers (CHWs) is in many ways ambiguous with a general lack of clarity of the various networks that build this practice. Their work differs from country to country. To uncover the ambiguity of their work, the first author empirically borrowed ideas from the rhizomatic approach (Deleuze & Guattari, 1987) where she explored the various networks in the practice to understand and explain how the work of HSAs is structured and built. It was important to study the community as a whole (nodes) in the CHW practice, their dynamics and how they inform each other.

With this approach the current research studied the different nodes that make up the micro-phenomena/elements of HSAs’ work and how they connect, collaborate and influence each other to make up the practice. This relational view of the nodes was intended to give a comprehensive overview of the CHW practice, understand how things come together and the logic of how CHWs work, and identify micro-elements in the nodes and consequences of their interactions. This was done to understand processes involved and the interactions between the micro-dynamics of practices and work change (Labatut et al, 2012). CHWs were studied to learn and identify work practices and how they are interpreted to give meaning to shared action. In this way, it was possible to link the micro-level of the individual to macro societal system/ community health work practice. The role of technology in these nodes was also examined to understand how it interacts with the work practice. Figure 1 illustrates the various networks in the CHW practice.
The study was conducted in Zomba and Dowa districts for two months (September and October 2015). Participants were 12 HSAs, three Health Personnel, two members from Organization mHealth, and four community members. Upon its introduction, HSAs were given training by officials from the District Health Office, along with smart phones and the system. Data was collected through observation and semi-structured interviews with HSAs to understand their work practice, the dynamics of their everyday work and interactions with technology. Community members and health personnel also gave accounts of their interactions with HSAs in semi-structured interviews.

The first author aimed to understand the local relationship and rationality between the nodes. She attended training sessions when the system was introduced and later observed activities such as child growth monitoring for children under five years to understand HSAs’ interactions with their new mHealth system. There were informal chats to gain a further understanding of why certain actions were taken.

**Analysis**

The analysis aimed at understanding the normative order of the work practice of HSAs and how they change with technology mediation. We sought to understand how the different nodes influence each other and to not only understand the role of technology in influencing change but also uncover the layers of meaning brought to technology by social systems (DeSanctis & Poole, 1994). Our theoretical themes grew and changed with continued data collection, analysis and literature review. Data was analyzed alongside data collection. Initially in the early phases of the research, the two concepts
of structures and agency by Giddens (1984) were drawn upon to guide data collection directing us to understand the normative order of the CHW practice during the fieldwork. We also drew on the work of Barley (1986). We sought to address questions such as: how did CHW’s actions reproduce their work structure? How did HSAs draw on the structures for their actions?

Continued data collection, analysis and further literature review revealed that it would be important for us to incorporate Urry’s (2000) ideas of mobilities to understand technology and work practice transformations. With later reading, it became clear that technology can also subject work practices to transformation (Labatut et al, 2012; Markus & Silver, 2008). We examined our interview transcripts and field notes and grouped data with similar experiences and meanings into codes and later identified themes and concepts from the data relating to the use of the mHealth system, including themes such as: Work practices, their normative order, role of human agency and technology agency, emerging mobilities and the relationship between mobilities and work practices. We also reflected on the themes and related them to the data to account for their relationship with the data. These themes were related to our theoretical basis when we developed the study’s reflections.

Presentation of findings

We highlight HSAs’ reflections of how work was previously organized and changes with the introduction of the mHealth system.

Organization of work

The Ministry of Health (MoH) develops structured activities for HSA programs aimed at primary healthcare provision in communities. Such activities include: mandatory home visits to follow up clients, treating and educating communities. HSAs follow guidelines on paper registers and either do their work individually or jointly with colleagues and village health committees (VHCs) depending on workload. We report on two main programs described below.

The Community Case Management (CCM) program focuses on childhood illnesses with activities such as treating children aged two months to five years for simple illnesses like cough, diarrhea, and fever. More complex health cases and children below two months are referred to the health facility. Immunization exercises occur in villages and at health facilities. Community education is done jointly with colleagues and VHCs. Village sanitation inspections and home visits occur in over 150 households per HSA. All activities are recorded in registers and reported monthly to the Ministry of Health.

The Community Based Maternal and Neonatal Heath (CBMNH) program addresses challenges associated with pregnancy and early infant life. It involves conducting at least three home visits to expectant, post-natal mothers and infants. HSAs used registers to guide these visits. HSAs must refer all expectant mothers with danger signs. Child growth monitoring, health education, HIV testing and counseling are other activities conducted in homes or the village clinic. All are recorded and reported monthly.
In addition, the logistics program complements the two programs. HSAs make monthly logistics requests on paper forms and submit them to the HSA coordinator, who aggregates these requests and submits a report to the health facility In-charge, who submits a request for the health facility’s logistic needs to the District health office every month.

Each of the two programs was performed by six of the 12 HSAs. Following the implementation of the mHealth system, the two programs were combined making all 12 HSAs work on both the CCM and CBMNH programs.

“All the programs are now combined on the phone which means that a single HSA does the activities from all the programs. At first those HSAs that focused only on CCM, were seen as mere growth monitors by the community. The incorporation of CBMNH requires all HSAs to have drugs. Their responsibility was elevated to incorporate treating simple illnesses. And the ones that did not get phones were asking me when they would get phones. They felt they were missing out on the opportunities the ones with phones had. They did not feel at equal measure and saw their colleagues with phones as more professional-like…” (HSA coordinator)

HSAs reflected on how work was conducted before and after introducing the mHealth system as presented below.

Care related work

Care related work was mainly attached to the CCM program. It was organized and performed by HSAs following guidelines on paper registers. HSAs are trained to treat some illnesses like; malaria, cough and diarrhea and refer patients to health facilities. In practice, patient treatment and referral depended on the HSA’s analysis of information s/he recorded in the paper forms. This took over 30 minutes and occurred at the village clinic or an individual’s home. One HSA narrated:

“From the training we gained skills to assess danger signs in infants. We have paper registers which we still use sometimes. They have the questions we ask... After an analysis, we decide to either refer an infant to a health facility or treat the baby if they simply have a cough, fever etc...” (HSA)

Presently, paper protocols were duplicated into the mHealth system and HSAs enter similar information. They replaced paper forms with the mHealth system due to its quick assessment of data leading to fast decisions on treatment or referral. HSAs take about 15 minutes attending to a patient with the mHealth system. Upon data entry, the HSA gets an immediate diagnosis and recommended protocols to follow while treating or counseling a patient. Two HSAs narrated:

“...We are following the same protocols, but the system helps us make decisions on what course of action to take. It simply states whether to refer a pregnant woman or counsel her following a particular form. It even reminds me what questions to ask which we honestly sometimes forgot. We used to carry around many forms, but we now just carry portable phones.” (HSA)
“The phone offers a holistic approach. Not only one diagnosis is conducted but it is used to manage and identify other conditions... I am more equipped to address health challenges and I feel more competent now in my job. Also, with the phone you cannot skip questions. This was very possible with the paper forms. For example, when reviewing a child, you might forget to ask questions about ear infections, but this cannot be skipped in the phone...The precise nature of the system allows for reaching precise conclusions...the right diagnosis, treatment etc. This helps reduce the number of visits to the health facility hence reducing the workload of health providers because all action is taken in the field and only those that need to visit the health facility do.” (HSA)

Besides using the decision support system in care, HSAs developed other uses. For example, utilizing the phone’s torch light at night when attending to patients and the timer to assess infants’ breathing. Work also always continued with the mHealth system unlike with paper forms whose delivery was sometimes delayed.

**Work related to data practices**

Data collection cuts across all programs to facilitate planning, supervision and monitoring of HSAs’ field activities. Monthly paper reports are still physically delivered to supervisors as directed by the Ministry of Health.

“... We still record activities on paper forms because the Ministry needs these reports. We have so many paper registers, it is tedious. We then summarize the daily paper entries at the end of each month into a monthly register and submit it to the HSA coordinator. The HSA coordinator then submits a summarized report from all HSAs’ reports to the health center In-charge who then submits it to the District Health Office.” (HSA)

Feedback is mandatory from supervisors but is seldom given. In a group discussion one HSA said,

“We never hear from the ministry. We don’t get feedback from the reports we send. They are there, and we are here in the field...” (HSA)

With the mHealth system, captured data while examining a patient is simultaneously reported into the system’s server skipping all organizational hierarchies. Paper reporting as required by the MoH continues alongside system reporting by Organization mHealth. HSAs however complained of an increased work load from double data reporting. One HSA narrates,

“...when we are in the field, we are required to use our phones by the implementing partner because if we do not they will take them away, yet they help us in decision-making...they see when we enter data and question when we do not. We prefer to use the phone in the field. And at the end of the day, we retrieve the information from the phones and then record it into our daily activity registers.” (HSA)
Preference to use the mHealth system in the field over the paper forms was due to it enabling quick decision-making when diagnosing patients. The app has replaced paper use in the field.

Communication practices

Generally, communication of events in the field to superiors is still done with monthly paper reporting. Requests for logistics were still communicated through monthly paper forms. Additionally, word of mouth among HSAs and the community was used to communicate during weekly meetings and in the field. Impromptu communications were sometimes done over the phone. Immunization and child growth monitoring days at the village clinic were also used to pass on information to villagers who in turn were urged to spread similar information to their neighbors. Information on important events was and is still written on the village clinic walls, as in Figure 2.

![Figure 2: A communication written on a village clinic wall. “Tonse sikero tibwere miwa pa 23 September mwezi wa mawo tidza twere pa 27 October.” Loosely translated as “Let us come together on the 23rd September and the 27th October.”](image)

Also, ten volunteers representing different villages make up the Village Health Committee. HSAs routinely meet this committee to discuss health concerns, mobilize communities and utilize them to relay information to communities. Village chiefs are also involved to announce vital information in communities.

With the mobile phone, communication is facilitated to different groups across the field and the health facility. To community members, communication can be done over the phone although it is expensive. Therefore, previous communication practices continue. The system captures individual’s contact details that HSAs use to follow up with patients. With the Village health committee, calls are made to ascertain the organization of work activities in communities.

Among HSAs, communication improved reaching each other whenever need arises. They created a WhatsApp group allowing constant communication and removing dependency on their coordinator to pass on information. One HSA narrated:

“We have a WhatsApp group now and we share experiences of what we have found interesting in the field, we make inquiries and seek assistance from colleagues. It is easier to communicate now…We all work in catchment areas far
Communication patterns with superiors become more direct surpassing previous bottom up flows through organizational hierarchies. This is because the system affords frequent field updates. HSAs also communicate their needs more often and logistics requisition is a case.

“A Health Surveillance Assistant sends a message to the ministry requesting logistical supplies. The ministry then sends me a message to check and organize for the HSA to receive the drugs. I check our drug store to see if the drugs are available. Then I send a message to the ministry that such and such drugs demanded are available. The ministry then sends the HSA a message confirming the availability of the drugs at the health facility drug store for pick up or their absence and requests the HSA to wait for the next delivery. Honestly they still deliver drugs only on a monthly basis and not when we demand for them but at least it is faster now to know what is available and what is not especially for HSAs away in the field.” (HSA coordinator)

The mobile phone also facilitates communication for consultations with health personnel. The short vignette below from one of the authors illustrates this.

It is 3pm at a rural health facility in Zomba, I am conducting an interview with a HSA who is today having duties at the health facility. We are almost through with our interview and a child comes calling the HSA informing him of a patient in need of urgent attention. As he asks me to pause our interview, a lady rushes into the room and asks him to come right away. “Dokitari (doctor), my daughter is very sick” she says in Chichewa which my colleague interprets. He rushes out and finds a girl laying on the floor covered with a thin shawl. He bends over as he reaches out to her neck to check her fever and rushes to another room. He comes out and immediately rushes to some of the other offices and realizes the doctor is not around. He gets his phone and immediately makes a call. From the conversation which my colleague interprets, he is informing the doctor that there is a patient in need of immediate attention. The doctor is a couple of hours away but is now on his way back after the notification and tells the HSA what to do in the meantime. The HSA paces around, goes into another room and comes out with a syringe, thermometer and gloves. This time he takes her blood and the mother helps him hold her daughter’s arm. “I will take her blood to test for malaria while we wait for the doctor so that when he comes, we know what we are dealing with. We should also take her to a room”. He reassures her mother.
The narration depicts the HSA intervening in a situation in the absence of professional medical personnel. His phone aids communication between him and the doctor instructing him on actions to take.

**Mobilizing and coordination practices**

Coordination of work activities across the field and the health facility often follows formal procedures developed by HSAs and their supervisors. It continues to involve plans developed with various networks depending on the activities’ location. For instance, with immunization exercises, the HSA supervisor coordinates and allocates tasks within HSA blocks. Some blocks stay to immunize children at the health facility and others conduct field activities. In the field, plans for activities like growth monitoring of infants are arranged with Village Health Committees (VHCs). HSAs’ catchment areas are vast and VHCs coordinate communities for events. HSAs in need of support would engage the HSA coordinator to mobilize other HSAs’ assistance.

Activities started to be coordinated over the phone, for example, organizing home visits with expectant mothers and informing VHCs of events to mobilize communities. HSAs cited this as time saving and efficient in the fast coordination of field activities. Coordination of activities with colleagues is also done in a WhatsApp group.

“We have a designated day we meet in the week and on this day all HSAs meet to draw plans of their activities and those that are going to be done together with colleagues. But now we do not have to wait for Monday to organize, plan or ask about something. With these phones..., we call to clarify certain aspects of work that need to be cleared...” (HSA)

**Collaboration in work**

Joint endeavors are undertaken to accomplish some big tasks like immunization, child growth monitoring, and community education. VHCs assist with community mobilization in outreach activities and the HSA coordinator was responsible for assigning joint work to teams/blocks. These collaborations are currently arranged over the phone. Joint tasks can be organized through WhatsApp eliminating the HSA

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1 HSAs attached to a health center are divided into groups referred to as ‘blocks’. These blocks take turns working in the field and at the health facility. Depending on the amount of work, the blocks also help each other both in the field and at the health centers.
The coordinator’s role. Calls eliminate previous physical movement for HSAs, easing and quickening collaboration arrangements.

“Sometimes when a HSA is in the field, there could be a lot of work to do and he/she calls the coordinator to find out if there are some HSAs to assist him/her. In that way it is easier and quicker to identify who to collaborate with ... The villages are far, and you cannot simply walk to another HSA’s village to find out if you can work together. Instead, you call the coordinator to see if such an arrangement can be made. Sometimes the HSA coordinator also has to call other HSAs if they are not at the Health facility to see if they can assist you in the field.” (HSA)

Supervision

In the past, HSAs’ supervisors solely depended on monthly reports of aggregated daily activities physically delivered to the HSA coordinator. It was the only way superiors got to know what was done in the field. Now, the HSA coordinator currently has more access to information about field activities because, as HSAs attend to patients, this field data is captured by the system. This makes work activities visible and immediately accessible for follow up by supervisors. Consequently, HSAs increased their work effort.

“Before, we only used registers that were tallied monthly by HSAs and delivered to me. From their reports, I make a report of all their work and submit it to the health facility in-charge, who then sends it to the district. Now with the phone, data entered goes directly into the implementing partners’ servers and it shows how much work HSAs do. If there is less data entry, it could imply that the HSA is not working... So, the Implementing partners get in touch with me to follow up on such cases and find out whether it is a case of a HSA not working or there are other reasons for why data is not showing up from an HSA’s phone.” (HSA coordinator)

Discussion

In this paper we have taken a mobility perspective to analyze the relationship between technologies and the social order of work. This develops previous related work on the relationship between technology use and work by exploring the motion in the social organization of work. Work structures are often presented as stable (Giddens, 1984; Orlikowski, 2000) unless influenced by human agency. Urry (2000) however argued that structures are not stable and involve various elements (human and non-human) that interact to create feedback loops. He calls for a critical understanding of the complex iterative processes that may undermine normative accounts and induce the emergence of new orders. We discuss the three mobilities presented by Kakihara and Sørensen (2002) and introduce social mobilities to expand their categorizations of mobilities as they emerge from our empirics. See Table 2 for a summary.
Table 2: Different mobilities identified, adapted from Kakihara and Sørensen (2002), with new dimension of social mobility

<table>
<thead>
<tr>
<th>Dimension of mobility</th>
<th>Example from empirical research</th>
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</table>
| **Spatial**           | - HSAs live more networked lives through communicating on their phones. They are no longer geographically dependent to organize, collaborate, mobilize, and consult with colleagues and health personnel in work.  
|                       | - WhatsApp group keeps HSAs connected across the field.  
|                       | - Online data reporting skips physical organizational hierarchies going directly to the organization’s servers and MoH. This facilitated supervision of work. |
| **Temporal**          | - Replacing paper protocols with the mHealth system due to the system’s quick assessment of data leading to faster decisions on treatment or referral  
|                       | - 30 minutes to assess a patient with paper forms and only 15 minutes do the same with the mHealth system.  
|                       | - Direct communication with superiors surpassing previous hierarchies when requesting for logistics.  
|                       | - Faster communication among colleagues and health personnel in case of consultations, activity mobilization and coordination |
| **Contextual**        | - Daily interactions bypass protocol to enable immediate logistic requests from the MoH and in return resulting in responses and traceable requests  
|                       | - HSA coordinator bypassed to arrange collaborations with colleagues. These interactions also allow immediate responses and follow up in the WhatsApp group. |
| **New dimension**     | - “…At first those HSAs that focused only on CCM, were seen as mere growth monitors by the community. The incorporation of CBMNH requires all HSAs to have drugs. Their responsibility was elevated to incorporate treating simple illnesses. And the ones that did not get phones were asking me when they would get phones. They felt they were missing out on the opportunities the ones with phones have. They did not feel at equal measure and saw their colleagues with phones as more professional-like…” (HSA coordinator)  
|                       | - Feelings of competence on the job as they use the mHealth system |
Spatial mobility

Spatial mobility has several aspects such as the increased human geographical movement of objects, space and symbols like sound, images and information that evoke complex patterns of interaction (Kakihara and Sørensen, 2002). In our empirical research, we identified geographical mobility as an aspect of spatial mobility. It refers to humans’ independence from geographical constraints in movement. HSAs live more nomadic lives but with reduced physical movement as they gain more interactional mobility over time and space through their mobile phones (Kakihara and Sørensen, 2002). Phone communications cut back on geographical dependence and previous physical movement required for home visits, organizing, planning and mobilizing work, seeking collaborations are sometimes forgone. With communication affordances on their phones, communication practices changed with less dependence on word of mouth and paper reports. Mondays at the health facility are no longer the only days to plan and organize work activities. Physical presence was no longer necessary to coordinate with VHCs to mobilize communities for health events.

As geographical dependence decreases, space mobility increases. Mobile phone communication has melted the distance between here and there in HSAs’ work. HSAs’ appropriation of mobile phones led to the creation of a virtual community on WhatsApp, based on a shared practice, knowledge experiences and common work interest (Essén & Yakhlef, 2012). HSAs are thus becoming independent workers that do not necessarily depend on physical arrangements made by the HSA coordinator to get assistance from colleagues. Consultations with health personnel are also happening on their phones, enabling knowledge sharing across space; an example in the vignette indicates this interaction and knowledge being passed on to the HSA from a professional medical staff. This suggests that the mobile phone itself is an enabler of mobilizing activities in space supporting HSAs to live more networked lives. It is a technological consequence (Hutchby, 2001) where the mobile phone affords HSAs virtual spaces of interaction and connectivity.

We further identified information mobility as part of spatial mobility. Mobile phone communication grew, and the system became a place where immense amounts of information traveled beyond the health facility and communities. As technology structures made of paper protocols inscribed in the system (Orlikowski, 2000) are enacted in care, data practices were altered to bypass traditional reporting hierarchies. As patients are attended to in communities, their data is simultaneously captured in the organization’s database shared with the Ministry of Health. However, it is important to note that previously held data reporting practices persist as Organization mHealth, an external player, cannot dislodge them from the institution of the Ministry of Health. Changes are happening at the ground level with HSAs opting for the mHealth system first and later entering similar data into their paper registers. An aggregated paper report is made from the paper registers and submitted as previously.

Temporal mobility
In addition to spatial mobility, we identified temporal mobility in our empirical work. It occurred through speeding up and saving time in especially the care related work of treating and referring patients. The mHealth system offers HSAs quick automated recommendations for action, making it possible to attend to more patients within a shorter time. Consequently, HSAs replaced paper protocols with the mHealth system in the field and duplicated paper reports for the Ministry of Health. There is also an element of temporal interpretation in the sense that HSAs realized a potential to plan, organize, collaborate and consult across geographical spans through quicker communication enabled by their mobile phones. Therefore, the temporal order of getting work collaborations done was re-arranged with HSAs bypassing their coordinator and forgoing the weekly meeting day to directly communicate, arrange inquiries and collaborations among themselves on WhatsApp. Logistic requests are made immediately the need arises and home visits are arranged over the phone to manage big catchment areas with more flexibility and less temporal constraints. The mHealth system thus restructured the structural and interpretive framework of the temporal order and action (Kakihara & Sørenson, 2002). This restructuring presents risks associated with mobilities of work and changing work relations. HSA coordinators lost some roles and managing new networked work relations from a distance required new skills. There is need for ‘soft skills’ (D’Mello and Sahay, 2007) like communication skills on the mobile phone with the work network. Managing and maintaining connections among the network is however costly for HSAs.

**Contextual mobility**

There was also an emergence of contextual mobility. HSAs’ interactions are predefined within a context of ‘in what way’, ‘in what circumstance’ and ‘towards what actors’ they occur. For example, during drug shortages, all HSAs made monthly paper requisitions. The HSA coordinator aggregated these demands and submitted them to the In-charge who made a general facility logistics request to the District Health Office. The mHealth system afforded HSAs with a new modality of daily interaction enabling immediate requests that replaced monthly logistic demands. Consequently, logistic requests are accompanied with obtrusive-persistent interactions prompting immediate responses to HSAs’ SMS logistic demands from higher authorities. These interactions become persistent as traces of logistic requests are left behind captured in the system. The system freed HSAs from contextual constraints of interaction that occurred monthly with the mediation of the HSA coordinator, In-charge and the District Health Office. It also altered communication practices, and the mHealth system created a new social reality where hierarchies of social order were broken.

Another form of contextual mobility is realized through the virtual space on WhatsApp in which HSAs connect with each other in distant places. HSAs in need of assistance make their requests known in this group moving away from involving the organization of their Coordinator. Consultations and collaborations made through the WhatsApp group are obtrusive-persistent as they enable immediate responses and possibilities for follow-up. Contextual constraints like having to make consultations only on Mondays at the health facility or the village clinic for community members are therefore reduced in
HSAs’ interactions. They are afforded through virtual spaces where everyone is accessible.

Social mobility

We also identified a new form of mobility that Kakihara and Sørensen (2002) do not cover in their descriptions of mobilities associated with technology. Social mobility was observed to occur with shifts in social position and status among HSAs and as seen by the community. Social mobility has similarly been linked to a movement in social status and position in society (Sheller, 2014; Glass, 1954; Lipset and Bendix, 1959). There were no economic gains among HSAs, but a growing sense of status when they used the mHealth system. With the mHealth system, HSAs reach precise diagnosis, treatment and make referrals. This impacted care practices with HSAs taking on more treating roles and responsibilities from the combined tasks in the CCM and CBMNH programs. As HSAs enacted the structures and protocols in their mHealth system, the community built a more ‘doctor-like position’ view of them in their engagement with patients. Instructions from health personnel and colleagues through their acquired mobile phones enable HSAs to conduct more treatment and deal with health challenges in villages.

Their structural positioning in the health system and short training, established HSAs in an assistant position to perform simple tasks in villages. These created constructions of meaning (Nicolini 2013) attached to being assistants with modest roles of referring patients and treating simple illnesses. The mHealth system amplifies this position by affording HSAs with more potential to treat patients using precise courses of action. These roles are likened to doctors’ tasks, and the community does not view HSAs as mere assistants to the formal health system but with almost equal roles as professional medical personnel. HSAs do not refute being called ‘doctors’ by community members. In the vignette, we see a mother entrusting the health of her daughter to the HSA as he is instructed on the phone by a doctor. HSAs expressed growth and an improved level of competence in their work as they used the mHealth system. However, Mukherjee (2017) in a similar study with CHWs in India using a Mother and Child Tracking System found that data entry was used for surveillance and control by supervisors. Consequently, CHWs felt that their roles were undermined. The same system led the community to lose its credibility in their CHWs as private data became open.

Notably, among this group of health workers, technology use in their practice opens dialectics in social status creating social mobility. In this study we saw that HSAs without the mHealth system did not consider themselves with equal measure to those that had it. The mHealth system enabled HSAs to perform care practices easier and utilize the mobile phone affordances to communicate, mobilize and collaborate in their work. What we see here has also been referred to by D’Mello and Sahay (2007) as existential mobility where workers evaluate their social positions in work. In our case, the recipients of care services, the community, also evaluated HSAs’ social position. Those with the mHealth system are enthusiastic about the prospects of the system although increased surveillance creates agitation. HSAs without the system seem to doubt their position.
Implications

This paper investigated how normative order in the work practices of health surveillance assistants (HSAs) is destabilized. We used the mobilities lens to identify how work structures shift when they are mediated by a mobile health system. We identified spatial, temporal, contextual and social mobilities to emerge as HSAs use an mHealth system. To place this discussion into context, we return to our main arguments and discuss the implications of the study.

First, our study adds to previous studies on technology and work transformations by emphasizing that a sole focus on human actions and interpretations (Barley, 1986) underplays the material in work transformations. We redress the balance by using a mobilities perspective that envisions a distributed agency in both humans and non-human actants (Urry, 2000; Hernes, 2014; Sheller, 2014). We have seen for example that through facilitating connectivity, the mobile phone has agency (Labatut et al, 2012; Monteiro & Hanseth, 1996; Latour, 2005). Additionally, the intentionality of HSAs’ agency is shown to align this connectivity with their work interests. We therefore look beyond the deterministic approaches (technology and social) and understand the interactive process of both social (work environments, structures and people) and technology actants. Accounting for the role of technology and the social in work transformations is complex (Monteiro and Hanseth 1996) and therefore each actant is not simply given equal status and measure. We account for changes according to responsible agency. In this way we get a more dynamic view of agency in relation to work transformations.

Second, we show the importance of examining power relations in the broader social structures of community health work. An emergent aspect here is how power relations are part of understanding how technologies influence mobilities of work. Leornadi and Barley (2010) are concerned that a focus on the here and now of practice makes it difficult to address pre-existing social structures and how they shape technology use. We take a historical perspective as suggested by Nicolini (2013), Orlikowski (2002) and Labatut et al (2012) to understand the context and how it influences existing orders of data reporting. The Ministry of Health has had predefined data collection rules that still stand despite outside interference from Organization mHealth. Data must still be reported on paper forms every month. The ministry does not however see that HSAs replaced paper forms with the mHealth system in the field. This relates to what Urry (2000) describes using the metaphors of ‘gardening’ and ‘game keeping’ in society. In gardening states, power relations try to maintain structures as stable and paralyzed while in game keeping states, power relations allow free movement in structures. As the ministry tries to garden working routines and structures, technology loosens this power by allowing HSAs to use a single mHealth system in this previously carefully husbanded work. However, it should be noted that information mobility has also fostered a more stringent form of surveillance breaking away from the lax supervision previously done through monthly paper reports. Daily data capture has made it possible for low performing HSAs to be questioned. However, there is no information feedback to HSAs regarding reported data.
Third, we also contribute to understanding how mHealth systems can be managed among community health workers. HSAs’ use of the mHealth system has especially created changed work relations that have been transferred from physical spaces to virtual spaces. This requires a new understanding on how to for example supervise workers that have become more independent. D’Mello and Sahay (2007) suggest the development of soft skills like communication skills to manage growing virtual work networks. Shifts in social status also need to be managed to maintain work expectations for both the community and the community health workers.

Conclusion

This study adds to our understanding of mobilities by extending accounts that richly describe the work context of HSAs. We add to Urry’s (2000) agenda for the development of a ‘sociology of mobilities’ by making thick descriptions of the various kinds of mobilities that characterize their work. Kakihara and Sørensen (2002) take on the mobility concept and attempt to describe three kinds of mobilities in ICT mediated contexts. Using their categorization of spatial mobility, we identified two distinct aspects in HSAs’ work. HSAs’ interactions were stretched over time and space making them less dependent on geographical movement. In addition, information mobility occurred, skipping traditional reporting orders. Temporal mobility allowed more efficient and quicker delivery of primary healthcare services to villagers through the mHealth system. Contextual mobility allowed new modalities of interaction between HSAs and those higher up in the health system hierarchy.

Kakihara and Sørensen (2002) however do not explore social mobilities linked to work identities that we describe in the study. We see that as HSAs enact the structures or care protocols in the mHealth system, they destabilize other practices in their work. This is mainly because HSAs start to collectively utilize the affordances of the technology to push their work interests. Urry (2000) urges a better understanding of the iterative process between structure and agency. Our observation is that mobilities in HSAs’ work do not simply occur with the emergency of technology in work. In this case, technology is introduced with an attempt to imitate and continue existing work structures. However, social agency with the intention to make work quicker and better, utilizes technology affordances (mobile phone, mHealth system) in social relations across HSAs’ work networks which leads work orders to shift. Consequently, social agency eludes structural determinism (de Certeau, 2004). In conclusion, this study illustrates that although technology flows into the ‘gardened’ (Urry 2000) work of HSAs, mobilities occur mainly as social agency utilizes technology affordances. It is an entanglement of material and social agencies. By using the mobilities lens we contribute to Walsham’s (2005) call to “letting a thousand theoretical flowers bloom” for understanding the interaction of human and machine agency in information systems and community informatics research. We suggest future research to aim at understanding how technology affordances or material features of technology influence the mobilities paradigm.
References


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Appendix 3: Paper 3

Bringing Visibility to Community Health Work with mHealth Systems: A Case of Malawi

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Abstract. The paper explores how technology created visibility of work and its implications. Places create social meanings and significance in which work is situated. Community health work is mostly confined in places of physical settings for many mobile and distributed workers. As their work contexts stretch in place and far from other actors, the visibility of their work becomes blurry. An in-depth interpretive case study of a mobile health system designed to support decision-making for Community Health Workers in maternal and infant care in Malawi was used to unravel how mHealth systems make their work visible. We uncover work aspects like; work interactions, collaboration, coordination, surveillance among others that flow through place and space in our empirical findings. Each relates to work visibility/invisibility creating both theoretical and practical implications.

Keywords: Visibility · Place · mHealth systems · Community Health Workers

“...work has a tendency to disappear at a distance, such that the further removed we are from the work of others, the more simplified, often stereotyped, our view of their work becomes.”

1 Introduction

Community health work has thrived for decades. The Alma Ata declaration backed this work to support primary healthcare in underserved communities with low human resource [2]. The term Community Health Worker (CHW) covers a generic type of community based workers known differently in various countries [3]. A widely accepted definition was proposed by the World Health Organization [4] as, “Community health workers should be members of the communities where they work, should be selected by the communities, should be answerable to the communities for their activities, should be supported by the health system but not necessarily a part of its organization and have shorter training than professional workers.”

They are trained as health aides to conduct various tasks in communities. For example; sanitation inspections, home visits, treating simple illnesses, facilitating
maternal and child health, collecting data among others. The tasks are performed with varying degrees of breadth and depth across countries [4]. Notably, CHWs remain lowly recognized [5, 6] with their work backgrounded in communities. Yet, this work input backs formal health systems. This invisible work has important consequences for CHWs and others involved. Making CHWs’ work visible creates community recognition, an incentive for CHWs [4]. It also motivates Ministries of Health to support and sustain CHWs. Visibility of work and actors has been implicated in influencing recognition, control, social identities and power relations according to social places and subjects [7, 8].

This paper does not cover the full range of services provided by CHWs. We study a group of CHWs in Malawi, referred to as Health Surveillance Assistants (HSAs). HSAs live with local communities, providing similar services in maternal and child healthcare. This work is currently supported by a mobile Health (mHealth) system developed to aid decision-making while attending to infants and expectant mothers.

HSAs’ work is conducted in their catchment areas far from their supervisors and other actors at health facilities, the district and Ministry of Health. Supervisors often see finished work products through indicators in reports and changed community conditions. This work becomes invisible to differently placed individuals who only see it through some indicators [1, 9]. Work contexts, practices and categorizations from a distance are often narrowed and simplified. This can be consequential for system development and implementations. We seek to address the following question;

How does the introduction of technology influence the visibility of the work of community health workers?

We address this question by combining two bodies of theory based on the notions of ‘visibility of work’ and ‘place’. With place, we take the two time-space configurations of place and space that characterize the temporal and spatial dimensions in which HSAs’ work is constructed. With visibility, we learn how work situated in different places may become visible or invisible. The mHealth system we describe is part of an initiative to strengthen HSAs’ work delivery in maternal and child health. We undertake an interpretive case analysis.

2 Theoretical Background

2.1 Place

Place elucidates how social meanings and existential significance are related to places—physical, social and electronic [10]. Places embody social and cultural milieus that shape and are shaped by recursive social actions [11–13]. Place and time are temporal and spatial environments in which individuals make sense of their interactions and work organization [14, 15].

Place and space should not be equated [13, 14, 16]. Space is an abstract and infinite expanse in which people and ideas freely move with potential for newness and growth [15]. Space is freedom [17] and a container for place, whose meanings are shaped by what one does in them [18]. Place on the other hand relates to a person’s sense of boundedness, being and contented belonging where tradition prevails [14].
In place, social activities and interactions occur in physical settings situated geographically where time and space are intertwined [14]. In Giddens’ account [14], modernity broke away from locality, tradition and cyclical time associated with place in what he describes as time-space distanciation. The social world is homogenized, interactions lifted out of the here and now and the ties that hold practices in their place are dissolved in space. Space takes on an image of a uniform and infinite expanse in which people and ideas move freely promising generalizability of knowledge, freedom of movement, social independence and growth [15].

Place and space are socially constructed configurations of the time-space continuum and are interrelated [17, 18]. We attempt to understand their difference in order to examine physical presence, an absence of it and work visibility without presence. Noteworthy, ICTs have disembedding mechanisms separating space and time, creating absent actors but simultaneously extending locally specific social relations to different space and time contexts. Interactions can thus occur in placeless spaces [19].

HSAs’ work provides a subtle case in which work is predominantly contained in a physical world. Situated in their rural catchment areas, HSAs are mobile and distributed workers but seek work coherence. However as their work is predominantly bound in place, it may become invisible to others differently placed. Suchman [20] notes that, “the relation between our own social location and our views of others sustains boundaries among organizational actors, including boundaries between professional designers of technology and technology users”. Implying that if a place of work is territorial, it can become blurry and black boxed by outsiders including technology designers who do not know the details of the territory but enter work contexts to build technology supporting systems. Place therefore creates a basis for our understanding of how work may be visible or invisible to those differently placed.

2.2 Visibility

Visibility denotes legitimacy and rescue from obscurity or exploitation [9]. Work invisible to formal requirements analysis, is crucial in representing effort levels and subtleties [9]. Making work visible is crucial in motivating and determining the significance of events [21]. But what exactly is work and whom should it be visible or invisible to? Star and Straus [9] describe how domestic work was for decades not considered work and invisible to family and workplaces. They stress the “contextual importance” of what work is and what may or may not be visible citing a scene from a film, “The Gods Must be Crazy”. The scene is between a western ecologist studying elephant migration and a !Kung tribesman curious about what the ecologist does. “The !Kung man asks the ecologist what he does to which he replies, he is an ecologist. Seeing a puzzled look on the !Kung man’s face, he narrows it down to the activity: “Well, actually, I walk around all day behind elephants and pick up their dung.” The !Kung man’s expression changes to pity mixed with amusement. Lacking a mutual context, only plain action is visible, which is of great importance in the scientific world, yet preposterous to the !Kung man. Suchman [20] describes it as work getting black boxed by those differently placed.
Work becomes invisible in three ways [9]. First, in work where the actor is seen as a non-person, the work product is visible to both employer and employee. The employee however is invisible due to power relations between employer and employee. For example domestic workers’ legitimate work is defined by employers and employees are invisible. This creates complications especially that certain work processes may get excluded and misrepresented in system development and implementation.

Secondly, work becomes invisible when it is disembodied background work [9]. Hamson and Junor [22] also refer to this as “invisible, routine work”. Workers are quite visible but their work is demoted to background expectations. For example, nurses are visible in healthcare but continue to struggle to make their work visible. Their work is expected but is backgrounded and invisible by virtue of routine and social status. Such work often supports others and CHWs in rural communities support formal health systems. Suchman [20] narrates the articulation work of air traffic controllers who improvised communication strategies outside standard procedures to maneuver the orderly arrival and departure of planes out of their sight blocked by buildings. This articulation work although relatively easy to uncover, is not registered yet it is necessary. Such background work is vulnerable in systems design especially because it is diffused through the working process, partly due to the social status of workers and also because it requires so much articulation work.

Thirdly, by abstracting and manipulating indicators, both work and people become invisible when; (1) formal and quantitative work indicators are abstracted from work settings and they become the basis for decision-making especially by those who do not see the work first hand. And (2) when work products are commodities purchased at a distance from the work setting making both work and workers invisible [9].

But should all work be visible? Much invisible work remains so for various reasons [9]. For instance, workers hide flaws. For technology design, the less of users’ behavior systems encode, the less functionality they can provide. The more behavior they encode, the more they may prescribe human activities [1]. Therefore, for information systems, forced representations of work may antagonize work processes.

Technology is implicated with visibility. It enlarges the field of the socially visible, liberating visibility from the spatial-temporal properties of here and now [8]. We assess the mHealth system’s implications on work visibility.

3 Research Approach

The research approach aimed at developing a detailed understanding of work processes among HSAs. We therefore undertook an interpretive case study [23] to achieve this. The case was selected because it represents the work of mobile and distributed workers in different physical settings currently using a mHealth system.

3.1 Research Context and Case

Malawi is a developing country in southeast Africa with over 17 million people [24]. This is one of the highest population densities in sub-Saharan Africa. It is among the
poorest countries in the world with 85% of its population in rural areas [25]. Among its many challenges, is its poor health system laden with a heavy disease burden [26]. This is evidenced by a high disease prevalence of; malaria, HIV/AIDS, other tropical diseases, high childhood and adulthood mortality rates.

Maternal mortality in Malawi is still considered the highest in Africa [27] at 675 births per 100,000 and infant mortality at 66 per 1000 live births [25]. Universal health coverage is low and the country still has a struggling healthcare system. For example, human resource challenges cannot meet Malawi’s health demands. The few medical personnel available are often distributed in urban areas.

In 2005, Malawi implemented an Emergency Human Resource Plan (2005–2010) to increase its health workforce [27]. By 2011, Malawi had over 12,000 HSAs linking communities to the health system [28]. These become the largest health workforce for the country offering both preventive and curative health services [5]. For maternal and child health, HSAs perform activities such as; educating, treating, referring and follow-up cases in communities. They are deployed in rural communities where professional health workforce is low and these under-recognized but important health workers endure most of the additional work pressure.

**What and Where is HSA’s Work?**

HSAs core work involves disease prevention and extending primary healthcare services to local communities. The health facility acts as a focal point of healthcare to community members in a catchment area. In this study, the catchment area serves 34,325 people. This catchment area is further divided into smaller catchment areas each with a HSA serving up to 10 villages, and an average of 2,286 people. HSAs work significantly in communities where they provide primary healthcare and link community members to the formal health system. A locally constructed structure- a Village clinic (VC) - in a HSA’s catchment area is a focal point for service provision. Community members come to the VC for immunization, treatment, education among others. A heavy workload requires collaboration with colleagues but HSAs also work with Village Health Committees in communities. Other activities like sanitation inspections, data collection, and follow-up exercises among others require HSAs to move around in catchment areas often walking or using bicycles.

HSAs are attached to a health facility, an average of 7.2 km away from their catchment areas. 12 HSAs are attached to the health facility we contacted. They make formal reports, get facilitation, training and organize their work at the health facility. Additionally, tasks like attending to patients, vaccinating women of reproductive age and children are assigned to HSAs by professional medical personnel in need of assistance. HSAs organize themselves in groups, often rotating their services in the community and at health facilities amongst these groups.

Their immediate supervisor is the HSA coordinator with similar duties. HSAs record daily activities in paper registers which they aggregate monthly. Monthly reports are physically delivered to the HSA coordinator at the health facility. The coordinator
aggregates all HSAs’ reports and submits them to the health facility In-charge. The In-charge makes a health facility report he delivers to the District Health Office and the Ministry of Health. However, daily work registers are stacked at the health facility. Apart from the HSA coordinator, all other superiors are differently placed in various physical and hierarchical places. They only receive aggregated reports on particular indicators from HSAs’ work and often give no feedback.

The Mobile System
Organization mHealth (pseudonym) developed a decision-support system on smart phones. The system is designed to facilitate HSAs’ decision-making. Existing paper protocols were integrated into the system to facilitate antenatal and postnatal care of expectant mothers and infants. The system goes through a step by step data capture of signs and symptoms which it analyses and gives a recommendation to either treat or refer patients. The data is simultaneously sent to the organization’s database shared with the Ministry of Health. Patient follow-up after an initial visit is crucial, as moving forward to a new section in the system, requires completion of previous sections.

3.2 Data Collection
Empirical data was collected with semi-structured interviews, observations and a Focus Group Discussion for two months in Dowa district. We visited 12 HSAs, 3 health facility staff and 4 community members. 6 HSAs were interviewed for a group’s perspective on their work. HSAs narrated their everyday work, where they conduct it, work interactions and experiences using the mobile system. Health personnel and community members also discussed their interactions with HSAs.

We also observed HSAs’ work in health facilities and communities. We combined observations with informal discussions to understand what HSAs said they did and what they actually did. This was done for a full understanding of their work and its interaction with the mobile system. We made field notes and recorded interviews.

3.3 Data Analysis
We started our analysis by reading and discussing emerging themes from collected data. Recorded data was transcribed from field notes and audio recordings to proceed with analysis. We moved from raw data by giving similar data codes to organize it. Then, we analyzed the coded data to generate themes with similar descriptions grouped as: HSAs’ work description, HSAs’ work location, social interactions and experiences with the mHealth system. We moved back and forth through the themes and transcribed data, to make sense of the data. We then related the themes to our theoretical concepts of place and visibility for further assessment. From this comparison, we generated interpretations for the study.
4 Findings/Discussion

The mobile system has driven some work aspects like collaboration, mobilization, data reporting and work organization previously bound by temporal or spatial constraints of here and now to be conducted in spaces. This impacts on work visibility as the next discussion depicts.

4.1 Work Made Visible/ Invisible with the Mobile System Implementation

Visibility Among Colleagues

HSAs work activities are physically bound in communities and the health facility that shape their work interactions [13]. One’s catchment area embodies locally specific activities and interactions in physical places of here and now. In communities, HSAs are highly mobile but seek sameness in work delivery across their distributed workplaces. Previously, the health facility was a common ground for HSAs to plan and seek assistance. The mobile phone has lifted these interactions out of the here and now of the health facility into space [15] affording work interactions, coordination and collaboration in space while sharing common interests and meanings [18]. An example is a ‘WhatsApp group created by HSAs.

“We have a WhatsApp group and we now coordinate some activities with each other there. We are very active in the group; we share interesting experiences and make inquiries amongst ourselves. We now do not have to wait until the weekly meeting or the monthly meeting at the health facility to do this because everyone is distributed in different geographical areas...we reach each other anytime on WhatsApp and if something is urgent, we call.” (HSA in group discussion)

The mobile phone affords HSAs with spatial features where group collaborations and inquiries occur. It liberates work from the confines of place and translates it into spatial integrations where HSAs interact. This accommodates knowledge sharing and work coherence across distributed physical locales. Locally specific social relations are dissolved to occur in placeless spaces without physical presence of colleagues creating visibility for work interactions occurring in a virtual space.

Visibility to Supervisors

The mobile system instantly captures fieldwork activities into the organization’s database. Work processes- the how, with whom and when- previously only in places of the community, become visible to supervisors. HSAs reported that data on how they attend to expectant mothers or infants in the community was immediately captured. Disembedded background work [9] formerly seen through monthly abstracted indicators become visible to contextually distanced supervisors at the District Health Office and Ministry of Health. Consequently HSAs focused on making their work visible due to increased control and surveillance. To HSAs, working more implied more registered work performance for supervisors to see, evaluate and appraise their efforts. Work processes were freed from places of the community and information entered by individual HSAs encompassed their work processes in electronic spaces (Fig. 1).
The HSA coordinator noted:

“Every field visit is accompanied with reporting whether we intend it or not. They (HSAs) are forced to do the work. Before, people were lazy but now they have improved. They can visit 10 expectant mothers in a day. That is good. If they do not, I can see that so and so is not registering any data in the system. I call them to ask what is going on. The phone has enabled me to monitor and follow up with what is happening in the field.”

Space denotes to freedom, a uniform expanse where people and ideas move freely [15, 17]. However, as HSAs work is lifted into this infinite electronic expanse, it becomes visible to supervisors and they are forced to work more due to increased surveillance. This raises the question whether all work should be made visible [9]. Traditional monthly reports did not entirely illuminate HSAs’ fieldwork processes as the mobile system does. Notably, HSA’s laziness is thrown out. Schultze and Boland [15] argue that space creates social independence but this is diminishing as HSAs feel more control and seek approval for their efforts by working harder.

Besides supervisors, HSAs’ fieldwork impacts in rural catchment areas also indirectly become visible to health personnel at the health facility. One noted,

“HSAs are the ones reaching out to expectant mothers in communities. The mothers tell us when they come here to the health facility, that they have been referred by so and so (a HSA). ...yes they do still refer patients but not as much because most times, cases are solved in the community. That mobile app is really supporting their decision-making which means more work is done in the field” (Community midwife Technician).

Health personnel reported having no access to the database or HSAs’ work in electronic space but insisted that reduced cases at health facilities indicated more impact in communities.

**Knowledge Visibility to the Community**

HSAs reported infant and maternal healthcare to require efficient knowledge to foster diagnosis and treatment. Patients are seen in homes or the village clinic. HSAs
traditionally used paper forms to register signs and symptoms, make thorough analysis and develop diagnosis. However, some acknowledged forgetting to ask some questions which affected diagnosis. With the mobile system, it is impossible to skip questions as interactions are standardized and continuation to another section requires completion of previous sections.

“...with the paper forms, sometimes we forgot to ask some questions. But with the mobile system app, you cannot go to the next level without filling in responses to all the various sections...we are able to properly assess various conditions and also give a proper diagnosis”
(HSA)

With the system, HSAs’ knowledge to effectively diagnose health conditions is made visible to community members who recognize them as knowledgeable village doctors. The HSAs’ social status and recognition increased as one noted,

“Our value has increased. The number of pregnant women one week after we received the phones went up. Now husbands are coming up to us and request we go to their homes to visit their expectant wives with the mobile phone. They see us with the smart phones and presume we are knowledgeable because they see the phone as a computer...With the phone we display our knowledge. For example the phone helps me to calculate the gestation period of a woman so I don’t come off like as if I do not know what I am doing.” (HSA)

Another HSA proudly added,

“...they [community members] do not even know the health center In-charge. They know me as the doctor because I am giving skilled health services...”

And a community member added,

“...our names are in that computer [referring to the HSA’s smart phone]. They enter our details so when I come back to the village clinic, they can trace my health information. They know what they are doing...” (Community member)

As HSA’s knowledge is displayed with the mobile system use, the health facility personnel’s identities slowly fade. Simultaneously, HSAs’ identity grows to a doctor-like level for the community. Community members sometimes consult HSAs physically distant, over the phone and are no longer limited to face to face interactions. HSAs’ knowledge is shared in space making it visible to communities across time-space spans. However with standardized care provision on the mobile system, other potential forms of knowledge like tacit knowledge gained through practice in patient care are underplayed. Suchman [1] warns that when every aspect of human behavior is encoded in information systems, they prescribe human activity.

**Work Needs Made Visible to Superiors**

HSAs’ traditionally made logistics demands from communities on monthly forms, delivered to the HSA coordinator who submitted them to the health facility In-charge and finally to the District Health Office. All interactions occurred in places of hierarchical structure. With the mobile system, it became possible to skip the hierarchies through instant messaging requests. This made visible HSAs’ logistics needs in communities to the Ministry of Health, prompting immediate responses. One HSA noted,

“Government now knows our needs whenever they arise. We send out our logistics needs anytime instead of the monthly forms and having to wait.” (HSA)
5 Contribution/Conclusion

This analysis has implications for ICT4D, Giddens’ agenda of place and visibility work. Place interacts dynamically with work, forming a sphere for shared meanings and interactions for HSAs. HSAs’ work requiring mobilization, collaboration and organization was mostly confined in physical places and obscured. The mobile system created space [14, 19] where work continued without physical presence. Noteworthy, place remains relevant for constructing some work aspects like patient treatment. This refutes Giddens’ [9] ‘phantasmagoric places’ logic where relations are between absent actors without face to face interactions. HSAs remained place-dependent and sought stability by situating patient treatment in places of the village clinic. Other activities like coordination and mobilization flowed into space. This implicated on visibility.

Practically, the movement of work from physical to technological spaces created more visibility in communities. This had implications like; facilitating work coherence, knowledge exhibition, work identity affirmation and increased work effort. However work interactions between HSAs and patients (expectant mothers and infants) were so standardized blocking the expression of other knowledge forms gained in practice. It raises questions for system design and implementation. How much work should be encoded in technology? How much work should be made visible? It is our view that approaches to system design and implementation understand work contexts and technology users to meet their objectives.

We have presented how HSAs’ work flows through the logics of place and space implicating on work visibility with technology intervention. We also found that work does not simply become place free as HSAs simultaneously sought work situatedness in place. The study demonstrates the significance of understanding place for various work actors and the implications of making work categorizations visible to differently placed actors with technology intervention. Our theoretical basis presents opportunities for perspectives that seek to discuss technological work representations.

References

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Appendix 4: Paper 4

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Appendix 5: Paper 5
