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NATIONAL UNIVERSITY OF IRELAND, CORK FACULTY OF BUSINESS AND LAW

DEPARTMENT OF BUSINESS INFORMATION SYSTEMS

A Holistic View of the Social and Technical Factors that Influence the Assimilation of an mHealth Tool in Developing Countries

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Thesis Submitted for the degree of Doctor of Philosophy in Business Information Systems

Supervisors: Dr Ciara Heavin and Dr Rob Gleasure

October 2018

Declaration

I declare that this thesis has not been submitted as an exercise for a degree at any other university. I declare that, except where duly acknowledged, this thesis is comprised entirely of my own work. I agree that the Library may lend or copy this thesis upon request.

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Emmanuel Eze

October, 2018

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Glossary of terms and Abbreviations

ANT	Actor Network Theory
CBSS	Centre for Basic Space Science
CHAI	Clinton Health Access Initiative
CMUA	Coping Model of User Adaptation
CR	Critical Realism
EMR	Electronic Medical Records
ESUT	Enugu State University and Technology
GT	Grounded Theory
HCWs	Healthcare Workers
HIS	Health Information System
HIV	Human Immunodeficiency Virus
iCCM	Integrated Community Case Management
ICT	Information Communication Technology
IMCI	Integrated Management of Childhood Illness
IS	Information System
IT.	Information Technology
I-TECH	Integrated Training and Education Centre for Health
KB	Knowledge Base
LGA	Local Government Authority
LMIC	Low Middle Income Countries
MCH	Maternal and Child Health
MDAU	Modular Data Analysis Unit
mDC	Mobile Data Collection
mDG	Mobile Diagnosis
mHealth	Mobile Health
MoH	Ministry of Health
MOU	Memorandum of Understanding
mP/E	Mobile Prevention and Education
mTM	Mobile Treatment
MVP	Millennium Village Project

NABDA	Natural Biotechnology Development Agency
OHE	Office of Health Economics
PATH	Partnership for Transferring Health System
PDA	Personal Digital Assistant
PGs	Parents/Guardians
PHC	Primary Health Care
PHI	Public Health Inspector
RHCWs	Rural Healthcare Workers
SD	System Developer
SM	Socio-materiality
SMS	Short Message Service
SOP	Standard Operation Procedure
TTAT	Technology Threat Avoidance Theory
UCC	University College Cork
UN	United Nations
UNESCO	United Nations Education, Scientific & Cultural Organisation
UNICEF	United Nations International Children's Emergency Fund
WHO.	World Health Organisation

Abstract

The integration of smartphones and mobile devices into healthcare systems has been proposed to address some of the physical barriers to healthcare delivery in rural areas of developing countries. This has prompted a number of intervention initiatives to develop novel mHealth tools for specific regions. However, despite all the research and the investment, there has been slow practical progress. This thesis attributes this slow progress to compartmentalised thinking and limited holistic exploration. In order to understand these problems, this thesis undertook a number of studies, i.e., a review-focused, a past-focused, a future-focused, and policy-focused studies to understand how an mHealth tool could be assimilated in rural areas of developing countries. These studies took place in the context of an mHealth app being explored for introduction to assist with the diagnosis and treatment of sick children under the age of five in Enugu State, Nigeria. Therefore, the objective of this thesis is *to create a more socially and technologically holistic understanding of the factors that influence the introduction of mHealth tools into rural areas of developing countries*.

First, findings from the *review-focused* study illustrate two key trends in existing research. Most strikingly, little research has looked at the role of patient-to-patient interactions. Furthermore, the interactions between system developers and the other stakeholder groups are notably under-represented.

Second, findings from the *past-focused* study indicate that, (i) at the *social-level*, there is a perceived limitation of services, human resources and a sense of exclusion from the urban health system; (ii) at '*material-level*, observations were made of the significant infrastructural and technological limitations that

discourage rural healthcare workers (RHCWs) and parents/guardians (PGs) from spending prolonged periods at the rural health centres; (iii) at the '*practice-level'*, there is the formal diagnosis treatment method practiced by the RHCWs in the midst of the PGs diagnosis and treatment practices and African traditional healing practices, and (iv) at '*imbrication-level'*, the entanglement of phones with internet access have exposed PGs to a range of health information outside the control or guidance of health professionals.

Third, from the *future-focused* study, findings show a set of factors which are bound as an emerging explanatory model which influence primary appraisal of an mHealth tool in a new context. These factors describe a set of individual and social influences that governments, funding bodies and non-governmental organisations should consider before the introduction of an mHealth tool.

Fourth, from the *policy-focused* study, a framework is proposed that differentiates between interventions targeting traits and states, the latter being situation-specific, and the former which seeks to improve individual's abilities, job knowledge, and skills as they relate to an mHealth tool. Furthermore, the framework differentiates between individual and social interventions, the former being resilient to personnel change, and the latter seeking to improve crucial situations that would otherwise cause social systems to break down around an mHealth tool.

These findings have implications for theory, practice, and future research. These implications are discussed in the final chapter of this thesis.

Chapter One

1. Introduction

This chapter presents an introduction to the research in this thesis. Section 1.1 presents the thesis rationale, highlighting the background information and justification for the studies in this thesis and noting the thesis objective. Section 1.2 describes the research philosophy. Section 1.3 presents the context of the thesis, leading to the main research objective. Section 1.4 presents the ethical considerations. Section 1.5 outlines the four studies undertaken as part of this research, i.e., the review-focused, the past-focused, the future-focused and the policy-focused studies. Section 1.6 presents the social and technical factors that influence the assimilation of mHealth tools.

1.1 Thesis Rationale

1.1.1 Health

Health "is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (WHO, 1948: 1). The World Health Organisation (WHO), while explaining this definition, highlights the importance of health for everyday living, emphasising the physical abilities, social resources and as well as the accompanying social skills. It is further asserted that health is considered a fundamental human right and as such, an essential component of human development which is necessary for both personal and national economic growth (WHO, 1948; 2016b).

In developing countries, the dual burden of disease and its impact on the livelihoods and the economic productivity of people are staggering (Kahn et al., 2010). That is, the people's livelihoods and economic productivity are

significantly impacted by the degree of healthcare outcomes (Kahn et al., 2010). Imagine a community where a farming household works as a production unit. If any member of this unit falls sick, it might mean that production stops as well. In that scenario, the family production process (farming) is shut down. This means that the crops in the farm are not being attended to and saved income is used to transport the sick to hospital, procure drugs if necessary, school fees are stopped, and in most cases it takes a long time for the sick to recover and go back to farm (their source of income). At this point, the family structure is weakened and the family becomes vulnerable.

1.1.2 Healthcare

Healthcare is defined *as "the prevention, treatment, and management of illness and the preservation of mental and physical well-being through the services offered by the medical and allied health professionals"* (Miller-Keane, 2003). This implies that an individual's health can be preserved or improved through various ways, including through behavioural changes and/or through the utilisation of the appropriate healthcare services.

Healthcare all over the world is mostly delivered through three levels, namely, primary care, secondary care, and/or tertiary care. Primary care is defined as the "essential health care made universally accessible to individuals and families in the community by means acceptable to them, through their full participation, and at a cost that the community and country can afford" (WHO, 1983: 14). Primary Healthcare (PHC) is usually regarded as the first point of consultation for all patients in a healthcare system (WHO, 2018b). PHC is further delineated as the "basic or general health care

traditionally provided by doctors in: family practice, paediatrics, internal medicine, and occasionally gynaecology" (1JohnHopkins, 2018). These entail the provision of all-inclusive, accessible, community-based care that meets the health needs of individuals throughout their life (WHO, 2018b). In other words, the primary aim of PHC is the provision of basic health services to everyone (Abdulraheem et al., 2012; WHO, 2018b). Secondary care is the next level of care after a primary care provider refers you to a healthcare professional. Implying that secondary care is "the provision of a specialised medical service by a physician specialist or a hospital on referral by a primary care physician" (Mosby, 2009: 1). It refers to a secondary level of healthcare system in which patients from primary level of the healthcare system are referred to specialists in higher hospitals for treatment. Tertiary care is the "specialised consultative care, usually on referral from primary or secondary medical care personnel, by specialists working in a centre that has personnel and facilities for special investigation and treatment" (JohnHopkins, 2018: 1). In other words, it refers to the tertiary level of healthcare system in which specialized consultative care is provided usually on referral from primary and secondary medical care.

Meanwhile, there is another type of healthcare known as preventive healthcare. This type of care consists of those measures taken to prevent the occurrence of disease or illness as opposed to disease treatment (Scott et al., 2002; Prochaska, 2008). These could be in the form of health education, health promotions, and health campaigns or disease prevention programmes (Prochaska, 2008; Veenhoven, 2008). According to Veenhoven (2008) this type of care is usually dispensed at the following levels. First, at the *individual*

level, it might mean the prevention of illness by means of inoculation programmes or by providing periodical health check-ups. Second, at the *institutional level* and this may mean directing health policies at reducing disease-producing conditions in the workplace and living environments. Third, at the *national level* and this may be achieved in numerous ways, by keeping people with infectious diseases from entering the country, preventing pollution from poisonous chemicals and/or putting safety controls on consumer commodities. In conclusion, the treatment care that occur after diagnostic process and which in itself is a form of treatment, is the management and care of patient due to illness or injury (Brody and Waters, 1980; Kane, 2006).

1.1.3 Access to healthcare in rural areas of developing countries

Many factors contribute to the cycle of ill health (see Figure 1-1) in developing countries (HPA, 2017; Lainfiesta, 2017; Chandra-Mouli et al., 2015). However, the major inhibiting factor to healthcare services in developing countries is access (O'Donnell, 2007; Lainfiesta, 2017).

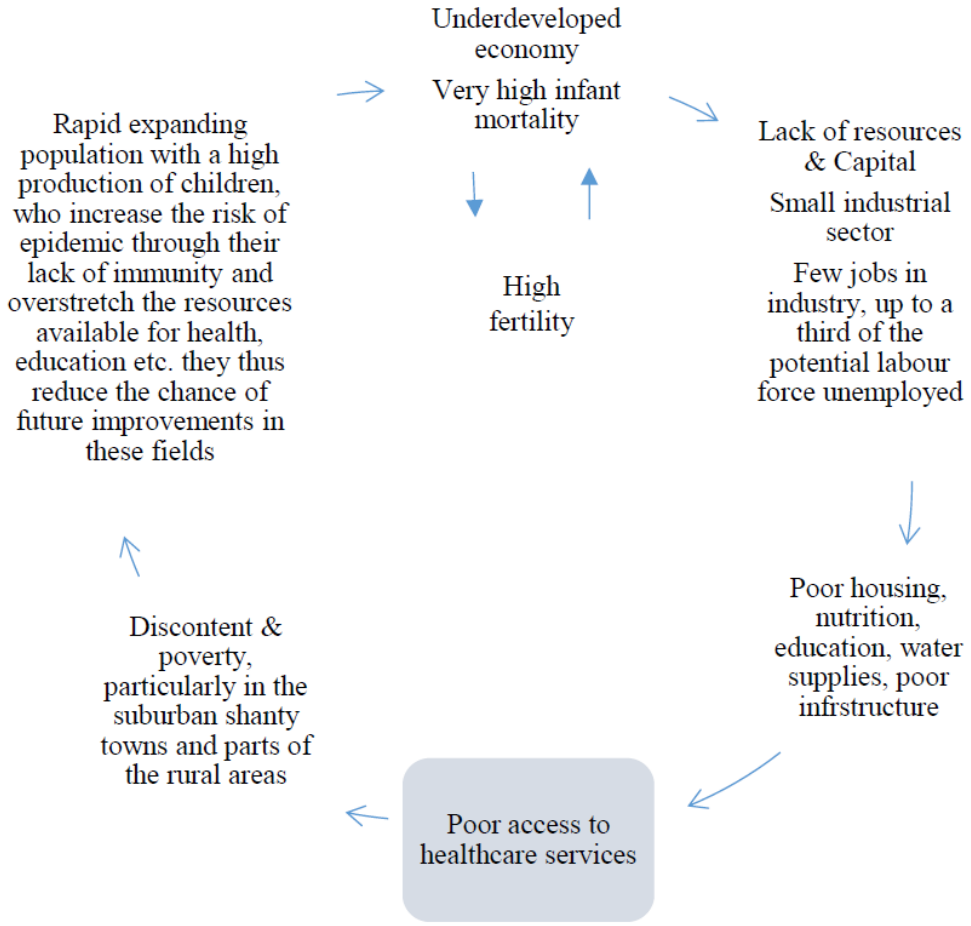

Figure 1-1: The cycle of ill health in Developing Countries

Adapted from Office of Health Economics (OHE) – (1972)

Access to healthcare services could be conceptualised in many ways (O'Donnell, 2007; Peters et al., 2008). However, most scholars agree that there are four dimensions of access: service availability; geographic accessibility; acceptability, and affordability (e.g., O'Donnell, 2007; Peters et al., 2008).

First, the *service availability* of healthcare. Service availability is usually measured by using indicators such as the healthcare workers (e.g. Doctors) or hospital beds per capita (Oliver and Mossialos, 2004; Gulliford et al., 2002; Peters et al., 2008). Developing countries are experiencing acute shortage of

healthcare workers, particularly in rural areas (Scheffler et al., 2009; Naicker et al., 2009). Health professional are seldom available to rural dwellers, thus limiting their ability to access healthcare (Hufnagel, 2012; Brian and Ben-Zeev, 2014; Medhanyie et al., 2015; Kay et al., 2011b). It is estimated that as of 2015 many African countries would have experienced shortages of the much needed healthcare workers to the tune of about 800,000 in number (Scheffler et al., 2009). Service availability could also be measured in terms of medicine availability (e.g., Peters et al., 2008; Ridde and Morestin, 2010; Matthews et al., 2010; Osungbade and Ige, 2011). The perennial lack of drug stocks at public healthcare centres in developing countries is evident in the literature (e.g., Chaudhury and Hammer, 2004; Mendis et al., 2007; Peters et al., 2008; Cameron et al., 2009; Cameron et al., 2011). For example, in a research study conducted by Cameron et al., (2009) across 36 developing countries on the fifteen commonly assessed drugs for a range of conditions, results show availability of only about 38% and 64% in the public and private health centres respectively. So, the non-availability of healthcare services, which is closely associated with the inadequate supply of medicine stocks is one of the factors that is linked to preventable deaths in rural areas (Rutherford et al., 2010).

Second, the *geographic accessibility* of healthcare services. Geographic accessibility of healthcare services is one of the factors that inhibit access in developing countries (Rutherford et al., 2010; Peters et al., 2008; O'Donnell, 2007; Rahman and Smith, 2000). Most of the roads are unpaved and often covered with pot-holes and ditches, impeding people's movements, distribution of drugs and other necessary health supplies to healthcare

facilities (Peters et al., 2008; Rutherford et al., 2010). This obstacle is more pronounced in the rural areas, where most communities are cut-off from the urban centres during raining seasons or adverse weather conditions (Peters et al., 2008; Schoeps et al., 2011). The distance to a healthcare provider is often cited as one of the factors that inhibit accessibility (Peters et al., 2008; Rutherford et al., 2010). There is evidence in the literature showing that children living close to a health clinic were less likely to die than children who have no access (e.g., Rutherford et al., 2010). Lack of communication is also mentioned as one of the factors that contributes to the lack of accessibility especially in the rural areas where network coverage is poor (Peters et al., 2008). If one could not communicate to anyone due to poor network, it means you have to physically travel to the place to get information on what one should do in a given health situation. Meaning that people living in remote areas have to spend time and money to travel long distances in order to access healthcare (e.g., Schoeps et al., 2011; Rutherford et al., 2010). In developing countries, most of the equipped healthcare centres are located in urban centres, making it potentially problematic for the poor rural dwellers to access or reach (Chetley et al., 2006; Osungbade and Ige, 2011).

Third, the *acceptability* of healthcare services. The acceptability of healthcare services is understood from the point of view of whether the provider meets the expectation of the individuals or the communities at large (Peters et al., 2008; Dyer et al., 2016). Implying that *acceptability* could be understood from an individual point of view or may equally reflect a shared collective opinion about the provider and the service/s provided (Sekhon et al., 2017; Dyer et al., 2016). For example, in a healthcare intervention, first, if patients

or communities, consider the intervention acceptable they would likely adhere to the treatment recommendations and reap the associated benefits (e.g., Hommel et al., 2013; Sekhon et al., 2017). However, if from the HCWs perspective, the intervention is known to have little or no acceptance from the patients or the communities, the HCWs may not deliver the service as expected (e.g., Proctor et al., 2009; Sekhon et al., 2017). Evidence in the literature has shown that there is lack of acceptability of treatments across cultures (Patel et al., 2011). In developing countries particularly, for example, language and treatment contents inhibit acceptability and thus constitute access obstruction to healthcare services (Patel et al., 2011). Gender inequalities which are known to constrain access are also common and the most affected are the poor rural women (e.g., Adedini et al., 2014; Lowe et al., 2016). In all of these, the acceptability of healthcare service is a variable and depends chiefly on local contexts (Patel et al., 2011; Peters et al., 2008; Dyer et al., 2016).

Fourth, the *affordability* of healthcare services. The financial affordability of healthcare services is regarded as a significant concern in healthcare service delivery for governments and organisations in developing countries (Han, 2012; Peters et al., 2008). This is because most of these countries are poor and financing healthcare services to the poorest of the poor in developing countries presents a very difficult proposition. Thus, the poor people in developing countries are less likely to have access to health services than their counterparts in developed countries because of affordability (O'Donnell, 2007; Peters et al., 2008). Being poor is multi-layered conceptually (Sife et al., 2010; Payne and Blair, 2005; Blocker et al., 2013), it has many causes and

expressions beyond the lack of earnings (Sife et al., 2010). It comprises lack of basic information on what to do (Payne and Blair, 2005), lack of services or opportunities and other aspects like social exclusion, and human rights, making an individual or community very vulnerable (Sife et al., 2010; Blocker et al., 2013). Thus, the financially poor people who mostly reside in remote areas have little or no access to health services (O'Donnell, 2007; Peters et al., 2008). As a result, the rate of preventable deaths is very high. It is posited that nearly one in five of all deaths worldwide are of children under the age of five and most are from developing countries (Mathers, 2008; Liu et al., 2015; Hug et al., 2017).

1.1.4 mHealth in rural areas of developing countries

Various approaches have been used to enable healthcare access to people or communities in developing countries (Han, 2012; Mills, 2014; Peters et al., 2008). One of these approaches is the nascent utilisation of the transformative role of mobile technologies that can enable healthcare delivery to where it is most needed (Robertson et al., 2009a). These mobile technologies when integrated into healthcare systems have the potential to address some of the physical barriers to health and service delivery (Kahn et al., 2010). These strategies based around the use of such mobile technologies are commonly referred to as mobile health (mHealth) (e.g., Donner and Mechael, 2012; Petrucka et al., 2013). The delivery processes can be grouped into four distinct types, namely, mPrevention/Education, mDataCollection, mDiagnosis, and mTreatment.

First, mPrevention/Education describes the use of mHealth tools for prevention, counselling, advisory, and/or educational purposes. Studies show

how this approach could be used for the prevention and control of diseases by promoting behaviour change (e.g. Sharma et al., 2017; Taki et al., 2017; Cole-Lewis and Kershaw, 2010; Hacking et al., 2016). There is evidence in the literature that this delivery process could be used by healthcare workers to improve counselling services for pregnant women in rural areas (e.g. Prinja et al., 2016; Diez-Canseco et al., 2015; Beratarrechea et al., 2015). This delivery process has been shown to afford Patients the opportunity to reach out to healthcare workers when they are in need of talking to someone for advice concerning an emotional or drug related problem (e.g. Nhavoto et al., 2017; Chandra et al., 2014; Chang et al., 2011).

Second, mDataCollection refers to the process of leveraging mHealth applications for data collection that could inform other aspects of healthcare delivery, such as, for diagnosis, campaign programmes or health policy purposes. That is, this process allows for "patients' vital health data collection, distribution, and processing" (Rolim et al., 2010: 95). In literature mHealth applications are used to collect or send disease incidences or outbreaks to a central location (e.g. Brinkel et al., 2014; Li et al., 2010; Prieto et al., 2017). There is evidence in existing literature on how handheld apps or sensors attached to hospital equipment collects and sends data into a central location usually known as database or knowledge base (KB) (e.g. Huang et al., 2014; Källander et al., 2013; Rolim et al., 2010). The most important aspect of this delivery process is that it enables healthcare workers to collect data with little or no errors due to the built-in error proof features in the mobile applications (e.g. Medhanyie et al., 2017; Kay et al., 2011b; Chin et al., 2013; Zhang et al., 2012).

Third, mDiagnosis describes the use of mHealth solutions for the diagnosis of illnesses or diseases. This involves the support of mHealth applications that could help healthcare workers in delivering quality health assessments to Patients in rural areas of developing countries (e.g. Dell, 2014; Knoble and Bhusal, 2015; Gupta et al., 2014; Chin et al., 2013; Florez-Arango et al., 2011; Iyengar and Florez-Arango, 2013). It also refers to the harnessing of Patients' stored data (e.g. in Database, Cloud. or Knowledge base) by experts around the world and who can then return recommendations via SMS or email to RHCWs (e.g. Hoang and Chen, 2010; Gupta et al., 2014; Busis, 2010; Vaidya et al., 2013; Breslauer et al., 2009).

Fourth, mTreatment refers to the utilisation of the mHealth delivery process to guide remedial healthcare interventions for specific Patients. Such interventions could be in the form of reminders (regarding upcoming tests, procedures, and/or medications), monitoring or tracking, and psychotherapy (e.g., to help addicted individuals stop compulsive drug seeking and use). Healthcare workers can reach Patients via SMS, this has been found to improve adherence and thus prevent relapses in the case of HIV patients under anti-viral drugs treatments (e.g. Wagner et al., 2016; Rodrigues et al., 2014; Kunutsor et al., 2010). Through this process, interventions could be achieved in the form of addictive treatments even as the Patients go about their normal daily lives (e.g. Quanbeck et al., 2014; Heron and Smyth, 2010). It has also been shown that mHealth applications enable tracking or monitoring of patients for treatment interventions. For example, in the case of pregnant mothers, it helps in the assessment of their level of risk and prioritises healthcare treatment for them (Alam et al., 2010).

All the aforementioned healthcare delivery processes could be achieved due to mHealth technologies' unique mobility. These healthcare delivery services via mHealth tool help to extend the reach of medical care into hard-to-reach remote areas of developing countries (Bakibinga et al., 2017; Yepes et al., 2016). As a result, there are various types of healthcare interventions in developing countries leveraging this potential. However, in studying the integration of smartphones and mobile devices into healthcare systems, there seems to be a lack of holistic understanding of what works, what does not and why, and how mHealth tool should be assimilated. Therefore, the objective of this thesis is *to create a more socially and technologically holistic understanding of the factors that influence the introduction of mHealth tools into rural areas of developing countries.*

1.2 Research Philosophy

This thesis assumes a critical realist ontology that is particularly associated with Bhaskar (1986; 2009). Critical realists argue that "the natural and social world differ in that the latter but not the former is dependent on human action for its existence – it is socially constructed" (Fairclough, 2005: 922). Critical realists see events as ontologically stratified, which is the result of the complex interaction of processes, structures, and social agents (Mingers, 2004; Fairclough, 2005; Easton, 2010). This implies that the world consists of not only events but includes objects and structures that are differently stratified with powers (properties) to generate events in social reality (Sayer, 2000; Fairclough, 2005; Easton, 2010). The significant features of critical realist's ontology include the distinction made between strata: the 'real' the 'actual' and the 'empirical'. First, the 'real' is the realm of structures and

objects with their accompanying ‘causal powers’, i.e., be it natural, physical or social that exists independent of us, whether we understand it or not (Sayer, 2000; Fairclough, 2005; Wikgren, 2005). Second, the ‘actual’ is the realm of practices/processes and events, i.e., the result of what happens when those powers are activated (e.g., human or social agencies in action) (Fairclough, 2005; Sayer, 2000). Third, the ‘empirical’ refers to the realm where social actors experience the real and the actual which may be observable or not (Sayer, 2000; Fairclough, 2005). For example, it is posited “while we may be able to observe things such as the structure of an organization or a household, as well as what happens when they act, some structures may not be observable” (Sayer, 2000: 12).

1.2.1 Research Approaches in IS Research

The actions of a researcher seeking to conduct a study are guided by his/her belief systems by which he/she generates and interprets reality (Wynn Jr and Williams, 2012; Easton, 2010). These belief systems according to Wynn Jr and Williams (2012) follow a sequence of answers to three sets of questions as proposed and formalised by Guba and Lincoln (1994). These three sets of questions involve, namely:

1) The ontological question, which refers to the assumptions about the nature of reality, i.e., the nature of the world;
2) The epistemological question, captures the evidential bases for the researcher’s justification of his/her knowledge claims, that is, the nature of the relationship between the researcher and what can be known, and

3) The methodological question, which deals with the processes or measures by which the researcher intend to create these knowledge claims.

The responses to these suggested questions as assembled by (Guba and Lincoln, 1994: 109) are presented in the table 1-1 below.

Question	Positivism	Critical Theory et al.	Post-positivism	Constructivism/ Interpretivism
Ontological	Naive realism- "real" reality but apprehendable	historical realism virtual reality shaped by social. political, cultural, economic, ethnic, and gender values; crystallized over time	Critical realism- "real" reality but only imperfectly and probabilistically apprehendable	Relativism-local and specific constructed realities
Epistemological	Dualist/objectivist; findings true	Transactional/ subjectivist; value mediated findings.	Modified dualist/ objectivist; critical tradition/community; findings probably true	Transactional/ subjectivist; created findings
Methodological	Experimental/ manipulative; verification of hypotheses; chiefly quantitative methods	Dialogic/ dialectical.	Modified experimental/ manipulative; critical multiplism; falsification of hypotheses; may include qualitative methods	Hermeneutical/ dialectical

Table 1-1: Basic beliefs of Alternative Inquiry Paradigms
Adapted from Guba and Lincoln (1994)

Under the positivist paradigm, researchers adopt a realist ontology believing that the world in which we live consists of pre-existing physical structures that exist independent of our recognition or being conscious of them (Fitzgerald and Howcroft, 1998). Positivism assumes that quantitatively

science measures truth about a single apprehendable reality (Krauss, 2005; Healy and Perry, 2000; Guba and Lincoln, 1994). Implying that data and its analysis do not change because they are being observed. As Guba and Lincoln (1994: 110) put it "inquiry takes place as through one-way mirror" in as much as the set-down procedures are adhered to. In other words, beliefs and prejudices are prevented from influencing outcomes, arguing that researchers are required to remain objective in their presentation of what is reality (Healy and Perry, 2000; Hammersley, 2005).

Constructivism (sometimes referred to as interpretivism (St George, 2010)) describes an ontologically relativist view of the world as consisting of multiple apprehendable realities which exist no matter what we call them (Guba and Lincoln, 1994; Porra et al., 2014). This is because according to Schwandt (1994), these two paradigms acknowledge that in order to understand the complex world of lived experience, one must interpret. Under the constructivist paradigm researchers assume the ontologically relativist view of the world. Multiple realities exist as a result of the subjective constructions of the mind in relation to how the socially transmitted terms which vary across different languages and cultures direct how reality is perceived (Fitzgerald and Howcroft, 1998). Thus, the constructivist/interpretivist approach attempt to understand phenomenon through the meaning people/researchers ascribe to them (Porra et al., 2014).

With the critical theory paradigm research approach, researchers assume an ontological point of view that there is no single reality, and being historical it also incorporates social structures (Guba and Lincoln, 1994; Healy and Perry, 2000). This implies that 'reality' is generated and shaped by historically

situated social, political, cultural, economic, ethnic and gender based structures (Guba and Lincoln, 1994; Healy and Perry, 2000; Krauss, 2005). That is, critical theory researchers focus on appraising, changing and improving political, social, cultural, economic, ethnic, and gender values (Healy and Perry, 2000; Guba and Lincoln, 1994). Thus, their studies are posited as being usually long-term involving studies of organisational processes and structures that are historical and ethnographic in nature (Healy and Perry, 2000). This means that researchers under this research paradigm approach employ dialogic/dialectical to challenge assumptions of world view (Guba and Lincoln, 1994). In other words, they rely on conversations and reflections to arrive at what they see as reality, and assumptions are usually subjective (Guba and Lincoln, 1994).

Finally, under the post-positivist paradigm, researchers assume the ontology of critical realism, rather than the naïve realism of positivism. It is posited post-positivism arose out of the frustration with some characteristics of the positivists stance (Ponterotto, 2005). A critical realism stance refers to an objective reality that is only imperfectly apprehendable (Lincoln and Guba, 2000; Lincoln et al., 2011; Ponterotto, 2005). This implies that one cannot truly capture reality since human cognitive mechanism is not perfect and that life's phenomena are fundamentally complex (Ponterotto, 2005). In other words, researchers' perceptions and feelings influence observations and findings, meaning that reality is seen through the eyes of the researchers and not necessarily the precise view of reality (Teddlie and Tashakkori, 2009). In conclusion, the complex nature of healthcare activities which involves many

stakeholders steered the researcher to the adoption of a critical realist approach.

1.2.2 Research Strategy

This thesis adopts an exploratory case-study approach to help create a holistic understanding of how mHealth technologies can be assimilated into rural settings of developing countries. The choice of a particular strategy to employ in any given research is dependent on the research problem (Noor, 2008). A case-study method is adopted in this thesis, because, it is posited to help researchers develop a holistic description of one or a small number of social structures or situations through an interactive process that involves using multiple sources of data collection methods (Easton, 2010). A case-study method is defined as "empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2003: 13). That is, as suggested by Yin (2003), this thesis specifically adopts a case-study strategy in order to cover the contextual conditions that are extremely significant to the phenomenon of study – healthcare delivery practice in the rural areas. Case-study has an advantage over other methods in that "it can 'close in' on real-life situations and test views in relation to phenomena as they unfold in practice" (Flyvbjerg, 2006: 235).

In IS research, the case-study method is used extensively for three significant reasons. First, it helps to understand the interactions between the fast changing technology related innovations and organisational settings (Darke et al., 1998; Dubé and Paré, 2003). Second, the holistic investigative approach it presents suits the need to understand the complexity involved in the use of

a wide-range of data collections methods that brings depth and richness to the overall research process for the study of IT use phenomenon (Dubé and Paré, 2003). Third, the case study method "is a research strategy which focuses on understanding the dynamics present within single settings" (Eisenhardt, 1989: 534).

In order to achieve the objective of this thesis, the case-study research strategy is specifically adopted in relation to the critical realist ontological underpinning of this thesis for the following three reasons. First, it is posited that for a comparatively and obviously bounded but complex phenomena, such as organisations with interconnected relationships (e.g., healthcare systems), the case study strategy suits well with a critical realist approach (Easton, 2010). For example, it is possible to understand social phenomenon such as the healthcare workers use of mHealth tool for diagnosis and treatment by recording and analysing the accompanying events that take place as a result of their actions. Second, a critical realism approach is associated with mechanism centred theorising in contrast to the variable centred that is typical of the conventional realist and positivist research strategies (Morais, 2011). That is, for critical realists, the principal aim of a scientific investigation is to obtain knowledge about underlying causal mechanisms (McEvoy and Richards, 2003; Wynn Jr and Williams, 2012). A mechanism, conceptually, refers to the ways 'things' act to generate outcome (Bhaskar, 1986; 2009). Generative mechanisms are inherently related to the structures both physical and social, and the powers that enable or inhibit outcomes in a given setting (McEvoy and Richards, 2003; Wynn Jr and Williams, 2012). In applying a critical realism strategy, this thesis is able to understand the

outcome generated when the material agencies (physical structures) of the mobile technologies (mHealth tool) are enacted by the human agencies (social structures) of the healthcare workers in healthcare delivery services. Finally, it is asserted a critical realist acknowledges the role of case-study research in empirical and theoretical generalisation and theory testing (Tsang, 2014). This recognition encourages researchers to strive towards exploring more fully for case finding generalisation (Tsang, 2014), as in this thesis, to understand how mHealth tools could be introduced in rural areas of developing countries. In this regard, this thesis is focused on "sustained consideration of activities and behaviour in a particular location" (Ackroyd, 2010: 535).

1.2.3 Sampling Strategy

In case-study research, the case selection is one of the most important aspects of the researcher's decisions. The researcher decides whether to carry out the research with a single case or multiple-case studies in order to arrive at his or her knowledge claims (Yin, 2003). However, the application of a single or multiple-case studies are in fact two different study designs (Yin, 2003).

Patton (1990) posits that the basic difference between qualitative and quantitative research is underpinned by the sample techniques adopted. In case-study research and specifically qualitative research, a purposeful sampling strategy is encouraged so that the significant amount of effort and time invested are devoted towards collecting rich data from a suitable case or cases (Patton, 1990). The sampling strategy adopted in this study is based on the purposeful sampling benchmark by Patton (1990) where the case chosen met the characteristics that would be of importance in understanding how

mHealth technologies can be introduced into a rural settings of developing countries.

The Nsukka Local Government Area in Enugu State, Nigeria was selected for this study. Nsukka Local Government Area was selected based on the following characteristics as espoused by Yin. First, it is a considered a critical case (Yin, 1994) based on the fact that poverty has been historically high, implying that infrastructural and cultural challenges are significant. Second, it is revelatory (Yin, 2003) in that the researcher is from the area, meaning that the phenomena could be studied with high level of access and immersion. Third, it is highly significant because an mHealth app has recently been proposed to assist the diagnosis and treatment of children under 5 years old in the rural communities of Nsukka local government.

In addition to the issue of selecting the case purposefully, the issue of the sample size must be addressed. The sample size is dependent among others on, the aim of the study, interest of the study, and most importantly, what could be achieved within the available resources in a given time period (Patton, 1990). In other words "there are no rules for sample size in qualitative inquiry" (Patton, 1990: 184). Following in the same line of thought, Lincoln and Guba (1985) specifically recommended sample selection to the point of redundancy, i.e., sample size should be determined by the informational needs of research interest. Therefore, the primary benchmark is to terminate sampling when no new information is being revealed going forward (Lincoln and Guba, 1985). This however, leaves the sample size question open, but the solution to this ambiguity could be found in the judgement and negotiation at

the disposal of the researcher in relation to the purpose of the study and the stakeholders interest (Patton, 1990).

1.2.4 Data Gathering and Analysis

Broadly speaking, there are two research methods, i.e., extensive and intensive research designs but sometimes researchers use both simultaneously (Sayer, 2000; Danermark et al., 2005). The extensive method deploys large scale questionnaires or surveys that generate statistical analysis, searching among others, the patterns of events, the identification of groups based on shared attributes, and the quantitative relations among groups (Sayer, 2000). However, it does not really seek to address the causal groups in which the particular individuals or network of people, and the institutions that are involved and how they interact (Sayer, 2000; Easton, 2010). The intensive approach focuses on individuals and/or groups within the context, using in-depth interviews, ethnography and qualitative analysis to establish causal relationships among individuals, groups or network of people, and institutions (Easton, 2010; Sayer, 2000). That is, while the intensive method is time-consuming, it is more robust on causal explanation and interpreting meanings in context than the extensive method (Sayer, 2000). Therefore, this study adopts an intensive approach, implying that the data gathering methods involved in-depth interviews, participants' observation, documents/records, field notes, and photographs from the target area.

1.3 Research Context/Setting

In an intervention programme, the purpose of that intervention, the implementation process, and the context in which you want the intervention really matter (Friemel, 2008; Bliese and Britt, 2001). This is because the interaction between these three elements determine the success of the programme. It is posited that "human action and experience are context dependent and can only be understood within their contexts" (Mishler, 1979: 2). The use of *context* is important in interactive applications such as mHealth tools (e.g., Andersson, 2012). It is particularly important for applications where the user's *context* is constantly changing, such as mobile nature of these devices and the ubiquitous computing generally (Brown et al., 1997; Dey, 1998; Abowd et al., 1999; Dourish, 2004). It means the physical environment where an mHealth tool could be used for healthcare delivery, for example, the healthcare centres in the rural communities. That is, "such an environment has boundaries and structures that together shape the setting for practice" (McCormack et al., 2002: 96).

In this thesis, the term *context* is referred to the environment or setting in which people receive healthcare. Healthcare practice "takes place in a variety of settings, communities and cultures that are all influenced by… economic, social, political, fiscal, historical and psychosocial factors" (McCormack, (2002: 96). Meaning that cultural, social and physical factors among others play a significant role in shaping the success of IT interventions.

The resultant effect on outcomes of introducing information technologies (IT) into a given context depends on how they fit within the pre-existing contexts (Tolmie, 2001; Davidson and Chiasson, 2005; Avgerou, 2001). That is, it is

important to take into consideration how outcomes are affected by the interaction between technology and context (Avgerou, 2001; Tolmie, 2001). This is particularly significant in the context of developing countries since IT innovation to a large extent involves the transfer of technologies and organisational practices which were originally designed and proved useful in other socio-organisational contexts (Avgerou, 2001). Implying that the varying social contexts of individual use result in different social influences that affect the individual's perceptions of user satisfaction with the mobile technology.

1.3.1 The Context (country, Nigeria)

In Nigeria, the under-fives mortality rate is the eight highest in the world (Adewemimo et al., 2017). Overall, it has reduced from approximately 140 per 100 births in year 2010 to 104 in 2016 (UN, 2018), but it is still considered high when compared with the global average and thus fell short of achieving the Millennium Development Goals (MDG4) (UN, 2015a; UNICEF-WHO, 2012). In Nigeria, malaria (20%) is the leading causes of death (Liu et al., 2015), closely followed by respiratory infections (19%) (CDC, 2013). In other to address this situation, clinical guidelines for rural healthcare workers (community healthcare workers) were developed by WHO and UNICEF to deliver healthcare services to children under the age of five in remote, hard-to-reach rural areas of developing countries (UNICEF-WHO, 2015). These guidelines are known as integrated Community Case Management (iCCM) and are to be adopted to individual countries basis based on their respective National Child Health Index. iCCM is a meticulous and systematic guideline which enables healthcare workers to assess, classify and treat seriously ill

children in rural areas (UNICEF-WHO, 2012; 2015). In employing this guidelines in rural areas, rural healthcare workers capture socio-demographic characteristics and clinical information regarding diseases, illness, and recommend treatments, especially in malaria prevalent countries in Africa (UNICEF-WHO, 2015), like Nigeria. In other words, it is an effective strategy to improve access and increase coverage of lifesaving interventions in order to minimise the under-fives preventable deaths (Daelmans et al., 2016; Miller et al., 2014). Overall, this is an equity-based approach that complements and extends the reach of healthcare services by providing timely and appropriate malaria, pneumonia, and diarrhoea treatment to populations (especially to children under 5) with limited access to facility-based healthcare providers (WHO, 2016a; Guenther et al., 2014).

Nigeria is an African country on the Gulf of Guinea located in Sub-Saharan Africa. Nigeria is bordered on the west by Benin Republic, on the east by Chad and Cameroon, on the north by Niger Republic, and on the south by the Atlantic Ocean (Figure 1-2). Nigeria is a developing country with an estimated population of more than 198 million (NPopC, 2017) and divided into 36 states and the Federal Capital Territory, Abuja. It is estimated that "120 million of Nigerians still live below or only just above the poverty line" (House of commons, 2016: 5), and a greater percentage of this population reside in the rural areas. Millions of children under the age of five die in the rural areas of developing countries due to the absence or inadequate healthcare delivery services (Epstein and Bing, 2011; Müller and Krawinkel, 2005; UNICEF., 2006). It was estimated that the largest percentage of new born deaths (39%) in 2016 occurred in South Asia (39%), followed by Sub-

Saharan Africa (38%) and Nigeria is one of the five countries that accounted for about half of that number (Hug et al., 2017; Liu et al., 2015).

Figure 1-2: Map of Nigeria with major cities
(EnchantedLearning, 2018)

The Nigerian healthcare system is decentralised into a three-tier structure comprised of federal, state, and local government levels (Okojie, 2009; Oluwatolania and Philip, 2010). The 36 state governments and the 774 local government areas (LGA) within the states are assigned the primary responsibility for the provision of basic public services for Nigerians (House of commons, 2016). These three levels of governments according to the 1999 constitution are entrusted with functions towards health provision and financing. At the federal level, it is the responsibility of the government to enact policies and technical guidance to the health system and as well, provide

health services in tertiary, teaching hospitals and national laboratories. At the state level, it is the responsibility of the government through the state's ministries of health (MoH) to provide regulation and technical support to primary healthcare services. At the local level, the government is responsible for the delivery of primary healthcare (PHC).

These structural arrangements may have put enormous financial pressure on the States and Local governments, for it is posited "the spending priorities of states often fail to sufficiently focus on basic services" (House of commons, 2016: 34). According to Abdulraheem et al. (2012), the role of PHC as stated in the Nigeria health policy seems to be unrealistic due to the present structure and therefore, requires restructuring. A number of reasons have been proffered in this regard. First, although PHC centres were established in both rural and urban areas, the rural communities are underserved when compared with their urban counterparts (e.g. Efe, 2013; Ameh et al., 2016; Alao, 2013; Ademiluyi and Aluko-Arowolo, 2009). Second, most of the PHC centres are in a poor state, equipment and infrastructure are either unavailable or obsolete (e.g. Efe, 2013; Ameh et al., 2016; Benson and Egbewole, 2018; Ademiluyi and Aluko-Arowolo, 2009). Third, the referral system is almost lacking (Abdulraheem et al., 2012; Onah et al., 2006; Welcome, 2011; Erim et al., 2012). Fourth, highly trained healthcare professional (e.g. doctors) avoid working in the communities because of the meagre salaries and poor working conditions that characterise rural healthcare centres (Abdulraheem et al., 2012; Efe, 2013).

1.3.2 Enugu State, Nigeria

In Enugu State, the rate of under-fives deaths (131) (Adewemimo et al., 2017) is higher than the national average. In a recent research finding, the causes of these deaths were delineated as follows: (i) for neonatal it was attributed to sepsis, birth/asphyxia and neonatal pneumonia; (ii) for 1-59 month mortality it was attribute to malaria, diarrhoea, and pneumonia (Adewemimo et al., 2017). Additionally, it is stated that maternal mortality rate of about 1,400/100,000 live-births in Enugu is attributed to preventable medical causes which is a function of socio-cultural factors (Okeibunor et al., 2010).

Enugu state is one of the 36 states in Nigeria and located at the south-eastern part of the country (Igwe et al., 2010; Ezeh and Ugwu, 2010). The state is positioned between latitude 5^0 56N – 706'N and longitude $6^0$53E and $7^0$55E (Agwu et al., 2008; Ozor and Cynthia, 2011) (Figure 1-3). Enugu is bounded to the North by the states of Kogi and Benue, to the east by the Ebonyi, to the south by Abia, and to the west by Anambra states (Agwu et al., 2008; Uzochukwu et al., 2011). Its capital is Enugu, and the name of the State is derived from its capital city, Enugu, means the top of the hill. Enugu state's area includes most of the Udi-Nsukka Plateau, which rises to more than 1,000 feet (300 m) (Encyclopædia, 2018a), and partly lies within the tropical rain forest belt to the south (Uzochukwu et al., 2011; Ozor and Cynthia, 2011). Enugu state is covered by open grassland, with occasional woodlands and clusters of oil palm trees. The State was created out of the then Anambra state in the year 1991 during the Military regime of General Badamusi Babangida (Uzochukwu et al., 2011). The State is divided into 17 local government areas (LGAs) (Onah et al., 2005; Nzeadibe and Ajaero, 2010) and three senatorial

zones, namely, Enugu East, Enugu North and Enugu West senatorial districts (Onah et al., 2005). The population of the state is approximately 3.3m with a land area of about 7,618 sq. km (NPopC, 2018; Onwujekwe et al., 2013; Ani et al., 2014).

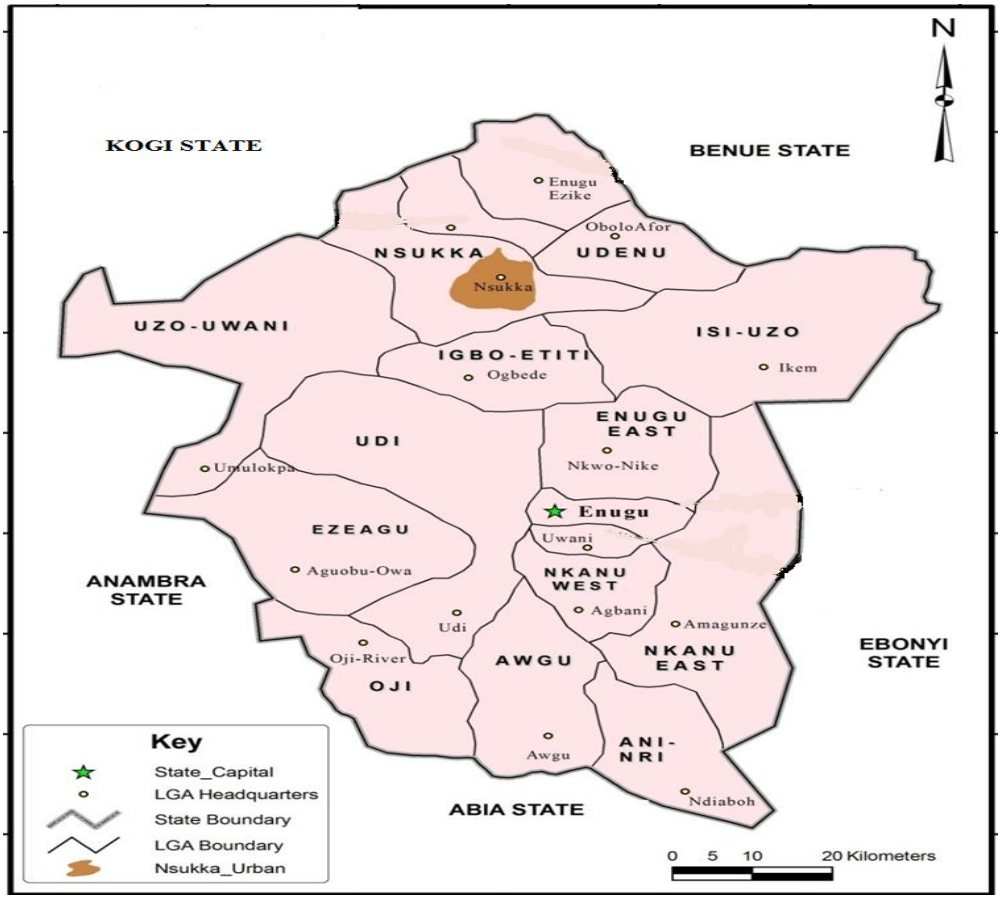

Figure 1-3: Map of Enugu State showing the 17 local government areas
Adapted from Chukwuma (2017)

The Igbo (Ibo) ethnic group constitute the majority of Enugu state's population (Uzochukwu et al., 2011; Encyclopædia, 2018a; Ani et al., 2014), most of which live in the rural areas (Chukwuma, 2017). Farming plays an important role in the state's economy; yams, oil palm products, taro, corn (maize), rice, and cassava (manioc) are the main crops (Ozor and Cynthia, 2011). Enugu, the state capital, is a major centre for coal mining – hence, it is

referred to as ‘Coal City’. Beside coal, iron ore also is mined, and deposits of limestone, fine clay, marble, and silica sand (Encyclopædia, 2018a). Industries include textile manufacturing, food processing, lumbering, soft drink bottling, brewing, and furniture manufacturing. A network of roads connects Enugu town with Awgu, Ezzangbo, and Nsukka. Economically, Nsukka local government people are typically farmers (Obidike, 2011; Ozor et al., 2015). Trading occurs but mainly on agricultural products (Ozor et al., 2015). Weaving is a traditional local craft and coal deposits has been discovered in Obollo area east of Nsukka located on the main Onitsha and Makurdi road (Encyclopædia, 2018b).

1.3.3 Nsukka LGA, Enugu State

In Nsukka local government area (LGA) of Enugu state, the healthcare issues are exacerbate because a good percentage of the population live in abject poverty (Ataguba et al., 2011). For example, in early year 2000, the maternal mortality rate was estimated to be more than 3000 deaths per 100,000 live births in the Nsukka senatorial zone of the Enugu state (Okeibunor et al., 2010). Some of the many socio-cultural that factors contribute to the high mortality in the area include; poor antenatal care practices, lack of healthcare access, lack of trained healthcare attendants at birth, and weak healthcare delivery system (Okeibunor et al., 2010; Adewemimo et al., 2017; Okeke and Okeibunor, 2010).

Nsukka Local Government Area is one of the 17 local governments in Enugu State. The headquarters is located at the hilly sites of Nsukka town. Nsukka town lies between the geographical coordinates of latitudes 6°45’N and 7°00’N, and longitude 7°15’E and 7°30’E of the Greenwich meridian (Ozor

et al., 2015; Felix et al., 2017; Chukwuma, 2017) (Figure 1-4). Nsukka local government shares common border with Igbo-Etiti L.G.A on the South, Uzo-Uwani L.G.A on the West, Udenu L.G.A on the East and Igboeze-North L.G.A on the North (Ozor et al., 2015; Chukwuma, 2017). The local government has an area of 1,810km2 and a population of 309,633 (NPopC, 2018; Ozor et al., 2015).

Nsukka local government area is home to various educational institutions. At the tertiary level, one of the foremost universities in Nigeria known as the University of Nigeria, Nsukka. It is the first indigenous Nigerian university, founded by the late Dr Nnamdi Azikiwe the first President of Nigeria. There are also a number of Federal Parastatals in the university such as National Biotechnology Development Agency (NABDA), Centre for Basic Space Science (CBSS), and the Energy Research Centre. At the secondary level, one of the oldest schools in Nsukka local government area is the all-boys St. Teresa's College, Nsukka that is located at the heart of Nsukka town, run by the Catholic Church of Nsukka diocese. The all-girls secondary school is the Queen of the Holy Rosary Secondary School, also operated by the Catholic Church of Nsukka diocese. Another secondary school, the Nsukka High School is a public (government-run) school with Anglican Church heritage. There is also a Model Secondary School, Nsukka, which is a day school for male and female students and St Cyprian's Special Science School Nsukka which is an all-science boarding school for girls. Additionally, there are also the Urban Girls Secondary School and the Federal Government Girls' College Lejja Nsukka, which is a federal government-owned girls' school. The University of Nigeria Secondary School belongs to the university. Also

located very close to St Theresa' Cathedral Nsukka Diocese is St Catherine Secondary School (all girls) operated by the Catholic Church. At the primary level, is St Joseph's primary school run by the Catholic Church diocese and the Anglican primary school attached to the Anglican church, just to mention a few.

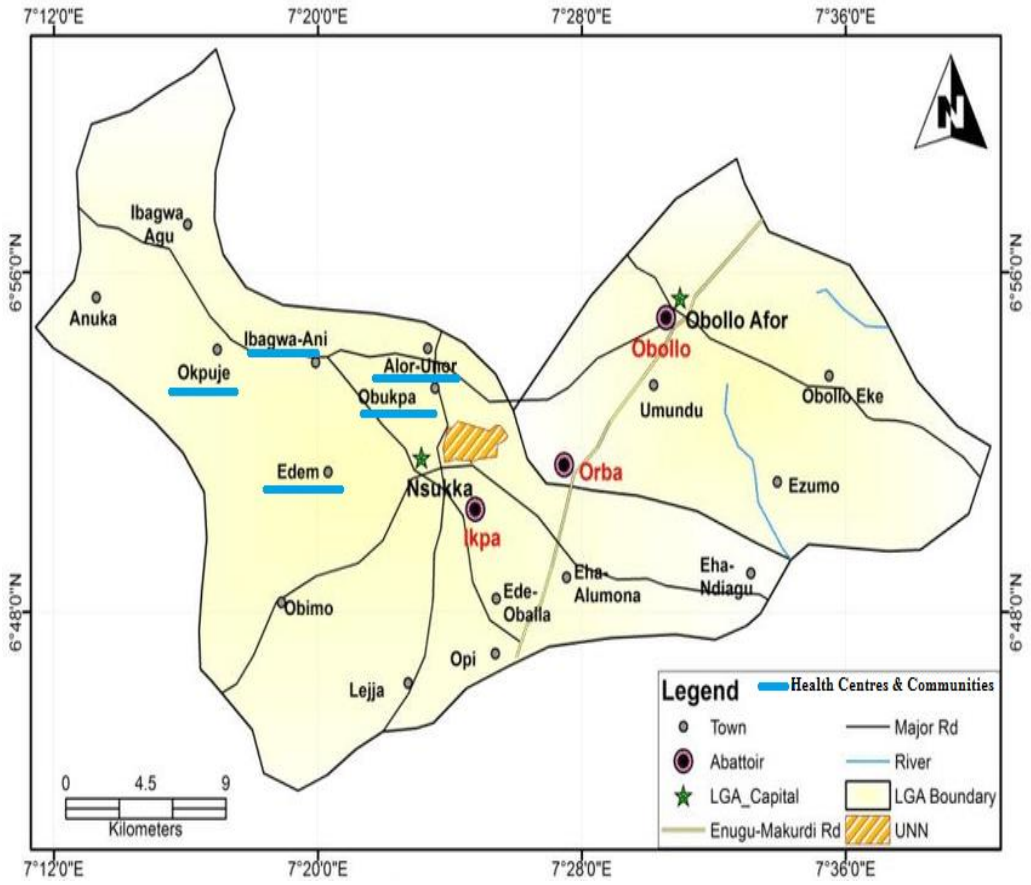

Figure 1-4: Map of Nsukka with all the communities
Adapted from Felix et al., (2017)

1.3.4 iCCM in Nigeria

Currently, in Nigeria, integrated community case management (iCCM) is being piloted in two states, namely, Niger and Abia, with future scale-up planned in an effort to cover the basic health needs of over 300,000 children (Malaria-Consortium, 2013; Ozor, 2013). Meanwhile, research findings in

other countries have shown defects emanating from the paper-based iCCM method with documentations of poor adherence of rural healthcare workers to the guidelines, leading to poor quality diagnosis and treatment measures (e.g., Guenther et al., 2014; Amouzou et al., 2014; Miller et al., 2014; Chandani et al., 2017). However, recent research findings show that these defects or inadequacies could be remedied with the introduction of information communication technology (ICT) (e.g., Tumusiime et al., 2014; HealthEnabled, 2016; Oliphant et al., 2017).

Enugu State currently does not have the integrated community case management (iCCM) guidelines integrated in their health system, meaning the sociocultural environment may be significantly different from that of other places currently running iCCM. Thus, necessitating a study to understand how mHealth technologies can be assimilated into the rural settings, such as Nsukka local government communities.

1.4 Ethical Considerations

It is important to note that the researcher undertook this research in their birthplace, a place where their family and friends live. With this in mind, the researcher had to consider the ethical implications associated with conducting this study. The four general considerations include: *information requirement*s, the *consent requirement*, the *confidentiality requirement*, and the *utilisation requirement* (Andersson, 2012; Sanjari et al., 2014). These four requirements are primarily targeted at the research participants. Ethical approval was secured from both the researcher's university and a university at the target context. *Information requirement*s were satisfied by informing the participants through the informed-consent process and through eliciting

signed consent (*consent requirement*) prior to the commencement of the research. It is essential that participants understand that they may withdraw from the study and remove their information. It was imperative that the researcher clearly explained how the research data would be used and who would access it (*utilisation requirement*) in the future. The *confidentiality requirement* was achieved by anonymising the information sources and by providing a guarantee that the data collected would be used for the purpose for which it was meant, as explained in the study information sheet.

Given the researcher's position precautionary considerations were taken to report findings devoid of bias. This was kept in check by, first, ensuring that participants felt that their participation in the study was voluntary, i.e., they were not mandated to participate in order to help the researcher. Second, the researcher ensured that participants provided honest opinions, meaning they did not provide answers that they believed the researcher needed to complete his study. Third, the researcher ensured that the study findings were dispassionately written-up as it happened by maintaining objectivity throughout. This meant making multiple visits to Enugu to further collaborate with the participants on the research findings. That is, findings were made known to participants as a form of 'venting' or 'member checking' exercise, thus testing the validity and reliability of the interpretation of their responses (Borman et al., 1986; Miles and Huberman, 1994).

Finally, language was a challenge because the researcher had to provide information about the study in English and Igbo to ensure the participants understood the research.

1.5 Overview of the Studies

1.5.1 Chapter Two – Review-Focused Paper

Chapter two presents the *review-study*. This study is titled "Mobile Health Solutions in Developing Countries: A Stakeholder Perspective" is published in Health Systems.

This review-focused study investigated the stakeholder perspective in healthcare systems. This was fuelled by the fact that a human focus is needed to understand how the different stakeholders participate and interact during use of mHealth tools in delivery process. Therefore, this review study adopts a systematic review of mHealth through a stakeholder perspective.

This study gathered mHealth studies focused in developing countries from each of the leading academic databases, namely the AIS Electronic Library (AISel); PubMed/MEDLINE; Science Direct & Web Science; JSTOR; Academic Search Complete & Scopus; OCLC FirstSearch; and Google Scholar. A structured approach to searching these databases was adopted, based on an evolving set of general synonymous search terms relating to mHealth, e.g. "mHealth", "m-Health", "mHealth Care", "mHealthcare", "Mobile Health Care", and "Mobile Healthcare". A set of exclusion and inclusion criteria were applied which resulted in the identification of 108 studies, which were analysed using a two-dimensional analysis (e.g., Healthcare workers to Patients or Patients to Healthcare workers) approach through the stakeholder perspective lens.

In studying existing literature in mHealth applications in developing countries, it was apparent that a number of studies highlighted the potential

for healthcare delivery in these settings. However, the relatively new promising nature of the phenomenon makes it hard to relate various findings from different studies into one holistic body of knowledge, meaning it is difficult to determine areas of common understanding. Specifically, while it is obvious that using an mHealth tool in a healthcare delivery process involves a range of stakeholders with various backgrounds, it is not very clear the extent to which interactions between each of these stakeholders have been studied. Therefore, the objective of this study is *to identify and synthesise existing research on the use of mHealth in developing countries with a view to establish what is known about the interaction across the mHealth process.*

This study made a significant contribution towards the overall objective of this thesis. Meanwhile, the existing studies focused mostly on the design of the mHealth artefacts, how to improve usability in order to generate acceptance, and maximise impacts. There is little or no studies on how cultural differences and existing practices might affect the manner in which technology are assimilated. In other words, how can social and material structures influence the assimilation of an mHealth tool in their environment?

1.5.2 Chapter Three – Past-focused Paper

Chapter three presents a *past-focused* paper titled "World Apart: A Socio-Material Exploration of mHealth in Rural Areas of Developing Countries" – This paper is under second review with Information Systems Journal.

The overarching theory behind this past-focused study is socio-materiality. This meta theory is encapsulated in the idea that technology, people, and process are inseparable and inextricably connected (Orlikowski, 2007;

Orlikowski and Scott, 2008). The term ‘social’ is chosen for ‘people’ to capture the variety of social actors involved in a system, including groups, institutions, norms, and perceptions (Orlikowski and Scott, 2008; Barad, 2003). The term ‘materiality’ is used in favour of the term ‘technology’, since the latter creates the impression there are some objects, artefacts or devices out there that do things, and therefore ignore that these objects, artefacts or devices only come to reality when manifested in practice (e.g., Leonardi et al., 2012).

This study adopts an exploratory case-study approach (Yin, 2013) using the socio-material perspective as a guiding theoretical lens. Data gathering involved interviews, participant observation, document/records analysis, field notes, and photographs from clinics in the rural communities. This involved thirty-two interviews, which were conducted in Igbo or English and recorded for subsequent analysis. All recordings were transcribed verbatim into English, along with the written notes from interviews. The data was thematically analysed using the method proposed by Braun and Clarke (2006). Analysis focuses on identifying the types of ‘social’ and ‘material’ actors involved, key ‘practices’, and signs of ‘imbrication’.

The past-focused study showed that there is little or no research studies exploring how cultural differences and prevailing social, material, and cultural practices in target areas might change the manner in which these technologies are used and the deeper goals with which they are associated. This particular study frames this problem using a socio-material approach based on an exploratory case study to understand *the factors that influence the assimilation of mHealth technologies by different stakeholders in rural*

contexts. This *past-focused paper* made important contributions towards the overall thesis objective through the social, material, and cultural practices identified, however, the study could not explain the appraisal processes that users experience during the adaptation of an mHealth tool. This study, therefore, asks *what are the users' appraisal processes before use or adoption?* In other words, what are the perceived threats and opportunities during an mHealth tool introduction in their environment?

1.5.3 Chapter Four – Future-focused Paper

Chapter four presents a *future-focused* paper titled "Understanding the Factors that influence Primary Appraisal in Assimilation of an mHealth Artefact in a Developing Country: An Exploratory Case-Study Approach". This paper is published in Australian Journal of Information Systems, 2018.

The overarching theory behind this study is the role of primary appraisal in the coping process (Beaudry and Pinsonneault, 2005). The process of 'primary appraisal' describes where individuals evaluate the importance of an event as a consequence of their situations and interests.

This study adopts an exploratory case study approach (Yin, 2013) using the coping theory perspective as a guiding theoretical lens. Grounded theory techniques (e.g., Glaser and Strauss, 1967; Corbin and Strauss, 1990; Corbin and Strauss, 2014) were used in data gathering and analysis.

This study frames the problem identified in the past-focused study, i.e. "*how can we understand the users' appraisal processes before use or adoption of an mHealth tool in their environment?"* by using coping theory to explore perceptions around new mHealth initiatives, with particular attention to the

perceived threats and opportunities as appraisal outcomes. That is, the research objective is *to understand the factors that influence different stakeholders' primary appraisal of mHealth technologies in rural contexts.*

This *future-looking* study made a number of contributions towards accomplishing the thesis objective. The study identified a challenge that needs attention and that is *how can we plan and position an mHealth intervention in developing countries?*

1.5.4 Chapter Five – Policy-Focused Paper

Chapter five is the *policy-focused* paper titled "Planning and positioning mHealth interventions in developing countries". This paper is accepted with Health Policy and Technology.

The overarching theory behind the policy-focused study is the 2*2 matrix used to build the mHealth intervention framework leveraging the five factor model and Hofstede's dimensions. The five-factor model (FFM) (Hurtz and Donovan, 2000; Roccas et al., 2002) are the five major types of individual personality traits that usually influence how an individual responds to stressful situations (e.g. a new IT) in their environment. The Hofstede's dimensional framework describes five independent dimensions that helps to explain the management structure of a social group (i.e., an establishment, organisation, community, or country). That is, "The collective programming of the mind that distinguishes one group or category of people from another" (Hofstede and McCrae, 2004: 58).

This study adopts theoretical perspective behind the five factor model (Hurtz and Donovan, 2000; Roccas et al., 2002) and the Hofstede's dimensional

framework (Hofstede et al., 2005; Hofstede, 1983). The framework was informed by the planning and positioning for an exploratory research initiative in Enugu State, in the South Eastern Region of Nigeria between January 2016 and March 2017 (15 months). That is, the 2*2 intervention framework was developed using the vignettes and examples from the results of the treatments in the workshops during the past-focused and future-focused studies.

This *policy-focused* study addresses the challenge identified by the *future-focused* study, which is, how to plan and position an mHealth intervention in developing countries in order to ensure that target goals are successfully achieved. This *policy-focused* study frames this problem by leveraging the five-factor model (FFM) of individual traits and Hofstede's framework on cultural dimension to understand how we can plan and position an mHealth intervention. Therefore, the objective of this paper is *to develop a framework for the planning and positioning of mHealth interventions in developing countries.* This *policy-focused* paper uses the data gleaned from the three aforementioned research paper findings about events, objects, and specific exemplars to establish a framework for the planning and positioning of an mHealth intervention in Nigeria that could be utilised in other developing countries.

1.5.5 Appendix A – Research-in-progress-focused paper

Appendix A is a research-in-progress paper titled "How can mHealth Applications that are developed in one area of the developing world be adapted for use in others?" This paper is published in the Journal of Decision Systems, June 2016.

1.5.6 Appendix B – Research-in-progress paper

Appendix B is a research-in-progress paper titled "Adapting an mHealth Tool for use in a Different Developing Country: A Sociomateriality/Coping Perspective ". This paper was presented at IFIP WG 8.2 Working Conference on Information Systems and Organizations, IS&O 2016 Dublin, Ireland, December 9–10, 2016.

1.5.7 Appendix C - Literature review-focused paper

Appendix C is a literature-review-focused paper titled "Reviewing mHealth in Developing Countries: A Stakeholder Perspective". This paper is published in the Health and Social Care Information Systems and Technologies (HCist) conference, October 2016.

1.6 Social and Technical Factors for the assimilation of mHealth tools

This thesis encompasses four studies which are organised and geared towards achieving the thesis objective which is to create a more socially and technically holistic understanding of the factors that influence the assimilation of mHealth tools in developing countries. Therefore, these studies' findings identified a number of factors that have significant influence on how mHealth tools are assimilated in developing countries. Figure 1-5 presents the conceptual framework of the social and technical factors that influence the assimilation of mHealth tools in developing countries. First, the literature *review-focused study* identified four stakeholders without which mHealth care service would not exist or function. Second, the *past-focused study* identified the cultural differences and the prevailing social, material and cultural practices that might change the way mHealth tools could be

assimilated in the rural areas of developing countries. Third, the *future-focused study* identified the social and material factors that influence the primary appraisal of mHealth tools. Fourth, *the policy-focused study* explained how the traits and states that could support decision makers in the designing and fine-tuning the portfolio of mHealth interventions in developing countries.

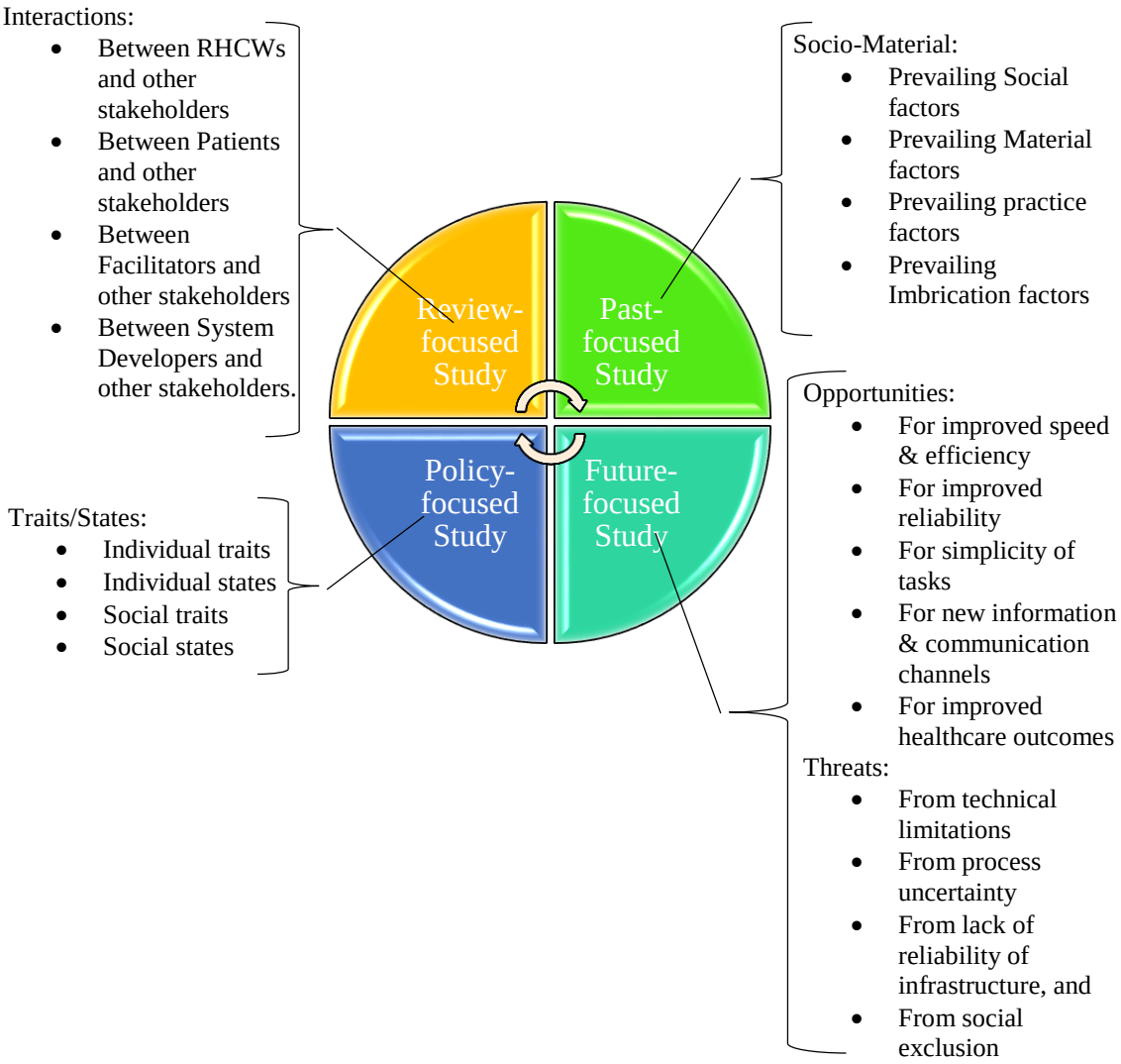

Figure 1-5 - Social and Technical Factors that Influence Assimilation

The factors present an integrated knowledge of the factors that influence the assimilation of mHealth tools in developing countries. The holistic approach adopted in this thesis helps to bridge the gap that might be created by compartmentalised thinking and limited holistic exploration. Put differently, "In collective thinking, knowledge boundaries are reframed as dynamic inter-relationships…" (Brown, 2015b: 209). That is, in applying holistic knowledge in times of transformational change such as the introduction of mHealth tool in healthcare systems, this offers a robust foundation for innovative solutions.

Chapter Two

2. Mobile Health Solutions in Developing Countries: A Stakeholder Perspective

2.1. Abstract

Infrastructural deficiencies, limited access to medical care and shortage of health care workers are just a few of the barriers to healthcare in developing countries. mHealth has the potential to overcoming at least some of these challenges. To address this, a stakeholder perspective is adopted and analysis of existing research is undertaken to look at the mHealth delivery process in developing countries. This study focuses on four key stakeholder groups i.e. healthcare workers, patients, system developers, and facilitators. A systematic review identifies 108 peer-reviewed articles, which are analyzed to determine the extent these articles investigate the different types of stakeholder interactions, and to identify high-level themes emerging within these interactions. This analysis illustrates two key gaps. First, while interactions involving healthcare workers and/or patients have received significant attention, little research has looked at the role of patient-to-patient interactions. Second, the interactions between system developers and the other stakeholder groups are strikingly under-represented.

Keywords: Mobile Technology**;** Mobile Health (mHealth); mHealth delivery process; Stakeholder; Developing Countries, Patient, System Developer, Healthcare Worker and Facilitator.

2.2. Introduction

Many factors are known to hinder healthcare delivery in developing countries, including infrastructural deficiencies (Avgerou, 2008; Xiao et al., 2013) and limited access to medical care and healthcare workers (Scheffler et al., 2009). The use of mobile technologies to support the realisation of healthcare objectives have the potential to address these issues by improving the management of health services, supply chains, and communication (Kahn et al., 2010). Strategies based around the use of such mobile technologies are collectively referred to as mobile health (mHealth) (Kahn et al., 2010; Petrucka et al., 2013). mHealth describes the utilisation of wireless technologies to transmit and enable various health data contents and services which are easily accessible through mobile devices such as mobile phones, smartphones, PDAs (including medical sensors), laptops and tablet PCs (Bakshi et al., 2011; Kamsu-Foguem and Foguem, 2014; Kay et al., 2011b).

Consequently, a role has been identified for mHealth in developing countries across a range of contexts, for example as an incremental extension of ongoing eHealth developments in urban areas (Mars, 2013; Varshney, 2014b). Yet the advantages of mHealth are brought most keenly into focus in rural areas where little or no conventional healthcare infrastructure is available (Avgerou, 2008; Ngabo et al., 2012; Varshney, 2014b; Kumar et al., 2013). In these areas, mobile devices can be rapidly deployed as a means of improving health interventions (Chang et al., 2011; Mars, 2013; Petrucka et al., 2013; Varshney, 2014b; Dammert et al., 2014), preventing communicable diseases (Piette et al., 2012; Varshney, 2014b) and improving the health

literacy of patients and healthcare workers (Ajay and Prabhakaran, 2011; Pimmer et al., 2014; Varshney, 2014b).

However, while existing research has highlighted many areas of potential for mHealth in developing countries, the nascent nature of the phenomenon makes it hard to relate various findings from different studies into one holistic body of knowledge, meaning it is difficult to determine areas of convergence and oversight (Chib, 2010; Chib et al., 2015a). In particular, while it is clear that mHealth systems involve a range of stakeholders with different backgrounds, it is not obvious the extent to which interactions between each of these stakeholders have been studied. Therefore, the objective of this study is *to identify and synthesise existing research on the introduction of mHealth in developing countries.* The rest of the paper is organised as follows. In section 2 we discuss stakeholder theory and identify the types of common stakeholder groups identified in mHealth research. In section 3 we present the methodology, including the search for existing research, screening and exclusion processes, and the coding of the sampled literature. In section 4 we synthesise the findings of the reviewed literature according to the interactions they describe between stakeholders. Finally, in section 5 we consider the contributions and implications of study for research and practice.

2.3. Stakeholder Perspective

Stakeholder theory emerged in the management literature during the 1960s and 1970s (Ansoff, 1965; Rhenman et al., 1973) and grew in popularity across the following decades (Carroll and Näsi, 1997; Freeman, 2010). The term stakeholder refers to "those groups without whose support the organisation would not exist" (Freeman, in Pouloudi, 1999: 1), thus the key principle of

stakeholder perspective is that a firm/corporation enables groups of people to unite in order to create value (Donaldson and Preston, 1995; Freeman, 2010; Harrison and Wicks, 2013).

Beyond the management literature, a stakeholder perspective has proven valuable for Information Systems (IS) scholars (Ahn and Skudlark, 1997; Pouloudi, 1999; Pan, 2005). This is partly as a means to understanding more of the process requirements involved in system design (Sharp et al., 1999) and partly as a means to managing conflicts or diverging interests that may otherwise lead to project abandonment (Pan, 2005; Bailur, 2006). Of note to this study, stakeholder theory has also been highlighted as having particular relevance to the design of healthcare systems, due to the many stakeholder groups involved (Werhane, 2000; Elms et al., 2002).

Stakeholder theory has three main components: 1) the descriptive, 2) the normative, and 3) the instrumental (Donaldson and Preston, 1995; Hendry, 2001). The descriptive component "describes the corporation as a constellation of cooperative and competitive interests possessing intrinsic value" (Donaldson and Preston, 1995: 66). An example of the descriptive component can be seen in Jawahar & McLaughlin, (2001), who used stakeholder theory to describe the uneven importance of different stakeholder groups at different points in an organisational lifecycle. In healthcare systems, examples of these stakeholder groups may include patients (without whom the system has no purpose), healthcare workers (without whom interventions to patient health could not be made), and administrative personnel (without whom the system would not be financially or practically sustainable over long periods) (Werhane, 2000). The normative component requires that actors

accept the following ideas: “stakeholders are persons or groups with legitimate interests in procedural and/or substantive aspects of corporate activity, ‘the interests of all stakeholders are of intrinsic value’ and ‘a system is managerial in the broad sense of that term” (Donaldson and Preston, 1995: 67). This is also relevant to healthcare systems, as it positions a moral responsibility at the heart of stakeholder theorising (Nyemba-Mudenda and Chigona, 2013). The instrumental component “establishes a framework for examining the connections, if any, between the practice of stakeholder management and the achievement of various corporate performance goals” (Donaldson and Preston, 1995: 66-67). This is especially important to mHealth research, as the novelty of mHealth systems means the goal-oriented design of systems is ongoing.

Following our initial exploratory review of mHealth across a range of contexts, four main stakeholder groups (illustrated in Table 2-1), i.e. Patients, Healthcare Workers (HCWs), System Developers, and Facilitators were identified. Healthcare workers are defined in this study as *those individuals who are directly responsible for one or more aspects of healthcare delivery*. This characterisation is in line with the WHO description of health systems “as comprising all activities with the primary goal of improving health – inclusive of family caregivers, patient–provider partners, part-time workers (especially women), health volunteers and community workers” (WHO, 2006: xvi). Several subgroups of Healthcare Workers were identified in existing mHealth literature. This includes Healthcare Workers with minimal training, e.g. rural/community healthcare workers whose main responsibility is to find patients in small villages in need of remote referral (Hufnagel, 2012;

Mars, 2013; Littman-Quinn et al., 2011b; Bakibinga et al., 2017; Prinja et al., 2016; Gupta et al., 2017), mid-level healthcare workers often times take the place of a doctor due to lack of doctors in developing countries (e.g. Afridi and Farooq, 2011; Nchise et al., 2012; Knoble and Bhusal, 2015), and highly skilled remote medical experts around the world, who receive data and return recommendations via SMS or email (Mars, 2013; Kamsu-Foguem and Foguem, 2014; Littman-Quinn et al., 2011b). Other stakeholders include general caregivers, who are responsible for monitoring the real-time status of vital signs of patients (Haberer et al., 2010; Kamsu-Foguem and Foguem, 2014; Kay et al., 2011b; Mavhu et al., 2017) and laboratory staffers send test results to clinics in order to reduce the time in physical transportation delays (Hufnagel, 2012; Hao et al., 2015).

Stakeholder	Subgroups identified	Literature identifying subgroups
Patient	Sick or ill people	(e.g. Hufnagel, 2012; Aggarwal, 2012; Chandra et al., 2014; Van Olmen et al., 2017; Stephan et al., 2017; Soto-Perez-De-Celis et al., 2017; Mavhu et al., 2017; Yepes et al., 2016)
	Pregnant women/ mothers	(e.g. Alam et al., 2010; Ngabo et al., 2012; Lund et al., 2012)
	Elderly	(e.g. Chib et al., 2013; Varshney, 2014a; Kamsu-Foguem and Foguem, 2014)
	Women	(e.g. Chib and Chen, 2011; Lund et al., 2012; Chandra et al., 2014)
	Children	(e.g. Danis et al., 2010; Florez-Arango et al., 2011; Hufnagel, 2012)
	Public/Community Members	(e.g. Li et al., 2010; Simon and Seldon, 2012; Prieto et al., 2017; Kay et al., 2011b; Sharma et al., 2017; Samelli et al., 2017; Yousuf Hussein et al., 2016)
Healthcare workers	Health Care Workers	(e.g. DeRenzi et al., 2011; Hufnagel, 2012; Knoble and Bhusal, 2015; Van Olmen et al., 2017)
	Clinicians	(e.g. DeRenzi et al., 2011; Hufnagel, 2012; Vélez et al., 2014; Stephan et al., 2017)
	Community health workers	(e.g. Alam et al., 2010; Haberer et al., 2010; Mars, 2013; Surka et al., 2014; Mavhu et al., 2017; Yousuf Hussein et al., 2016)
	Carers/Caregivers	(Kay et al., 2011b; e.g. Bigna et al., 2014; Lucas, 2014; Mavhu et al., 2017)
	Health workers	(e.g. Alam et al., 2010; Chang et al., 2011; Piette et al., 2012)
	Frontline health providers	(e.g. DeRenzi et al., 2011; Hufnagel, 2012; Kamsu-Foguem and Foguem, 2014; Yepes et al., 2016)
	Counsellors	(Jamison et al., 2013; Chandra et al., 2014; e.g. Bediang et al., 2014; Mavhu et al., 2017)
	Laboratory staffers	(Sanner et al., 2014; e.g. Hao et al., 2015)
	Midwives	(e.g. Chib and Chen, 2011; Hufnagel, 2012; Vélez et al., 2014)
	Nurses	(e.g. Florez-Arango et al., 2011; Zargaran et al., 2014; Soto-Perez-De-Celis et al., 2017; Mavhu et al., 2017; Littman-Quinn et al., 2011b)
	Physicians	(e.g. Florez-Arango et al., 2011; Kay et al., 2011b; Littman-Quinn et al., 2011b)
	Doctors	(Hufnagel, 2012; Lucas, 2014; e.g. Hao et al., 2015)
	Health/Medical Professionals	(e.g. Kay et al., 2011b; Littman-Quinn et al., 2011b; Mars, 2013; Pimmer et al., 2014; Stephan et al., 2017; Soto-Perez-De-Celis et al., 2017; Prieto et al., 2017)
	Specialists/Experts	(e.g. Afridi and Farooq, 2011; Littman-Quinn et al., 2011b; Mars, 2013; Kamsu-Foguem and Foguem, 2014; Prieto et al., 2017)
System Developers	Developers	(e.g. Hufnagel, 2012; Surka et al., 2014; Knoble and Bhusal, 2015; Kumar et al., 2013)
	Software developers	(Tran et al., 2011; Littman-Quinn et al., 2011b; Vélez et al., 2014; Stephan et al., 2017)
	Systems Designers	(e.g. Bakshi et al., 2011; Kay et al., 2011b; Kamsu-Foguem and Foguem, 2014; Stephan et al., 2017)
	ICT Designers/Developers	(e.g. Ashar et al., 2010; Chib et al., 2013)
	Application Developers	(Sanner et al., 2012; e.g. Craven et al., 2014; Varshney, 2014a)
Facilitators	Ministry of Health	(Hufnagel, 2012; Ngabo et al., 2012; e.g. Hao et al., 2015; Prieto et al., 2017; Mavhu et al., 2017; Yepes et al., 2016)
	District health offices	(e.g. Kay et al., 2011b; Nchise et al., 2012; Sanner et al., 2014; Sharma et al., 2017; Mavhu et al., 2017)
	Research Institution	(e.g. Chang et al., 2012; Littman-Quinn et al., 2011b; Craven et al., 2014; Van Dam et al., 2017; Soto-Perez-De-Celis et al., 2017)
	Provider org./ NGOs	(Kumar et al., 2013; Littman-Quinn et al., 2011b; e.g. Craven et al., 2014; Van Olmen et al., 2017; Yepes et al., 2016)
	Network Service Providers	(Sanner et al., 2012; Varshney, 2014a; e.g. Medhanyie et al., 2015; Soto-Perez-De-Celis et al., 2017)

Table 2-1: Stakeholders identified in existing mHealth literature

Patients are defined in this study as *vulnerable individuals whom the mHealth systems are intended to help*. Notable among these are women, either as a general group (Chib and Chen, 2011; Lund et al., 2012; Chandra et al., 2014) or specifically pregnant women/mothers (Alam et al., 2010; Lund et al., 2012; Ngabo et al., 2012). Other groups were characterised as vulnerable due to their age, i.e. children (Danis et al., 2010; Florez-Arango et al., 2011; Hufnagel, 2012) and the elderly (Chib et al., 2013; Varshney, 2014a; Kamsu-Foguem and Foguem, 2014; Müller et al., 2016; Soto-Perez-De-Celis et al., 2017). More broadly, this also includes the sick or ill members of the society (Aggarwal, 2012; Hufnagel, 2012; Chandra et al., 2014; Holl et al., 2017) and the targeted public or community members for general health promotion/education (Li et al., 2010; Simon and Seldon, 2012; Kay et al., 2011b; Sharma et al., 2017; Modi et al., 2015).

System Developers are defined as *those individuals directly involved in the design or/and development of an mHealth artefact*. Most of these individuals identified in existing literature were primarily technical in nature, e.g. application developers (Hufnagel, 2012; Surka et al., 2014; Knoble and Bhusal, 2015); software developers (Tran et al., 2011; Littman-Quinn et al., 2011b; Vélez et al., 2014); and ICT designer/developer (Ashar et al., 2010; Chib et al., 2013; Kumar et al., 2013). Several studies also pointed to the role of designers, specifically system designers (Ngabo et al., 2012; Piette et al., 2012; Matheson et al., 2012; Stephan et al., 2017); and the application designers (Ashar et al., 2010; Danis et al., 2010; Aggarwal, 2012).

Facilitators are defined as *those individuals or bodies that expedite or enable the development, implementation and provision of mHealth*. This includes

government bodies, e.g. the health ministry (Hufnagel, 2012; Ngabo et al., 2012; Hao et al., 2015; Yepes et al., 2016) and its affiliates, such as district health offices (Kay et al., 2011b; Nchise et al., 2012; Sanner et al., 2014; Sharma et al., 2017) and research institutions (Littman-Quinn et al., 2011b; Craven et al., 2014; Thapa et al., 2016). It also includes individuals working for private or semi-private organisations, such as NGOs (Kumar et al., 2013; Littman-Quinn et al., 2011b; Craven et al., 2014), and the network service providers (Sanner et al., 2012; Varshney, 2014a; Medhanyie et al., 2015; Soto-Perez-De-Celis et al., 2017).

2.4. Methods

2.4.1 Gathering Literature

Literature was gathered from each of the leading academic databases, namely the AIS Electronic Library (AISel); PubMed/MEDLINE; Science Direct & Web Science; JSTOR; Academic Search Complete & Scopus; OCLC FirstSearch; and Google Scholar. A structured approach to searching these databases was adopted, based on an evolving set of general synonymous search terms relating to mHealth, e.g. "mHealth", "m-Health", "mHealth Care", "mHealthcare", "Mobile Health Care", and "Mobile Healthcare". Once the sample of literature was collected, a set of exclusion criteria were applied as part of title and abstract review. First, literature predating 2010 was excluded. This was done because the rapidly evolving capabilities of mobile devices could have made it misleading to compare studies of mHealth systems from before this period, so compromising the internal consistency of the sample. Second, only literature written in English was included. This was because the authors were not fluent in other languages included, thus there

was a significant risk that findings from those articles could have been misinterpreted, had they been included. Third, studies not using mobile devices specifically for health-related activities were excluded. Fourth, only peer-reviewed research was considered from journals, conferences or workshops. This was done to ensure the collective body of findings was as reliable as possible. Fifth, mHealth studies that focused on technologies that did not include the following were excluded: mobile phones, smartphones, and tablets. This was done because other studies have adopted different definitions of mHealth that include, for example, mobile clinics. Sixth, studies must be focused on developing countries. This process reduced the initial set of 329 papers down to a final set of 108. Figure 2-1 illustrates the process while Table 2-2 provides a breakdown of the number of papers excluded according to each criterion.

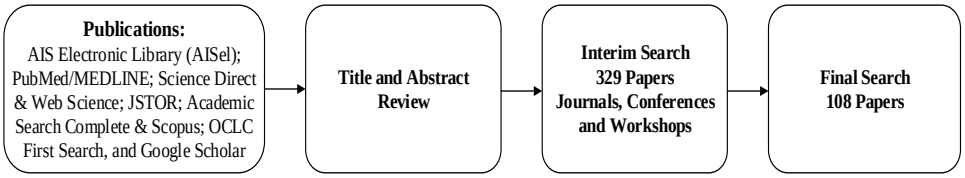

Figure 2-1: Review Process

Exclusion Criteria	Number of papers excluded
Not published since 2010	68
Not written in English	12
Not using mobile devices specifically for health-related activities	37
Not published in peer-reviewed journals, conferences, or workshops	21
Not based on pre-defined mHealth technologies	20
Not focused in developing countries	63

Table 2-2: Summary of Exclusion Criteria

2.4.2 Coding of Samples Literature

Literature was coded along two dimensions (see Figure 2-2 & Table 2-4 to 2-7 below). Previous research has suggested that healthcare delivery should be considered as a process (Rubin et al., 2001; MacIntosh et al., 2007; Minkler and Wallerstein, 2011). The first commonly documented stage of this healthcare delivery process is prevention and education, which allows interventions to be made before individuals become seriously ill (Danis et al., 2010; Piette et al., 2012; Ngabo et al., 2012; Chandra et al., 2014). The second stage is data collection, which allows Healthcare Workers a means of understanding the needs of individuals and detecting issues quickly (Asangansi and Braa, 2010; DeRenzi et al., 2011; Zhang et al., 2012; Medhanyie et al., 2015). The third is diagnosis, wherein Healthcare Workers determine the cause of an individual's deterioration (Florez-Arango et al., 2011; Hufnagel, 2012; Surka et al., 2014; Knoble and Bhusal, 2015). The fourth is treatment, as Healthcare Workers act to address the deterioration through various medicines, surgeries, etc. (Busis, 2010; Alam et al., 2010; Hufnagel, 2012; Knoble and Bhusal, 2015). Each of these stages is thus mapped to the analysis of mHealth in this study, i.e. mPrevention/Education (mP/E), represents the use of mobile health (mHealth) for preventive, advisory, counselling, and educational purposes; mData-Collection (mDC) represents the use of mHealth applications to collect data that may inform other aspects of healthcare delivery; mDiagnosis (mDG) represents the use of mHealth applications for the diagnosis of specific conditions, and; mTreatment (mTM) represents the usage of mHealth systems to guide remedial healthcare interventions for specific Patients. In the context of this

study, developing countries could be defined as countries in transition, most of which lack the necessary social, economic, and political resources to cope with a variety of problems (i.e., population growth, famine, poverty, etc.), and a huge burden of foreign debt which negatively impacts development (UNESCO, 1998).

With the delivery of mHealth conceptualised, the actors involved may then be considered. The stakeholders of a system have been identified as integral to the design development and implementation of mHealth solutions (Donaldson and Preston, 1995; Asangansi and Braa, 2010; Sanner et al., 2012). This is especially important in healthcare contexts, wherein different groups can possess varying perceptions, attitudes, skill-sets, and behaviours (Clarkson, 1995; Akter et al., 2013; Varshney, 2014a). Thus, the second dimension considers the interactions between the four main groups of stakeholders. The first stakeholder group describes those involved in providing healthcare, i.e. the Healthcare Workers (HCWs) (Kay et al., 2011b; Varshney, 2014a) (medical doctors, medical specialist, nurses, midwives, laboratory technicians and community health workers). The second group describes those individuals receiving healthcare, i.e. Patients (P) (individuals who may potentially receive preventative or curative care from the system). The third stakeholder group describes those individuals responsible for building the mHealth system, i.e. System Developers (SD). The fourth stakeholder group describes those individuals or groups that support the implementation and provision of mHealth, i.e. Facilitators (F). In considering the stakeholder view of mHealth, we place the Knowledge Base (KB) at the centre of the interactions (Figure 2). The KB is the data/information store or

health information repository that underpins mHealth delivery. Interaction flows for each of these stakeholder groups are considered between that group and the KB enabled by the system, e.g. Healthcare Workers to Knowledge Base, between that group and other groups, e.g. System Developer to Healthcare Workers, and within members of that group, e.g. Healthcare Workers to Healthcare Workers. These interactions are illustrated in Figure 2-2.

One researcher collected and coded these papers. Samples of coding under each of the analytical headings were discussed routinely among three researchers to ensure consensus in coding.

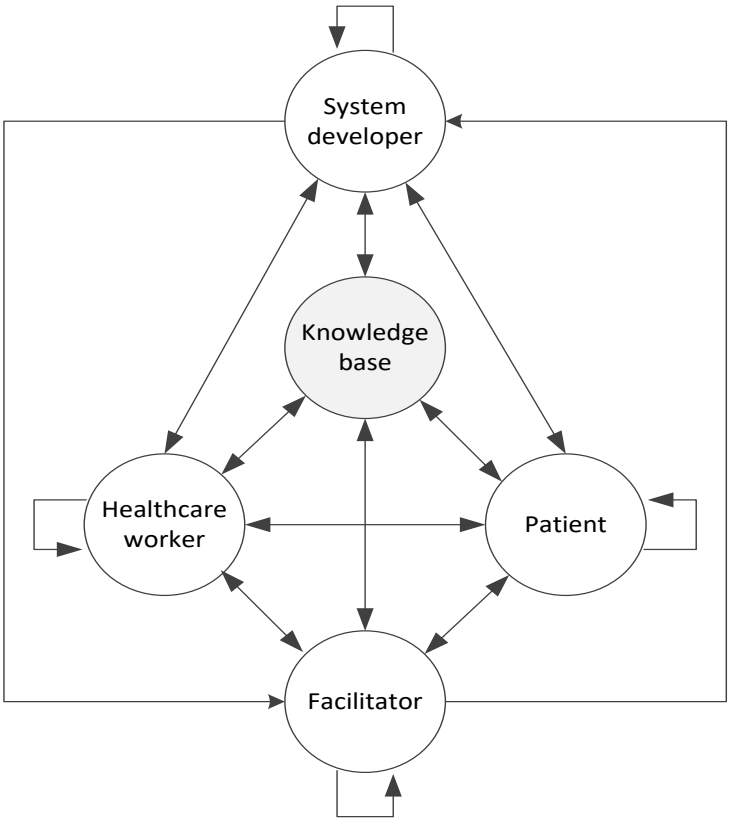

Figure 2-2: Stakeholder View of mHealth

2.5. Results

Analysis of the sampled literature reveals significant diversity in the stakeholder interactions studied and the methods employed. These methods include: focus groups (Chib and Chen, 2011; Pop-Eleches et al., 2011; Ly et al., 2012; Chandra et al., 2014; Sanner et al., 2014; Tomita et al., 2016; Thapa et al., 2016); surveys (Kay et al., 2011b; Piette et al., 2012; Rajput et al., 2012; Chib et al., 2013; Yepes et al., 2016; Stanton et al., 2015; Armstrong et al., 2012); case-studies (Ezenwa and Brooks, 2013; Madon et al., 2014); randomised experiments (Florez-Arango et al., 2011; Bigna et al., 2014); open-ended questionnaires (Tran et al., 2011; Lund et al., 2012; Vélez et al., 2014; Machingura et al., 2014); pre and post intervention studies (Sharma et al., 2017; Munro et al., 2014); pilot studies (Van Dam et al., 2017; Chib et al., 2012; Mahmud et al., 2010; Modi et al., 2015; Osei-tutu et al., 2013); semi-structured interviews (Nhavoto et al., 2017; Adedokun et al., 2016); cross-sectional observational studies (House et al., 2015); in-depth interviews (Thondoo et al., 2015; Zhang et al., 2013; Rotheram-Borus et al., 2012); feasibility studies (Gupta et al., 2017; Istepanian et al., 2014; Soto-Perez-De-Celis et al., 2017); mixed methods (Chib, 2010; Chang et al., 2011; Nchise et al., 2012; Lemay et al., 2012; Chang et al., 2013; Knoble and Bhusal, 2015); qualitative interviews (Matheson et al., 2012; Jamison et al., 2013; Pimmer et al., 2014; Hao et al., 2015; Medhanyie et al., 2015), and action research (Asangansi and Braa, 2010; Sanner et al., 2012).

The different types of stakeholder interactions are discussed in the following sections. Further, consistent with the ethical view of stakeholders proposed by (Werhane, 2000) (and to avoid repetition), the order in which these

interactions are presented reflects their centrality to health outcomes. Thus, the first section looks at the five stakeholder interactions directly involving Patients (Patient-to-Patient, Patient-to-HCW, Patient-to-SD, Patient-to-Facilitator, and Patient-to-Knowledge Base). With those interactions discussed, the second section looks at all remaining interactions involving HCWs (HCW-to-HCW, HCW-to-SD, HCW-to-Facilitator, and HCW-to-Knowledge Base). The third section then looks at all remaining interactions involving SDs (SD-to-SD, SD-to-Facilitator, and SD-to-Knowledge Base). Finally, the fourth section looks at all remaining interactions involving only Facilitators (Facilitator-to-Facilitator and Facilitator-to-Knowledge Base).

2.5.1 A Patient Perspective

Stakeholder Interaction	mPrevention/ Education	mData-Collection	mDignosis	mTreatment
P-HCW	74	76	53	54
P-KB	29	33	21	23
P-SD	6	11	9	9
P-F	7	5	4	4
P-P	3	2	-	-

Table 2-3: Patient Interaction

2.5.1.1 Interaction between Patients and Healthcare Workers

The interaction between Patients and HCWs were broadly studied by the sampled literature across all the four stages of mHealth delivery (see Table 2-3 above). In terms of mPrevention/Education, studies documented the opportunity afforded Patients to reach out whenever they had emotional problems or felt like talking to a HCW (Chang et al., 2011; Hufnagel, 2012; Chandra et al., 2014; Munro et al., 2014; Odigie et al., 2012). Such findings

are part of a broader theme where mobile technology enables Patients to be connected to remote HCWs (Bakshi et al., 2011; Hufnagel, 2012; Simon and Seldon, 2012; Sharma et al., 2017; Armstrong et al., 2012; Quinley et al., 2011; Mahmud et al., 2010), as part of which Patients' data can be collected and stored as personal health records. Such data are available to the individual to HCW responsible to the Patient in the future, allowing ongoing care to accumulate (Simon and Seldon, 2012; Hufnagel, 2012; Stephan et al., 2017; Gupta et al., 2017; Kabuya et al., 2014). Specifically, these data help HCWs to diagnose those individuals, design treatments for them, and to monitor their adherence and health needs (Chib and Chen, 2011; Hufnagel, 2012; Mars, 2013; Wagner et al., 2016; Mahmud et al., 2010; Garcia-Dia et al., 2017; Leon et al., 2015; Mavhu et al., 2017)

2.5.1.2 Interaction between Patients and the Knowledge Base

Interactions between Patients and the KB were less salient in discussions of mHealth delivery, though still extensively researched. Discussions addressing mPrevent/Education described systems where Patients can send SMS questions to a KB, then receive automated SMS messages on their cell phones that provides information and reminders for their self-care (Bakshi et al., 2011; Piette et al., 2012; Simon and Seldon, 2012; Hufnagel, 2012; Nhavoto et al., 2017; Wagner et al., 2016; Yepes et al., 2016; Hacking et al., 2016; Mangone et al., 2016; Müller et al., 2016; Diez-Canseco et al., 2015; Odigie et al., 2012; Armstrong et al., 2012; Garcia-Dia et al., 2017). Patients have also been equipped with wearable devices to keep track of parameters such as blood pressure, pulse rate, temperature, weight, blood glucose are stored as relevant data in the Knowledge Base (Simon and Seldon, 2012; Hufnagel,

2012; Kumar et al., 2013). This opportunity to monitor Patients' physiological state outside of Health institutions has been identified as a key protocol in mHealth systems in the future (Ajay and Prabhakaran, 2011; Simon and Seldon, 2012; Hufnagel, 2012; Mavhu et al., 2017; Wagner et al., 2016; Munro et al., 2014).

2.5.1.3 Interaction between Patient and System Developer

Table 3 illustrates that the interactions between Patients and SDs were not widely studied in the sampled literature. Of the studies that explored this aspect of mHealth, the most popular subject matter was the potential for Patients to amass perceptions of poor quality of service, which is identified as a key threat for the spread of mHealth systems (Hufnagel, 2012; Akter et al., 2013; Varshney, 2014a; Van Olmen et al., 2017). Varshney (2014a) elaborates on this by laying out five variables that determine Patients' continued intention to use an mHealth system: i) satisfaction, ii) confirmation of expectations, iii) perceived usefulness, iv) perceived service quality and v) perceived trust. The impact of the latter two variables (perceived service quality and perceived trust) were similarly found to be vital to Patients' continued use of mHealth systems according to feedback received by Akter et al. (2013). However, cost is seen as a key threat to those Patients or individuals with scares financial resources, thus limiting mHealth programme's reach and impact (Mangone et al., 2016; Holl et al., 2017).

2.5.1.4 Interaction between Patients and Facilitators

The interaction between Facilitators and Patients mostly occurred at the level of mPrevention/mEducation. In some cases, this involved notifying the public

about disasters or outbreaks of disease (Li et al., 2010; Hufnagel, 2012; Prieto et al., 2017; Toda et al., 2016). In other cases, facilitators sought to equip patients with the means to avoid falling ill, for example by distributing chemical treatment to minimise the spread of mosquito bites or spray an area once some clinical episodes are observed (Dammert et al., 2014).

2.5.1.5 Interaction between Patients and Patients

Interestingly, three studies in the sample explicitly addressed the interaction between Patients. All three studies (Chang et al., 2011; Mavhu et al., 2017; Rotheram-Borus et al., 2012) focused on mPrevention/Education. In addition, two of these studies (Chang et al., 2011; Mavhu et al., 2017) focused on mData-Collection. In particular, observations from the country specific initiatives in Uganda, Zimbabwe and South Africa found that Patients could be trained to care for other Patients to allow (1) greater health support for fellow Patients (2) greater opportunity for HCWs to attend to other high-priority responsibilities in their daily schedules. L.W Chang et al., (2011) note this approach of Patient training leads to changes in information-seeking among the broader Patient population, who become more likely to turn to these peer Healthcare Workers (PHCWs) for care than to conventional HCWs. L. W. Chang, et al., (2011) remark that "as one Patient illustratively said: ''I may have no money and I go to a friend. I might ask him to help me call the PHCW because the PHCW gave us their numbers. From that I will be able to explain the problems that I am going through. The PHCW will call the HCWs and they will come to attend to me'' (Chang et al., 2011: 1778).

Authors	Year	Stage of mHealth Process				Stakeholder Interaction														Types of mHealth	Country
		mP/E	mDC	mDG	mTM	PtoP	HCWtoP	PtoKB	SDtoP	HCWtoHCW	HCWtoKB	SDtoHCW	SDtoKB	FtoF	FtoP	FtoHCW	FtoSD	FtoKB	SDtoSD		
Adedokun et al	(2016)	√					√								√	√				SMS app	Nigeria
Afridi and Farooq	(2011)	√	√	√	√		√			√	√		√				√			Mobile-based app	Pakistan
Aggarwal	(2012)	√	√	√	√		√		√		√					√				SMS-based app	South Asia
Ajay and Prabhakaran	(2011)	√	√	√	√		√	√		√	√					√	√			Mobile-based app	India &China
Alam et al	(2010)	√	√	√	√		√			√	√									Mobile-based app	Bangladesh
Armstrong et al	(2012)	√						√			√								√	SMS app	Botswana
Asangansi and Braa	(2010)	√	√	√	√		√			√	√		√				√			Mobile-based app	Nigeria/India
Ashar et al	(2010)		√										√				√			Mobile-based app	Global
Bakibinga et al	(2017)		√	√	√		√	√		√	√									Mobile-based app	Kenya
Bakshi et al	(2011)	√	√	√	√		√	√		√	√									SMS-based app	India
Balakrishnan et al	(2016)	√	√	√	√		√		√	√	√	√	√	√		√	√			Mobile-based app	India
Bediang et al	(2014)	√	√		√		√	√			√						√			SMS/Voice-based app	Cameroon
Bigna et al	(2014)	√	√	√	√		√				√									SMS/Voice-based app	Cameroon
Bourouis et al	(2013)			√				√			√									SMS/MMS-based app	Algeria
Busis	(2010)	√	√	√	√		√	√		√	√									SMS/Voice-based app	Developing Countries
Chandra et al	(2014)	√	√	√	√		√	√												SMS/Voice-based app	Bangalore
Chang et al	(2011)	√	√			√		√		√	√						√			SMS/Voice-based app	Uganda
Chang et al	(2012)	√	√	√	√		√			√	√					√	√			Mobile-based app	Botswana
Chang et al	(2013)	√	√	√	√		√			√	√						√			Mobile-based app	Uganda
Chib	(2010)	√	√	√	√		√			√	√									Mobile-based app	Indonesia
Chib and Chen	(2011)	√					√			√	√									SMS/Voice-based app	Indonesia
Chib et al	(2013)	√	√	√	√		√	√		√							√			SMS-based app	Uganda
Chib et al	(2012)	√					√			√										SMS app	Uganda
Dammert et al	(2014)	√	√				√	√			√				√					SMS/Voice-based app	Peru
Danis et al	(2010)	√					√	√		√										SMS-based service	Uganda
DeRenzi et al	(2011)	√	√	√	√		√			√	√									Mobile-based app	Developing countries
DeStigter	(2012)	√	√	√	√		√			√	√									Mobile-based app	Uganda
Diez-Canseco et al	(2015)	√					√	√	√			√					√	√		SMS app	Argentina,GuatemalaPeru
Ezenwa and Brooks	(2013)	√	√		√		√				√									Mobile-based app	Nigeria
Florez-Arango et al	(2011)	√	√	√	√		√				√					√				Mobile-based app	Colombia

Table 2-4: Coding of papers by stakeholder interaction at each stage of mHealth delivery

Authors	Year	Stage of mHealth Process				Stakeholder Interaction													Types of mHealth Initiatives	Country
		mP/E	mDC	mDG	mTM	PtoP	HCWtoP	PtoKB	SDtoP	HCWtoHCW	HCWtoKB	SDtoHCW	SDtoKB	FtoF	FtoP	FtoHCW	FtoSD	FtoKB	SDtoSD	
Garcia-Dia et al	(2017)	√	√				√	√			√					√		√		Voice/SMS/MMS	Philippines
Ginsburg et al	(2015)		√	√	√		√	√		√	√		√				√	√	√	Mobile-based app	Ghana
Gupta et al	(2017)		√	√	√		√		√	√	√					√	√			Mobile-based app	India
Haberer et al	(2010)	√	√		√		√				√									SMS/Voice-based app	Uganda
Hacking et al	(2016)	√					√										√			SMS app	South Africa
Hao et al	(2015)		√							√	√									Mobile-based app	Swaziland
Holl et al	(2017)	√	√	√	√		√	√		√										Mobile-based app	Cameroon
House et al	(2015)	√	√		√		√							√		√				Voice/IVR app	Kenya
Hufnagel	(2012)	√	√	√	√		√	√		√	√		√		√	√	√			Mobile-based app	India, Tanzania, Zambia
Istepanian et al	(2014)	√	√	√	√		√			√	√			√	√			√		Mobile-based app	Iraq
Jamison et al	(2013)	√					√				√						√			SMS/Voice-based app	Uganda
Jimoh et al	(2012)		√				√			√	√			√						Mobile-based app	Nigeria
Johnson et al.	(2017)	√					√			√										SMS app	Kenya
Kabuya et al	(2014)		√				√	√			√							√		Mobile-based app	South Africa
Kamsu-Foguem & Fog.	(2014)	√	√	√	√		√				√						√			SMS/Voice-based app	Developing Countries
Kay et al	(2011b)	√	√	√	√		√	√		√	√						√			Mobile-based app	Developing Countries
Knoble & Bhusal	(2015)	√	√	√			√			√	√	√						√		Mobile-based app	Nepal
Lemay et al	(2012)	√	√		√					√	√									SMS-based service	Malawi
Leon et al	(2015)	√					√													SMS app	South Africa
Li et al	(2010)	√	√	√	√		√	√		√	√				√					SMS-based service	Malawi
Littman-Quinn et al	(2011b)	√	√	√	√		√	√		√	√			√						SMS/MMS-based app	Botswana
Lucas	(2014)	√	√		√			√						√						Mobile-based app	IndiaBangladeshCambodia
Lund et al	(2012)	√	√		√		√			√	√									SMS/Voice-based app	Zanzibar
Lwin et al	(2017)		√				√	√		√	√						√			Mobile-based app	Sri Lanka
Machingura et al	(2014)	√	√	√	√		√				√									Mobile-based app	Developing Countries
Madon et al	(2014)	√	√				√				√					√	√			Mobile-based app	Tanzania
Mahmud et al	(2010)	√	√				√			√	√									SMS app	Malawi
Mangone et al	(2016)	√		√	√		√	√												SMS app	Tanzania
Mars	(2013)	√	√	√	√		√	√		√	√			√		√				SMS/Voice-based app	Africa
Mavhu et al	(2017)	√	√				√	√		√	√		√	√				√		Mobile-based app	Haiti

Table 2-5: Coding of papers by stakeholder interaction at each stage of mHealth delivery continued

Author	Year	Stage of mHealth Process				Stakeholder Interaction														Types of mHealth Initiatives	Country
		mP/E	mDC	mDG	mTM	PtoP	HCWtoP	PtoKB	SDtoP	HCWtoHCW	HCWtoKB	SDtoHCW	SDtoKB	FtoF	FtoP	FtoHCW	FtoSD	FtoKB	SDtoSD		
Matheson et al	(2012)	√	√		√	√	√													SMS/Voice app	Zimbabwe
Medhanyie et al	(2015)		√	√			√				√						√			Mobile-based app	Ethiopia
Modi et al	(2015)	√					√	√	√			√	√							SMS/Mobile-based app	India
Müller et al	(2016)	√					√													SMS app	Malaysia
Munro et al	(2014)		√				√		√	√	√	√	√							SMS app	Liberia
Nakashima et al	(2013)	√	√	√	√		√				√							√		Mobile-based app	Bangladesh
Nchise et al	(2012)	√					√	√			√						√			Mobile-based app	Uganda
Ngabo et al	(2012)	√	√	√			√				√	√		√		√	√			SMS-based service	Rwanda
Nhavoto et al	(2017)	√					√				√							√		SMS app	Mozambique
Odigie et al	(2012)	√					√													SMS/Voice IVR	Nigeria
Osei-tutu et al	(2013)		√				√	√		√	√									SMS/MMS/IVR	Ghana
Petrucka et al	(2013)	√	√	√	√			√		√							√			Mobile-based app	Ghana
Piette et al	(2012)	√	√	√	√		√	√			√						√			Mobile-based app	Honduras and Mexico
Pimmer et al	(2014)	√								√	√									Mobile-based app	South Africa
Pop-Eleches et al	(2011)				√		√				√									SMS/Voice-based app	Kenya
Praveen et al	(2014)		√	√	√		√		√	√		√	√							Mobile-based app	India
Prieto et al	(2017)		√				√	√	√		√	√	√					√		SMS/Mobile-base app	Guatemala
Quinley et al	(2011)	√	√	√	√		√			√	√				√	√				SMS/MMS/IVR	Botswana
Rajput et al	(2012)	√	√	√	√		√				√			√			√			Mobile-based app	Kenya
Ricard-Gauthier et al	(2015)		√	√	√		√				√						√			Mobile-based app	Madagascar
Rotheram-Borus et al	(2012)	√				√	√													SMS app	South Africa
Samelli et al	(2017)		√	√	√		√	√	√	√	√	√								Mobile-based app	Brazil
Sanner et al	(2012)		√	√			√			√	√		√	√			√			Mobile-based app	India
Sanner et al	(2014)		√				√				√		√				√			Mobile-based app	Malawi
Selke et al	(2010)	√			√		√													SMS app	Kenya
Sharma et al	(2017)	√	√				√							√		√				SMS/Voice app	India
Simon & Seldon	(2012)	√	√				√	√			√									Mobile-based app	Malaysia
Soto-PerezDeCelis et al	(2017)	√	√		√		√	√			√									Mobile-based app	Mexico
Stanton et al	(2015)		√	√			√	√			√	√	√			√	√			SMS app	Malawi, Ghana
Stephan et al	(2017)		√	√	√		√		√		√	√								Mobile-based app	Brazil

Table 2-6: Coding of papers by stakeholder interaction at each stage of mHealth delivery continued

Authors	Year	Stage of mHealth Process				Stakeholder Interaction														Types of mHealth Initiatives	Country
		mP/E	mDC	mDG	mTM	PtoP	HCWtoP	PtoKB	SDtoP	HCWtoHCW	HCWtoKB	SDtoHCW	SDtoKB	FtoF	FtoP	FtoHCW	FtoSD	FtoKB	SDtoSD		
Stine Lund et al	(2014)		√	√	√		√	√	√	√	√	√				√	√			SMS/Voice IVR app	Tanzania
Surka et al	(2014)	√	√	√			√				√									Mobile-based app	South Africa
Thondoo et al	(2015)	√	√	√	√		√			√	√					√				SMS/Voice app	Uganda, Mozambique
Toda et al	(2016)	√					√								√	√		√		SMS app	Kenya
Tomita et al	(2016)			√			√													SMS app	South Africa
Tran et al	(2011)			√	√		√			√	√						√			SMS/MMS-based app	Egypt
Van Dam et al	(2017)	√	√				√							√					√	Mobile-based app	Kenya
Van Olmen et al	(2017)	√	√				√	√			√			√			√			SMS app	DRCongo/Cambodia/Philippines
Varshney	(2014a)	√	√	√	√		√	√	√	√	√	√	√				√			Mobile-based app	Global
Vélez et al	(2014)	√	√	√	√		√				√	√				√				Mobile-based app	Ghana
Wagner et al	(2016)	√					√													SMS app	Burkina Faso
Wu et al	(2014)	√		√			√					√	√							Mobile-based app	China
Y. Zhang et al	(2013)		√				√				√									Mobile-based app	China
Yepes et al	(2016)	√					√											√		SMS app	Seychelles
Yousuf Hussein et al	(2016)		√	√	√		√			√	√						√			Mobile-based app	South Africa
Zaidi et al	(2013)		√				√			√	√									SMS/Voice app	Pakistan
Zargaran et al	(2014)		√				√			√	√									Mobile-based app	South Africa
Zhang et al	(2012)		√				√				√						√			Mobile-based app	China

Table 2-7: Coding of papers by stakeholder interaction at each stage of mHealth delivery continued

Abbreviations: mP/E - mPrevention/Education; mDC – mDataCollection; mDG – mDiagnosis; mTM –mTreatment; PtoP - Patient to Patient; HCWtoP - Healthcare Worker to Patient; PtoKB - Patient to Knowledge Base; SD/P - System Developer to Patient; HCWtoHCW - Healthcare Worker to Healthcare Worker; HCWtoKB - Healthcare Worker to Knowledge Base; SDtoHCW - System Developer to Healthcare Worker; SDtoKB - System Developer to Knowledge Base; FtoF - Facilitator to Facilitator; FtoP - Facilitator to Patient; FtoHCW - Facilitator to Healthcare Worker; FtoSD - Facilitator to System Developer; FtoKB - Facilitator to Knowledge Base, and SDtoSD - System Developer to System Developer.

2.5.2 A Healthcare Worker Perspective

Stakeholder Interaction	mPrevention/ Education	mData-Collection	mDiagnosis	mTreatment
HCW-KB	54	70	47	48
HCW-HCW	37	46	35	36
HCW-F	17	18	14	13
HCW-SD	9	15	13	9

Table 2-8: Healthcare Workers Interaction

2.5.2.1 Interaction between Healthcare Workers and Knowledge Base

The interaction between HCWs and KB was also extensively studied in the sampled literature across all four stages of mHealth delivery. In terms of mPrevention/Education, studies suggest that by gaining access to some established KB or health information repository, HCWs can enhance or improve their health knowledge even when residing in a resource-poor settings (Hufnagel, 2012; Pimmer et al., 2014; Bakibinga et al., 2017; Gupta et al., 2017; Thapa et al., 2016). Studies demonstrated a willingness among HCWs to gather and transmit collected Patient to data national repositories or databases (Alam et al., 2010; Varshney, 2014a; Van Dam et al., 2017). Further, there is evidence that these HCWs are also willing to refer to such centralised systems to guide their diagnoses and treatments at the point-of-care in developing countries (Alam et al., 2010; Hufnagel, 2012). At the facility level, it can improve the timelines for stocks replenishment as a result of automatic stock reporting system (Hufnagel, 2012; Lemay et al., 2012; Madon et al., 2014).

2.5.2.2 Interaction between Healthcare Workers and Healthcare Workers

The interactions between HCWs were studied extensively by the sampled literature across all four stages of the mHealth delivery process. Among the

literature addressing mPrevent/Education, most discussion centred upon the infeasibility of scarce HCWs to make themselves available for workshops or class-room teaching as such expectations fail to consider the practical realities of these resource-poor settings (Hufnagel, 2012; Mars, 2013; Gupta et al., 2017). This presents an important challenge, as contact with HCWs is necessary to reduce the sense of isolation experienced by rural HCWs in the developing countries (Mars, 2013; Pimmer et al., 2014; Thondoo et al., 2015; Nhavoto et al., 2017). Discussion around mData-Collection, and mTreatment were frequently combined in studies, most notably in discussion of mHealth systems with the capacity to transmit locally gathered data to medical experts located anywhere in the world. This allows those experts to make use of remote specialisation and resources to transfer their findings and diagnosis back to HCWs in the developing countries via SMS or email which can then inform Patient treatment (Chib and Chen, 2011; Hufnagel, 2012; Pimmer et al., 2014; Thondoo et al., 2015). For instance, maternal mortality is one of the biggest health problems in developing countries (Alam et al., 2010; Chib and Chen, 2011; Medhanyie et al., 2015; Bakibinga et al., 2017; Munro et al., 2014). The lack of maternal care specialists in these areas can be mitigated by sharing data from pregnant with specialists in more resource-wealthy environments, who in-turn assesses different levels of risk for the Patient and help prioritise healthcare for those most in need (Alam et al., 2010; Chib and Chen, 2011; Medhanyie et al., 2015).

2.5.2.3 Interaction between Healthcare Workers and Facilitators

The interactions between Facilitators and HCWs are typically designed to guide and improve the delivery of mHealth by the latter. In some cases this

involves improving HCWs' ability to access and respond to data (Gupta et al., 2017; Balakrishnan et al., 2016; Madon et al., 2014; Thondoo et al., 2015; Stanton et al., 2015). For example, the Tanzania's National Institute of Medical Research (NIMR) sponsored a scalable smart phone-based management information system to help deliver a neglected tropical disease (NTD) programme, that would empower local HCWs to take action (Madon et al., 2014). In other cases, the focus was less on centralised IT solutions and more on IT-enabled training sessions for HCWs (Hufnagel, 2012; Nchise et al., 2012; Mars, 2013; Stanton et al., 2015). The interaction between HCWs and network service providers was also discussed as a key enabler of mHealth practices, mostly because sudden interruptions or inconsistencies in telecommunications networks could devastate those in the midst of services, potentially preventing new users from engaging with mHealth technologies (Aggarwal, 2012; Thondoo et al., 2015; Stanton et al., 2015). In some cases, government bodies and network service provision have converged to interact with HCWs as one, e.g. in Ghana, the Government Millennium Village Project (MVP) is currently implementing the Millennium Village Global Network (MVG-Net), the aim of which is to closely partner the coordination of care between HCWs and MVP clinical facilities (Vélez et al., 2014).

2.5.2.4 Interaction between Healthcare Workers and System Developers

The interaction between HCWs and SDs was the least well-represented in the sampled literature across all stages of the mHealth delivery process. Of those studies that did address this interaction, discussion centred mostly on usability and implementation issues (e.g. Stephan et al., 2017; Vélez et al., 2014; Akter et al., 2013; Ginsburg et al., 2015). Ensuring continuous use of mHealth

systems by healthcare workers is often a key determinant of their success (Akter et al., 2013; Vélez et al., 2014). Thus, collaborative design processes are undertaken between HCWs and SDs to minimise adoption issues at various parts of the mHealth delivery process (Akter et al., 2013; Vélez et al., 2014). This is illustrated in case studies of rural setting in developing countries, where feedback provided from HCWs to the SDs led to significant functional changes in applications (Vélez et al., 2014; Knoble and Bhusal, 2015). Collaborative design and implementation processes with HCWs have also been used to ease tensions around the introduction of mHealth systems (Ngabo et al., 2012; Vélez et al., 2014). These collaborative processes help SDs to form an in-depth understanding of HCWs' task structure, their special mobility in places of work and the associated information technology liabilities that will ultimately influence continued usage of the IT artefact (Akter et al., 2013; Varshney, 2014a).

2.5.3 A System Developer Perspective

Stakeholder Interaction	mPrevention/ Education	mData-Collection	mDignosis	mTreatment
SD-F	23	30	24	21
SD-KB	8	13	10	8
SD-SD	19	23	17	14

Table 2-9: System Developer Interaction

2.5.3.1 Interaction between System Developers and Facilitators

The interaction between Facilitators and SDs is the translation of policies into infrastructure and working IT systems. System designers require approvals from MoH in the respective countries for the introduction of any mHealth tools regarding ethical issues (e.g. Chang et al., 2011; Piette et al., 2012; Bediang et al., 2014; Van Dam et al., 2017; Lwin et al., 2017). It appears that

transitioning these developed tools from the SD to MoH can be a problem if the MoH are not part of the system design from the outset (Hufnagel, 2012; Thondoo et al., 2015; Van Dam et al., 2017). System Developers cannot develop devices that can communicate over a network and also be capable of running all applications required for mHealth delivery without the support of the network providers (Chib et al., 2013; Hacking et al., 2016; Thapa et al., 2016). Other challenges that SDs might encounter with the respective governments include delivering its services into the institutional framework of each country, which is facilitated if the countries concerned have an eHealth strategy and related policies and coordination structures put in place (Varshney, 2014b; Hufnagel, 2012).

2.5.3.2 Interaction between System Developers and Knowledge Base

As with other SDs-related interactions, interactions between SDs and the KB were also studied infrequently in the sampled literature. Amongst the literature addressing mPrevention/Education, much of the discussion focused on the development of new technologies that continuously improve health outcomes, quality of life, and/or that will offer solutions to emerging problems (Matheson et al., 2012; Wu et al., 2014). For example, an examination of scalability issues suggested all mobile applications should be carefully designed and introduced so as to support ongoing efforts at a cohesive mobile supported health information infrastructure in developing countries (Asangansi and Braa, 2010). In the same vein, Sanner et al., (2014) recommend the concept of "grafting" as a new perspective on information infrastructure, wherein new solutions must be 'grafted' onto existing resources and local interested parties. New reusable system archetypes were

also discussed as basic utilities. Afridi and Farooq, (2011) explained the workings of OG-Miner – an intelligent health tool that presents a novel combination of data mining techniques for accurate and effective categorisation of high risk pregnant women. According to Lwin, et al., (2017), Mo-Buzz – a Mobile Pandemic Surveillance System for Dengue could digitally record site visit information by public health inspectors (PHI) and track dengue outbreaks in real-time using a built-in global positioning system technology. MDAU – a modular data analysis unit, which is a USB powered multiparameter diagnostic device that captures ECG, temperature, heart & lung sounds, SPO2 and BP, and communicates with the remote doctor through a low bandwidth audio/video/data conferencing (Hufnagel, 2012). This device according to Hufnagel (2012), allowed the incorporation of the whole healthcare delivery ecosystem in order to provide meaningful service.

2.5.3.3 Interaction between System Developers and System Developers

The interaction between SDs and other SDs was referred to by a number of studies in the sampled literature in terms of collaborative development challenges. Most interactions in the sampled literature were focused on data collection by integrating open-source platforms. In Ethiopia, Medhanyie, et al., (2015) installed and customised data collection application named Open DataKit with electronic maternal healthcare forms on smartphones for the assessment of pregnant women's health by Healthcare Workers. In Kenya, Van Dam et al (2017) integrated an open-source CommCareHQ application with cloud infrastructure into mobile phones as job aids for rural Healthcare Workers. In the case of Malawi, Li, et al (2010) used an open-source kit FrontlineSMS to create an SMS-based communication hub for instantaneous

data transmission between community Healthcare Workers and hospitals. The focus of these collaborative product development is for public availability and communication, and is usually obtained via the Internet.

2.5.4 A Facilitator Perspective

Stakeholder Interaction	mPrevention/ Education	mData-Collection	mDiagnosis	mTreatment
F-F	13	14	8	9
F-KB	9	8	4	4

Table 2-10: Facilitator Interaction

2.5.4.1 Interaction between Facilitators and Facilitators

The interactions between Facilitators and other Facilitators described an international web of organisations, each of whom possess different areas of expertise, which interact to coordinate large mHealth projects. In Botswana, some organisations, including the Orange Foundations, the Clinton Health Access initiatives (CHAI) and the Ministry of Health of Botswana (MoH) aimed to develop ICT tools for health provision and education within the health public health sector (Littman-Quinn et al., 2011b). In Ghana, PATH (Partnership for Transforming Health Systems) collaborated with the University of Washington to develop an android-enabled IMCI (Integrated Management of Childhood Illness) guidelines on tablets for healthcare providers in rural communities in Ghana (Ginsburg et al., 2015). In Bihar, India, Care India with the support of Bill and Melinda Gates Foundation developed a public health initiative called ‘continuum of care services using mHealth tool to improve maternal and new-born health (Balakrishnan et al., 2016). In the case of Haiti, the informatics group at the International Training and Education Center for Health (I-TECH), formed as a result of the collaborative activity between the University of Washington and University

of California at San Francisco. In this instance, an electronic medical record (EMR) system called iSanté has been implemented as part of Haiti's response to HIV (Matheson et al., 2012). The key challenge in this partnership is the facilitation of a smooth transition from a donor driven pilot oriented relationship in conjunction with the mobile operators into a business model that is sustainable where the respective ministries of health in those countries obtain the capacity to assume ownership of the programme (Sanner et al., 2012).

2.5.4.2 Interaction between Facilitators and Knowledge Base

The interaction between Facilitators and the KB typically takes the form of contributing or retrieving information for/about the public. In terms of retrieving data from the KB, one example was the Nepalese Ministry of Health's use of data from the e-algo platform (Knoble and Bhusal, 2015). The e-algo platform was primarily used by HCWs to diagnose and treat different conditions, however it also provided an overview of health conditions in different areas, which the Ministry of Health uses to inform the ongoing policy development. Another example was in Haiti where the Ministry of Health Ministry track the incidence of HIV and progress of prevention efforts store in iSanté platform (Matheson et al., 2012).

2.6. Conclusion

Before discussing contributions, the possible limitations of this study are outlined. First, including only studies written in English may have excluded inputs that would have added some richness to the findings of this study. For example, studies written in non-English languages may have provided us with

deeper insights into the interactions between stakeholders that were not captured by those written in English language. Second, although the review set out to address the interactions between the pre-identified stakeholders within a country during an mHealth interventions, the actual review did not reveal any other stakeholder. This means that a continued research is needed into the breakdown of these other stakeholders within the group/s from outside looking to do mHealth interventions in a country, thereby adding high-level research trends. Third, the review was conducted at the developing countries level, the disparity or otherwise in the results of the type of mHealth, and the quality of interventions across countries were outside the scope of this study. This is an opportunity for further research into this important part in mHealth interventions in developing countries.

This study performed a literature review of mHealth research in developing countries. A preliminary review identified four high-level stakeholder groups of interest to mHealth systems, namely Healthcare Workers (HCWs), Patients, System Developers (SDs), and Facilitators. A systematic review of mHealth in developing countries was performed to identify existing research, initially retrieving 329 peer reviewed articles, which were subsequently reduced to 108 eligible studies. Studies were analysed and coded according to the stages of mHealth delivery that they described (mPrevention/Education, mData-Collection, mDiagnosis and/or mTreatment) and which stakeholder interactions were studied. This allowed meta-level themes to be identified from existing research, as well as areas that have been less well considered to date. This review has made six significant contributions to IS research.

First, a contribution is made in the form of a novel two-dimensional lens used to analyse the literature. This lens provided a useful (and reusable) means of sense-making for the diverse body of research in healthcare, revealing several important high-level trends in the analysis and design of mHealth systems in developing countries. Among these trends was a triangulated meta-level investigation of the potential of mobile phones to transform healthcare delivery services in resource-poor settings (e.g. Kay et al., 2011b; Hufnagel, 2012; Soto-Perez-De-Celis et al., 2017; Sharma et al., 2017), to address heterogeneous information needs in rural communities (e.g. Piette et al., 2012; Ngabo et al., 2012; Akter et al., 2013; Van Olmen et al., 2017), to boost information penetration in areas where access to health information is limited (e.g. Li et al., 2010; Ngabo et al., 2012; Littman-Quinn et al., 2011b; Piette et al., 2012; Ezenwa and Brooks, 2013; Nhavoto et al., 2017; Lwin et al., 2017), and to provide real-time collaborative and adaptive interventions (DeRenzi et al., 2011; Littman-Quinn et al., 2011b; Nchise et al., 2012; Leon et al., 2015). The validation of these claims across multiple stakeholder perspectives and different stages in mHealth delivery reinforces the importance of the role of mHealth for these contexts.

Second, a balanced focus of mHealth was observed across each of the stages of the mHealth delivery. Several of the sampled papers report findings from pilot studies in which the maturity and reach of system implementation was limited, meaning many issues of integration and scale may yet emerge. However, the fact that mHealth efforts represent a proportional breadth of activities means that the value of each stage can be observed and discussed. For example, in India mPrevention/Education interventions that targeted the

mental health of teenage girls between the ages of 16-18 years from urban slums resulted in 62% of users feeling more supported (Chandra et al., 2014). Similarly, in low-resource settings, in Cameroun mobile-phone-based reminders significantly increased attendance for scheduled HIV appointments with carers of paediatric patients (Bigna et al., 2014). The demonstrable success of these types of initiation paves the way for subsequent holistic endeavours in comparable contexts.

Third, analysis of the literature showed that interactions around HCWs are being extensively researched. This makes sense, given these stakeholders are likely to be the most intensive users of mHealth systems. Thus, understanding these stakeholders is essential to understanding their mental model, cultural biases, and tacit expectations of a new system (Norman and Draper, 1986; Maguire, 2001; Dearden, 2008). Further, given mHealth systems will involve significant new practices for these HCWs (e.g. Florez-Arango et al., 2011; Vélez et al., 2014; Kumar et al., 2013), it is important for scholars and designers to understand the existing practices users may already have in place (Bødker, 2000; Kaptelinin and Nardi, 2006).

Fourth, this study found that, although the role of Patients is generally well-researched, there is a significant oversight in terms of the design and analysis of system-relevant Patient-to-Patient interactions. This is a significant shortcoming for the body of knowledge around mHealth, as peer-based observation, discussion, and referral plays an important role when introducing new systems (Jasperson et al., 2005; Lou et al., 2005). One of the three papers that studied this stakeholder interaction (Chang et al., 2011) suggests this is equally relevant for mHealth systems in rural areas of developing countries,

demonstrating that when Patients are trained to care for other Patients it brings support to others through peer-based exchange of information and counselling.

Fifth, but perhaps most importantly, analysis of existing literature revealed a significant under representation of research studying System Developers' interactions. Recent advances in system design have shown that the manner in which System Developers interact with potential users is key to eliciting good requirements, spotting issues early, and allowing creative solutions to be presented for complex situated problems (Buchanan, 1992; Brown, 2008; Brown and Wyatt, 2010). Thus, this under-representation may be limiting the effectiveness of mHealth initiatives by inadvertently creating design contexts where System Developers have limited capacity to empathise with Patients and Healthcare Workers. The interactions between System Developers highlighted the collaborative viability of using an open-source mobile platform specifically designed for use in low-resource settings by mHealth implementers to conduct data collection (e.g. Van Dam et al., 2017; Rajput et al., 2012; Kumar et al., 2013; DeRenzi et al., 2011). Researchers believe collaborative approaches to system development would encourage mHealth implementers to adopt accepted standards and interoperable technologies, preferably using open-source architecture, making it cost-effective to everyone (e.g. Kumar et al., 2013; Hufnagel, 2012; Kay et al., 2011b; Rajput et al., 2012; Istepanian and Woodward, 2016).

Sixth, this study found that most of the mHealth interventions took place in African Countries, constituting about 65% of the sampled papers with variations among countries by mHealth type. This may be due in part to the

fact that most African countries are lagging behind the rest of the world regarding healthcare access (Barber et al., 2017). Most of these initiatives in the sampled data are either funded by private-public partnerships, or NGOs and oversea initiatives (Istepanian and Woodward, 2016). Approximately 26% of the sampled papers were from Asian Countries. The Americas constitute about 9% of the sampled papers. There were few interventions measuring quality clinical outcomes but a considerable number of the sampled literature were explicit on the processes undertaken and with high level of satisfaction expressed by both Patients and Healthcare Workers alike (e.g Nhavoto et al., 2017; Leon et al., 2015; Adedokun et al., 2016).

Based on these findings, we thus call for future research that focuses specifically on the interaction between System Developers and other stakeholders. Further, we call for research that delves into the critical peer-based information exchange, referral, and knowledge sharing that happens between Patients, either as a result of new mHealth initiatives, or those interactions that may impede new developments. The importance of understanding cultural variation in the analysis and design of IT systems is long documented (e.g. Walsham, 2002; Walsham and Sahay, 2006; Avgerou, 2008; Reinecke and Bernstein, 2013). Addressing these gaps will be crucial to increasing cultural sensitivity and allowing mHealth systems to reach the poorest and most remote regions.

Chapter Three

3. World Apart: A Socio-Material Exploration of mHealth in Rural Areas of Developing Countries.

3.1 Abstract

Healthcare in developing countries has been limited by shortages of social and physical infrastructure, particularly in rural areas. The integration of mobile devices into healthcare delivery has been proposed to overcome some of these issues. Mobile health (mHealth) solutions allow diagnostic and analytical practices to be performed beyond the traditional boundaries of urban healthcare institutions. Mindful of the added pressure this places on rural healthcare workers, previous studies have mostly focused on encouraging individuals to engage with these new technologies. Technical studies have focused on issues such as usability, adherence, and security, while social studies have focused on issues such as public image, peer pressure, and acceptance. Yet there are few if any holistic studies exploring how cultural differences and prevailing social practices in target areas might change the manner in which these technologies are used and the deeper goals with which they are associated. This study frames this problem using a socio-material approach, based on an exploratory case-study in West Africa. Findings suggest that, while urban healthcare is highly structured and best practice-led, rural healthcare often relies on peer-based knowledge sharing and community support. This has implications for the enacted materiality of mobile technologies, as while urban actors may see them as tools for automation and the enforcement of responsible healthcare best practice, rural

actors may see them as tools for greater interconnectivity and independent, decentralised care. The paper concludes by discussing the implications of these findings for future mHealth research and practice.

Keywords: *Healthcare; Developing Countries; Mobile Technology; Socio-materiality; mHealth; Rural Healthcare Workers.*

3.2 Introduction

The introduction of information and communication technology (ICT) in healthcare has evolved from an initial focus on the administrative and financial accounting of medical transactions (Anderson, 1997; Goldschmidt, 2005), to clinical decision support systems (Hersh, 2004; Bates, 2002), to the direct provision of healthcare through digital platforms, often termed 'electronic health' or eHealth (Eysenbach, 2011). These digital platforms allow medics to improve healthcare locally, regionally or internationally by leveraging the scale and reach of ICT (Eysenbach, 2001). More recently, the focus has turned to mobile health (mHealth), whereby healthcare services are supported by mobile devices, such as smart phones, tablets, and other mobile devices (Kay et al., 2011b; Petrucka et al., 2013).

The focus on mHealth is especially relevant for people living in rural areas of developing countries where a lack of traditional infrastructure may limit the healthcare services on offer (Chetley et al., 2006; Kahn et al., 2010; Aryee, 2014). Mobile phones have reached developing countries relatively quickly when compared to other digital technologies, such as desktop computers and laptops (Kahn et al., 2010; Furuholt and Matotay, 2011). This is partly because mobile technologies do not require the same level of individual

investment or legacy infrastructure (Asangansi and Braa, 2010; Furuholt and Matotay, 2011). Yet mobile devices still allow users to make and receive telephone calls, send and receive multimedia messages, and in many cases, access the web. These practices and the underlying mobile devices have already become engrained into many peoples' everyday lives (Asangansi and Braa, 2010; Mwakaje, 2010). Thus, it is logical that healthcare delivery systems should build upon these practices and technologies to extend care services into rural areas of developing countries, which are otherwise isolated (Braa et al., 2004; Avgerou, 2008; Kahn et al., 2010). This would help to alleviate the burden on individuals to travel to urban centres for care (Chetley et al., 2006; Robertson et al., 2009a) and provide an information channel from health professionals in centralised health bodies to those in urban centres (Kay et al., 2011b; Chetley et al., 2006).

Despite this potential, many mHealth applications struggle due to unforeseen limitations of technical infrastructure (Chetley et al., 2006) or dominant social norms and practices (Wagner et al., 2010). These oversights can be attributed to a lack of holistic understanding, as designers expect patterns and solutions to behave similarly across different environments. However, contemporary IS thinking acknowledges the way a technology in use depends on context and the local problems it encounters as local users try to understand and accommodate it in their lives (Orlikowski, 2000; Avgerou, 2001; Avgerou, 2002; Setia et al., 2011; Leonardi, 2012; Leonardi, 2013). Therefore, in order to understand and predict how mHealth solutions will be assimilated in rural areas of developing countries, we need to understand prevailing practices in

those areas, as well as how those practices are produced and reproduced over time.

This study frames this problem using a socio-material perspective. Specifically, we ask *how may prevailing social structures, material features, and health-related practices influence the assimilation of mHealth technologies in rural areas of developing countries?* The rest of the paper is structured as follows. The next section characterises existing literature on mHealth in rural areas of developing countries, noting a lack of holistic sociotechnical analysis. We then introduce socio-materiality and discuss the unique analytical perspective it affords. Following this, a research methodology is outlined based on an exploratory case-study in Enugu State, Nigeria. Finally, a thematic description of findings is presented under the analytical headings of social, material, practice, and imbrication. The paper concludes with discussions and summary.

3.3 mHealth in Rural Areas of Developing Countries

The strengthening of health systems with mobile technology has prompted a number of initiatives to develop novel mHealth tools for healthcare delivery for specific regions or countries. One example is a system that coupled a C905 Sony Ericsson mobile phone (which comes with an 8.1-megapixel camera) and an application called ClickDiagnostics. This system was used in Botswana to send digital referrals from remote areas to a specialist in a central hospital, so connecting people in resource-poor areas with remote specialists (Littman-Quinn et al., 2011b). A second example was a mobile phone SMS-based system known as RapidSMS-MCH. This system allowed community health workers to track maternal and child health records remotely in their

community in Musanze, Northern Rwanda (Ngabo et al., 2012). A third example was the introduction of Sene PDA in Ghana, West Africa. This system generated accurate reports from remote areas to help district health managers make informed decisions (Afarikumah, 2014). A fourth example was LabPush, an application in the Kingdom of Swaziland that replaced paper-based processes with SMS to transport results from laboratories to remote areas (Hao et al., 2015). A fifth example was a diagnostic application called e-algo designed to aid remote clinical diagnosis in Napel. Analysis of that project suggested patients were actually more confident when healthcare workers used e-algo in their patient care (Knoble and Bhusal, 2015).

Research on these systems has focused on three dominant streams. The first stream focuses on the improvements in healthcare enabled by mHealth tools. In rural communities, rural healthcare workers are often the first and only point of contact with the healthcare system for community members (Agarwal et al., 2015; Rowe et al., 2005). Therefore, the ability to improve healthcare interactions between rural healthcare workers and community members is crucial (Akter and Ray, 2010; Kaplan, 2006; Kijsanayotin et al., 2009). Several studies have focused on general improvements in scope, efficiency, and quality (e.g. Chib et al., 2008; DeRenzi et al., 2012; Florez-Arango et al., 2011; Varshney, 2014a). Other studies have focused on training for rural healthcare workers (e.g. Chib et al., 2015b; Littman-Quinn et al., 2013; Littman-Quinn et al., 2011b) and balancing new tools with competing demands for attention and multiple priorities (e.g. Chang et al., 2011; Selke et al., 2010).

The second stream is more technology-focused, highlighting the ability of different individuals to make sense of new technologies at an interaction and interface-level. Several studies have focused on usability and the need to design mHealth interfaces that can be used as easily and effectively as possible (e.g. Chib, 2010; Vélez et al., 2014; Zargaran et al., 2014). Other studies have taken a slightly different approach, focusing on the reduction of errors, particularly as regards data recording and data entry (e.g. Brown, 2015a; DeRenzi et al., 2012; Rajput et al., 2012; Sadasivam et al., 2012; Zhang et al., 2012).

The third stream focuses on the process of change management around the introduction of new mHealth processes. Examples include remote clinical check-ups (e.g. Blaya et al., 2010; Hall et al., 2014; Hufnagel, 2012), remote tracking of treatment and medication adherence (e.g. Chandra et al., 2014; Haberer et al., 2010; Smith et al., 2012), remote dissemination of health information for chronic diseases (e.g. Kumar et al., 2013; Madon et al., 2014), remote assistance in the treatment of patients with mental disorders (e.g. Brian and Ben-Zeev, 2014; Knoble and Bhusal, 2015; Li et al., 2014), and participatory community healthcare reporting (e.g. Boulos et al., 2011; Freifeld et al., 2010; Kulkarni and Agrawal, 2008).

Despite the range of topics covered, there is a lack of studies combining these concerns in a single cohesive and holistic perspective, i.e. the role of the tools, the manner in which they are designed and used, and the prevailing attitudes, perceptions, and practices of the people required to use them. Each of these concerns are interdependent if mHealth tools are to have a meaningful impact. They have to target suitable goals, they must be designed so they can be used

effectively towards those goals, and they must be compatible with the environment in which they will operate. Further, given each of these dimensions present unique challenges in rural areas of developing countries, assumptions concerning these interdependencies are particularly dangerous.

3.4 A Socio-Material View of mHealth

The concept of socio-materiality is encapsulated in the idea that *technology, people*, and *process* are inseparable and inextricably connected (Orlikowski, 2007; Orlikowski and Scott, 2008). The term *materiality* is preferred to the term 'technology', since the latter creates the impression there are some objects, artefacts or devices out there that do things, and therefore ignore that these objects, artefacts or devices only come to reality when manifested in practice (Suchman, 2007; Leonardi et al., 2012). *Materiality* is understood to be the fashioning of physical or digital materials into useful forms that endures across time and space (Leonardi et al., 2012). That is, the combination of material and form, and not solely the material out of which a technology is formulated (Leonardi et al., 2012). Using the word technology alone in practice gives the impression of a specific type of hardware or software that can be used to augment work process, and this leads to researchers remaining fixated on the adoption and diffusion periods without giving recognition to the fact that IT infuses all aspects of a projects' life (Linderoth and Pellegrino, 2005; Orlikowski and Iacono, 2001; Orlikowski, 2007). As a result, studies (Orlikowski, 2000; Volkoff et al., 2007; Leonardi, 2007) have used terms like 'material' properties in their description of technology to capture that aspect of technology that is inherently related to it and not just as part of the social context in which it is being used (Leonardi

et al., 2012). Technology exercises material agency when humans engaged with its materiality in pursuit of their goals (Leonardi et al., 2012). That is, material agency is triggered when human use technology with a particular goal or intention at any particular time (Leonardi et al., 2012). Important material features that were identified in previous research include the size of mobile devices (including buttons and screens), network coverage (Bullen, 2013; Medhanyie et al., 2015; Manda and Herstad, 2015), customisation options (Hilliard et al., 2014), battery life and charging facilities (Sanner et al., 2014; Medhanyie et al., 2015), and unpaved roads (Sanner et al., 2014; Manda and Herstad, 2015).

The term *social* is preferred to 'people' to capture the variety of social structures involved in a system, including individuals, groups, institutions, norms, and perceptions (Orlikowski and Scott, 2008; Barad, 2003). Social essentially refers to every static force or quality in a system that is not *material*. Different *social* actors interact differently with different *material* artefacts (Orlikowski, 2007; Gherardi, 2012), meaning they assimilate these tools differently to suit their organizational structures and environmental properties (Ulmer and Pallud, 2014; Efendioglu et al., 2005). As a result, technologies are understood only in relation to the meanings attributed to them and the ways in which people interact with them. Thus, *socio-materiality*, the fusion of the two words (social and materiality) describes that materiality is shaped through social processes, understood and used within a social context, and social action is made possible as a consequence of materiality (Leonardi, 2012; 2013). Therefore, socio-materiality is the enactment of a set of undertakings that merges materiality with people,

institutions, discourses or norms and every other thing that is called social (Leonardi et al., 2012). It describes what happens when humans (social) and things (material) interact in practice without ignoring the impact of either of them on one another (Leonardi, 2013; Leonardi et al., 2012; Orlikowski and Scott, 2008). Consequently, the term 'socio-materiality' aims to overcome the shortcomings associated with treating the social at the expense of the material or vice versa (Orlikowski and Scott, 2008; Leonardi et al., 2012).

The terms *practice* and *imbrication* are preferred to 'process' as these emphasize the dynamic and evolving state of a system. The word 'practice' is understood in a socio-materiality context to mean the space in which the social and the material imbricate (Leonardi, 2011; Leonardi et al., 2012). That is where material and social agencies are activated in response to one another. In effect, "it is not so much what materials… symbolize within social action that matters but their constitutive agentic effects within the entangled networks of sociality/materiality" (Pels et al., 2002: 2).

Examples of important practices identified in existing literature include some practices that may be intuitive to developers, e.g. end-user training (Medhanyie et al., 2015; Sanner et al., 2014), and some that may not be obvious without local knowledge, e.g. the sharing of phones and SIM cards among multiple rural users (Bullen, 2013; Manda and Herstad, 2015). Each of these are important to consider, however the latter group may easily go under the radar when the focus is limited to specific groups, features, or goal-specific interactions.

The metaphor of imbrication "enables IS scholars to conciliate the organisation and technology mutually shaping nature: thus, the structure

between individuals…, and technologies… evolve as a socio-material creation" (Ulmer and Pallud, 2014: 4). Imbrication describes how the social and material mingle in flexible situations, i.e., how practices are created and maintained. Further, imbrication is the result of social agency, which is "typically defined as the ability to form and realise one's goals" (Leonardi et al., 2012: 35). That is, imbrication is characterised as the process of the interweaving of human and material agencies to achieve defined goals (Leonardi, 2012; Leonardi, 2011). An example of imbrication can be seen whereby frequent unsolicited advertising messages from service providers have caused many subscribers to ignore messages from unfamiliar numbers (Bullen, 2013). This has important implications for mHealth programmes reliant on SMS for communicating with different groups in rural areas of developing countries.

There are various positions on this duality (social and materiality) that allow for different theorising approach to the study of socio-materiality in IS. It is understood from the writings of Orlikowski (Orlikowski, 2007; Orlikowski, 2010; Feldman and Orlikowski, 2011), building on the works of Barad (Barad, 2003; 2007) and Latour (Latour, 1992; 2005), that social and material are inseparably related. Much of Orlikowski's argument is hinged on the *agential realism* developed by Barad. That is, "there is no social that is not also material, and that there is no material that is not also social" (Orlikowski, 2007: 1437). For example, Barad argues that "phenomena do not merely mark the epistemological inseparability of 'observer' and 'observed'; rather, phenomena are ontological inseparability of agentially intra-acting 'components" (Barad, 2003: 815). Latour's work on actor-network theory

(ANT) made a similar argument that there is nothing inherently different between the material and the social. That is, "we live in a world made of both social and technical artefacts; we cannot detach society from technology – neither can we isolate technology in the abstract" (Díaz Andrade and Urquhart, 2010: 353). That was why Latour included nonhumans in an attempt to understand the social and in fact, he designated human and nonhumans as 'actants' in the lingo of ANT (Latour, 2005). These research streams' conceptualisation of socio-materiality "makes a distinctive move away from seeing actors and objects as primary self-contained entities that influence each other… either through impacts… or interactions… away from discrete entities of people and technology… to composite and shifting assemblages" (Orlikowski and Scott, 2008: 455). In effect, humans or technology (entities) have no intrinsic properties, but obtain form, characteristics and abilities through constitutive entanglement (Orlikowski and Scott, 2008). In effect, entities, people and technology have no intrinsic boundaries but are relationally manifested in practice (Cecez-Kecmanovic et al., 2014).

This study adopts Leonardi's (2012; 2013) point of view, which is grounded on substantialist (non-relational), i.e. critical realist ontology (Mutch, 2013). The substantialist ontology "takes as its point of departure in the notion that it is *substances* of various kinds… that constitute the fundamental units…, self-subsistent entities, which come "preformed," and only then to consider the dynamic flows in which they subsequently involve themselves" (Emirbayer, 1997: 282-283). That is, entities, be it humans (social) or things (material) exists as separate and self-contained entities that interrelate and

affect each other in practice (Cecez-Kecmanovic et al., 2014). Building on the works of Mutch (2002; 2010; 2013) and Faukner and Runde (2012; 2013) it is difficult to operationalise the empirical constructs in agential approach due to the interlocking of the social and material (Leonardi, 2011; 2012). Instead, the substantialist approach assumes the inherent distinction between human and material agencies but at the same time recognising the outcomes that ensures during their interlocking in practice (Leonardi, 2011). Thus, it is argued that this approach offers a more effective foundation upon which to anchor the study of socio-materiality, especially as it relates to the studies of digital technology and organising (Leonardi, 2013). The introduction of a mHealth tool to a new context introduces new *materiality* that prompts a change in the socio-material *practices* binding the system. During this process of change, the simple building blocks of the mHealth tool are *imbricated* to fit with the goals, needs, and expectations of *social* actors. Yet the degree of this *imbrication* depends on the extent to which these *social* actors actually adopt the system, i.e. "ultimately, people decide how they will respond to a technology" (Leonardi, 2011).

3.5 Method

This study adopts an exploratory case-study approach (Yin, 2013) using the socio-material perspective as a guiding theoretical lens. A case-study approach was selected because case studies permit the exploration and understanding of complex, loosely bounded contexts (Feagin et al., 1991; Zainal, 2007). Additionally, case studies can be useful in capturing the emergent properties of rapidly changing environments (Feagin et al., 1991; Noor, 2008). Furthermore, the detailed qualitative account of events obtained

in case studies describes or explains the complexities of real-life situations which may not be captured through experiment or survey research (Zainal, 2007; Yin, 2013). That is, case studies help to answer 'why' and 'how' questions (Yin, 2013), especially in emergent situations where designers and developers have limited ability to control the influence of context. Specifically, we perform a single-case analysis for two key reasons. First, single-case analysis helps to bring the researchers closer to the empirical matter under investigation, allowing the data to 'talk back' in a way that increases those researchers' sensitivity to emerging variables and demands re-inspection of pre-existing biases (Ragin, 1992; Flyvbjerg, 2006). Second, where a sufficiently rich case can be studied, a single-case analysis helps the researchers to less reductive description of the phenomena under study (Darke et al., 1998; Patton, 2005).

To promote the selection of an 'information rich' case for this study, a purposeful sampling approach (Patton, 1990) was used to maximize understanding and learning from the case (Ram and Khatri, 2005: 106). Nsukka Local Government Area in Enugu State, Nigeria was selected following the reasons outlined by Yin (1994), i.e. 1). It is a case where poverty has traditionally been high yet phenomena could be studied with high levels of researcher access and immersion 2). It a revelatory case that meets all the conditions for theory testing. Most notably, a mHealth app has recently been proposed to assist the diagnosis and treatment of children under 5 years old in the rural community. This has created a natural transitional period for the region that should help to make practices more lucid as different tensions emerge.

Interviewees were selected based on reputational, and positional methods in the target communities (Knoke, 1994). That is the interviewees/stakeholders that occupy key roles, participate in key binding policy decisions, have the actual power to make changes, and have the important political relational power with other systems (Knoke, 1994) in the Enugu State healthcare delivery system. Specifically, the authors engaged with four key groups of stakeholders in the rural healthcare delivery system (Eze et al., 2016b) in Nsukka Local Government Area: Parents/Guardians; Rural HealthCare Workers (RHCWs); Developers, and Facilitators. According to this classification, the Parents/Guardians (PGs) are individuals that help their children to receive preventative or curative care from the healthcare system; the RHCWs are those directly involved in healthcare processes; the Developers are those responsible for building and maintaining the mHealth system, and; the Facilitators are those individuals or bodies that expedite or enable the development, implementation and delivery of mHealth processes.

3.5.1 Data Collection

Data were collected between 2nd and 23rd September, 2016, and between 25th February and 25th March, 2017. Data were gathered at the headquarters of Enugu State's civil service, Ministry of Health (MoH), Parklane Teaching Hospital Enugu State University of Science and Technology (ESUT), Nsukka Local Government Headquarters, Nsukka, Health Centres in the rural communities (Figure 1) and a university in the North-West Europe with experience in mHealth projects in rural areas of Africa. Prior to data gathering, ethical approval was obtained in both the primary host institution

of the researchers and a local university in Nigeria involved with recent mHealth initiatives.

Figure 3-1: Edem-Ani Health Centre in Edem-Ani Community, Nsukka, Enugu State

Figure 2 presents a summary of key data sources and interviews. Data gathering involved interviews (Figure 3), participant observation, document/records analysis, field notes, and photographs from clinics in the rural communities. Thirty-two interviews were conducted. Interviews were conducted in Igbo or English and recorded (with informed consent) for subsequent analysis. All recordings were transcribed verbatim into English, along with the written notes from interviews.

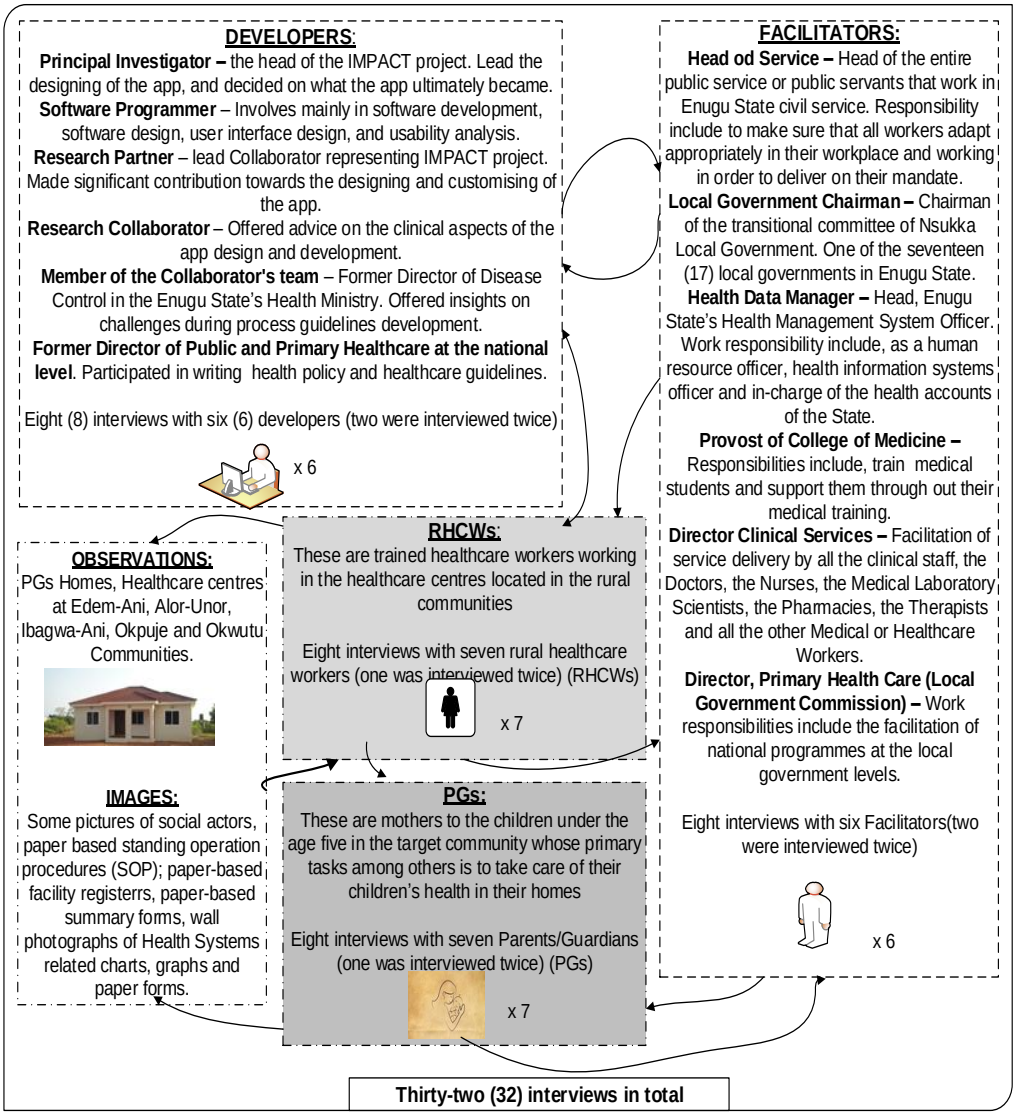

Figure 3-2: Data Sources and Interviewees

The focus of these semi-structured interviews was to ascertain the socio-material factors that influence the assimilation of mHealth tool. We interviewed the RHCWs at the community health clinics who would be the end users of the mHealth tool for accessing, classifying and treatment of children under the age of five. Interviews with the other stakeholders were mainly conducted in the respondents' offices. Initial interview questions are available in the Appendixes C1 – C4. In the interest of '*collaborative partnership'* (UN, 2015b), the design and development of the mHealth

technology depends on the collaboration of geographically dispersed stakeholders. Hence, the system developers who were involved the development of the mHealth tool and who work in a University North-West Europe were interviewed in their respective offices. Additional data included: the paper-based Standing Operation Procedure (SOP) used by RHCWs; paper-based facility registers, paper-based summary form, wall photographs of HIS related charts, graphs and paper forms. These documents were reviewed in order to get background information about Enugu State's HIS and to corroborate data from interviews and observation.

Figure 3-3: Interviewing One of the RHCWs at the Health Premises

3.5.2 Data Analysis approach

Data analysis focuses on identifying the types of *social* and *material* actors involved, key *practices*, and signs of *imbrication*. Data analysis was performed using the thematic analysis method proposed by (Braun and

Clarke, 2006). Thematic analysis is a flexible approach to theorising that concentrates on the identification of recurring patterns and narratives, often as a foundation for subsequent construct-based process or variance theorising (Vaismoradi et al., 2013). In addition, many IS scholars (e.g. Skelley et al., 2013; Olatunji et al., 2016; Ismail et al., 2016) have used thematic method in their data analysis to help make sense of collective experiences (Newman et al., 2016; Aronson, 1995).

Braun and Clarke (2006) identify six phases. The first phase demands the researchers familiarise themselves with the data. We did this by repeatedly revisiting transcripts and field notes during the study. The second phase involves generating initial codes. This involved listing patterns of experiences and observations in relation to the already classified categories, i.e. *Social*; *Material; Practices, and Imbrications*. The third phase involves searching for themes. We did this by relating patterns with each other and the research questions. These themes represent the meanings attributed by the researchers to specific quotes or other pieces of data (Taylor and Bogdan, 1984). The fourth phase reviewed these themes. This involved testing the ability of data to support specific themes or their underlying explanations. The fifth phase requires that themes are given names. This demanded we connect together all the themes that emerged from the data in order to provide a wide-ranging picture of the experience of the stakeholders following the works of Aronson (1995). It also required we commit to the 'essence' of what each theme was about and thus provided a 'feedback point' between the authors and the stakeholders in this analysis. Phase six requires the research is compiled into

a report. This took the form of a descriptive 'theme statement' (Aronson, 1995), which is presented in the research findings in this paper.

Key validity issues were identified prior to data collection. The first, *'construct validity'* (Cronbach and Wainer, 1988; Yin, 2013), which is also described as *'theoretical validity'* (Maxwell, 1992; Kirk and Miller, 1986), describes the link between data measures and the corresponding theoretical perspectives. That is, how the data collected are justifiably related and consistent with the theoretical approach adopted (Golafshani, 2003). We managed this by making use of the pre-existing concepts from socio-material perspective to define the type/s of data to be collected from the onset. The second is '*internal validity'* (Yin, 2013), i.e., the degree to which the emerging themes match (Street and Ward, 2012; Gwet, 2014). Following the works of Cohen (1968), we went through samples of coding collectively to agree on what the 'presenting' themes should be. The third issue is '*interpretive validity threat'* (Maxwell, 2012), i.e., a way that the authors might interpret the result of data analysis in one way or the other. This kind of threat may point to an alternative explanation or interpretation which is often referred to as 'alternative hypothesis' (Huck and Sandler, 1979). This was managed by introducing an 'audit trail' (Creswell and Miller, 2000; Rodgers and Cowles, 1993) that included 'Collaboration' (Creswell and Miller, 2000; Rodgers and Cowles, 1993); 'Peer debriefing' (Davis, 1992); 'Thick, Rich Description' (Creswell and Miller, 2000) and illustrative quotes. The fourth issue is *'reliability'* (Yin, 2013; Golafshani, 2003; Davis, 1992), i.e. the ability of others to follow the same research process and arrive at the same result. This was managed by documenting the research processes for

others to follow in future. Finally, the fifth issue '*generalizability*' (Lee and Baskerville, 2003) or '*external validity'* (Yin, 2013) relates to problem of knowing that the findings of this study is generalizable beyond this case-study. We managed this by linking the result to the adopted socio-material perspective, which helps to connect findings with those from previous sociotechnical studies in other contexts.

3.6 Analysis

The data provided evidence in relation to the social, material, practices and imbrications of socio-material perspective and their links to the themes and overarching interpretations. We present and discuss these chains of evidence relating to the four delineated parts of socio-material perspective. Tables 1 – 4 present the social, material, practice and imbrication-related themes, descriptions, and the corresponding illustrative quotes.

3.6.1 Social Themes

Theme	Description	Illustrative Quotes
Perceived limitations in skilled personnel in rural areas	Social actors (PGs, RHCWs, Facilitators, and Developers) feel that there is lack of necessary human resources in rural health centres.	"I want a place I can go and see a doctor as there are no doctors at this centre" (PG2); "We lack health workers in the rural health centres" (RHCW3).
Perceived divide between urban and rural healthcare systems	Social actors (RHCWs, Developers, and Facilitators) believe rural healthcare needs are secondary to those administering central health systems.	"… we share a feeling of being left out by the system" (RHCW4); "The aberration in healthcare distribution and healthcare provision is hurting the primary health system healthcare system in Enugu State" (Facilitator2).
Perceived collegiality among stakeholders in rural community.	Social actors (PGs and RHCWs) share a sense of common identity in addressing challenges and difficulties confronting them.	"I approach my friends or neighbours who may know what is happening to my child and they offer some suggestions on how to go about in the immediate" (PG3); "We interact with the villagers that come here as patients, like children with various illness, sharing in their feelings especially as most are poor and find it difficult to go for medical treatment in the urban area" (RHCW5).

Table 3-1: Social themes, descriptions, and illustrative quotes

The first *social* theme describes perceived limitations of skilled personnel in the rural health centres. Stakeholders complain about a lack of nurses and doctors in rural health centres. PG7 said 'we do not see doctors when we go to the rural health centre in my village". This view was shared by Faciltator6 who remarked "most well trained personnel do not like to work in rural areas". It was observed that RHCWs are not happy about lack of doctors in their facilities. To this end, RHCW6 said, "…we need enough doctors and nurses whom we can post to those villages so that when patients come they will be able to attend to them". Developer6 remarked "it is even worse in some certain communities… the properly trained nurses are not available at all because every nurse that is properly trained will want to stay in the town… doctors, they are not also not there, even the ones that are in the rural

communities are involved in their own private practice, they are not involved in the healthcare system in the State, …and of course… the consultants who should be taking decisions are not available in all the rural communities in Enugu State". In effect many qualified health professionals have little incentive to work and live in the rural areas. Qualified healthcare workers migrate into urban areas where they can earn better wages, with better schools, and better environment to raise their children.

The second social theme describes a perceived divide between urban and rural healthcare systems. RHCWs and PGs feel rural healthcare systems are isolated from urban health systems. Developer6 stated that "at the beginning, the rural healthcare system has no institutional base, as they were not accorded any status on which to operate in relation to the … healthcare delivery centres in the rest of the State". Developer6 further explained "to compound issues, the …healthcare centres that would have helped support/nurture the rural/primary healthcare apparatus have broken down leaving only the tertiary institutions as the sole functional healthcare delivery structures in Enugu State". Thus, the lack of intermediaries and localised referral alternatives could be destabilising the development of rural healthcare systems in Enugu State.

The third *social* theme describes a perceived collegiality among stakeholders in the rural community. This collegiality is in contrast to the perceived disconnect between PGs/RHCWs and urban health systems. Data suggest PGs and RHCWs maintain strong social relationships. It was also noted that PGs can typically reach RHCWs outside their working hours with health-related queries. PGs also help each other to find solutions to health problems.

PG2 summarised this by saying “I approach my friends or neighbours who may know what is happening to my child and they offer some suggestions on how to go about it in the immediate”. This often means PGs and RHCWs rely on informal shared understandings to confront the healthcare challenges they face. RHCWs may even feel responsible for protecting PGs from third parties who may exploit their desperation or lack of understanding, e.g. pharmacies selling illegitimate or overpriced drugs. RHCW2 explained “if you leave them to buy for themselves, they may buy fake drugs which is being sold out there”. RHCWs recommend specific hospitals to PGs or villagers. This is due to the high price tag associated with consultation at some urban hospitals.

3.6.2 Material Themes

The first *material* theme describes the limited flexibility of existing guidelines. The Ministry of Health introduced a set of guidelines called the standing operation procedure (SOP) for use by RHCWs throughout Nigeria. Developer5 described this as “a step by step, blow by blow method whereby a well-trained health officer can act in the absence of a doctor or when a doctor cannot be physically present”. However, RHCWs have concerns about the rigid rules associated with the SOP and long processes involved, which more often than not lead to PGs’ referrals for further diagnosis and treatment in urban health centres. These concerns stem from the emotional attachment RHCWs have with the PGs as they would like to offer immediate solutions where possible. They are also concerned by the associated transportation burden on PGs when referred to urban health centres. RHCW4 said “we want guidelines without many referrals, so that we can treat as many as possible who come to us at the centre… the guidelines contain many pages …many

referrals and parents do not like it when we refer them to urban hospital for further assessment and treatment". RHCW6 commented "before they used to treat them under one page but now they have split it into different pages, which makes it very difficult & stressful for us somehow". This view was shared by Developer6, who remarked "my experience is that the [RHCWs] don't actually use this SOP as it should because simply they feel … it is a very cumbersome thing you know". These comments identify a tension between the limited flexibility of health guidelines and RHCWs' desire to offer immediate solutions.

Theme	Description	Illustrative Quotes
Limited flexibility of existing guidelines	The treatment steps of health guidelines are considered cumbersome. Strict adherence is required, often resulting in a referral.	"we need something that will help us in treating our patients instead of the many referrals that are present in the present SOP" (RHCW4); "most of the steps in SOP is always refer, refer, even simple things we can treat they direct us to refer" (RHCW7)
Limited utilities in rural healthcare centres	The supply of drugs and utilities, such as water and electricity are inadequate	"Facilities in the villages are poor" (Developer5); ''we do not have the required drugs for treatment here" (RHCW1); "…the epileptic power supply of electricity could hamper its use as the workers will need to charge their phones or devices in those areas" (Facilitator5).
Limited security at rural healthcare centres	The rural healthcare centres do not have physical security personnel to protect RHCWs from threat (e.g. night marauders and detractors)	"There are many things we do not have…we do not have security in our place of work" (RHCW5); "The major thing is security, no security in the villages. No security in any of the health centres, even on the road to move around especially in the night when you can have emergencies" (Facilitator6).
Limited transportation to and from rural healthcare centres	The roads used by PGs and RHCWs to access health centres are in poor condition.	"Roads are filled with gullies in the rural communities" (RHCW3); "the roads are very bad that motor public transport services are not operational" (PG4); "…most roads are inaccessible" (Developer5) "motorcycles (Okada) or Tricycles (Keke) are being used in the rural areas, with the exception of private individuals with their personal cars" (PG5)

Table 3-2: Material themes, descriptions, and illustrative quotes

The second *material* theme describes the limited utilities in rural health centres. Health centres in the villages are not equipped to anything like the standard of urban health centres. Facilitator5 explained "you know the functionality of the healthcare facilities are better in the urban areas". Developer6 linked this issue to staffing problems, remarking "no properly trained nurse will like to work in such an environment". Limited utilities in rural health centres also fuels the exodus of PGs into urban areas for treatment. Facilitator6 acknowledged "there is lack of infrastructure and very

few health centres are worth to be called places where any sick person can even go into" (Figure 4). Water supply is a major cause for concern for the RHCWs in the communities as there is no steady supply of clean water. RHCWs often rely on the private suppliers of water or resort to harvesting rainfall water in tanks (Figure 5). Another aspect of these limited utilities is the irregular availability of drugs at rural health centres. RHCW2 remarked "the availability of the drugs we use is also a challenge, if drugs are supplied to us in large quantity it will be a good thing, instead of having to stay and wait for the request to come through". Furthermore, RHCWs complained about non-availability of electricity in health centres. RHCW2 pointed out, "…in Nigeria of today, the irregular supply of power is considered as a normal way of life. The small generators used by individuals comes as a saviour in charging of phones, those centres in the urban areas have electricity generators in their various offices while there is none at the rural health centres". As a result, RHCWs make use of oil-based lanterns (Figure 6) at night to light-up the health centres. This presents a further challenge from an mHealth perspective, as RHCWs will be tasked with the additional responsibility of assuring mHealth battery is charged at all times.

Figure 3-4: The inside of the rural health centre at Edem-Ani Community

Figure 3-5: Front of the heath centre showing the strategy adopted to collect water into a tank and one of the modes of transportation (motorcycles - known locally as 'Okada')

Figure 3-6: Oil-based lanterns used for lighting health centre due to absence of electricity

The third *material* theme describes limited security at the rural healthcare centres. RHCWs complained about the absence of security at the rural health centres. Most of the centres are not wall-fenced and there are no security personnel stationed at rural health centres to prevent unwanted intruders. The absence of physical security at rural health centres is a serious concern for RHCWs and PGs due to the perceived ongoing threat of attack from night marauders. This threat is further compounded by the fact many RHCWs work in the centres during the night. RHCW4 said "When somebody knocks at the door at night you will be afraid to open because you do not know whether the person knocking is a patient or those that are coming to rob or harm you". When asked about the security issue at rural healthcare centres, Facilitator2 explained "the resources of the state are limited and government… provides infrastructure as much as it can". In the absence of government-provided security, rural communities rely on neighbourhood-watch to minimise the perceived threat from night marauders. This neighbourhood-watch is made

up of groups of youths who come together to watch over their communities and help to prevent attacks.

The fourth *material* theme describes the limited transportation to and from the physical premises in rural areas. The general impression among interviewees was that roads in the urban areas are substantially better than roads in the rural areas. PG1 remarked "the roads are not good, there are gullies and ditches on these roads and here you see, no public motor transport driver wants to work on the rural roads because of this". These conditions make it difficult for public road transportation. As result, the inhabitants in this part of the State are forced to rely on motorcycles known as *'okada'* (Figure 5) or tricycles known as *'keke'* for their everyday journeys. PG2 pointed out that "these keke or okada people charge us a lot of money to take us to urban areas, and as a result, we sometimes walk to urban health centres". Facilitator6 explained "a good number of communities are completely inaccessible, inaccessible by road, which is the major means of transportation in this part of the world, and the fact that you cannot access those places no matter how you want to look at it is disheartening". It was observed that during rainy season most of these villages are almost entirely cut-off from other parts of Enugu State.

3.6.3 Practice-related Themes

The first *practice*-related theme describes the reliance on formal diagnosis and treatment practices. RHCWs were trained to use SOP for assessment, classification and treatment of patients. RHCW4 said "we know of only one set of guidelines called SOP for treating malaria, cough, diarrhoea, vomiting, and pregnancy". During the treatment exercise, RHCWs are required to

collate data recorded in summary forms and transfer these records to local government headquarters. Subsequently, these data are transferred to the federal health office via Enugu State's Ministry of Health. Presently, RHCWs make use of a newly introduced mobile data collection mHealth app to collect and transfer data. These apps allow workers at rural health centres to collate health data in a summary form at the end of every month and forward same via mobile device to state and federal bodies. Thus these practices, according to RHCW2, "have saved us from the associated problems of working with paper-format". In particular, the mHealth app proposes to save transportation costs and errors associated with transferring hard-copies of summary papers to local government offices.

Theme	Description	Illustrative Quotes
Reliance on centrally regulated diagnosis and treatment practices	RHCWs rely on SOP for diagnosis and treatment of patients in rural health centres.	"The SOP is used to diagnose illnesses, treat or refer the patient to a doctor" (Developer3); "we were using the paper-format before they brought an app for sending to State and federal directly" (RHCW4)
Reliance on informal PG-driven diagnosis and treatment practices	PGs circumvent RHCWs and SOPs to buy medicine directly from pharmacists.	"I visit the pharmacy to get some medications I use at home before I take the person to the clinics" (PG3); "If my child is sick I buy drugs that I feel is going to cure my child" (PG6)
Reliance on informal traditional healer-driven diagnosis and treatment practices	PGs use traditional healing practices to treat sicknesses, e.g. drinking liquid from boiled mango leafs to treat various stomach ailments.	"Sometimes when we have no money we make use of herbal methods of treatment within our village" (PG7); "Parents do make use of traditional healing methods for treatment" (RHCW7).
Reliance on informal and clustered communication practices	PGs and RHCWs rely on informal communication channels between these groups, rather than communication with urban centres.	"[RHCWs] do not refer to us and we don't write back to them even if their referrals will come in a secret way" (Developer5); "We are not even in talking terms with [RHCWs]" (Developer6).

Table 3-3: Practice-related themes, descriptions, and illustrative quotes

The second *practice*-related theme describes a reliance on informal PG-driven diagnosis and treatment practices, whereby parents bypass doctors and go straight to pharmacists for medicines. These diagnosis and treatment practices are typical among PGs in the area. PG7 remarked "Once I notice that my child is not feeling well, I make use of some medication I have at home first before going anywhere". PG3 commented similarly "I only take my child to health centre when I notice that the medication I have administered to my child at home is not working". This is possible because PGs often have drugs stocked at home, drugs bought from pharmacy attendants without formal prescription from a healthcare professional. The

availability of medicines without a prescription has removed much of the perceived need to visit trained health professionals. Many pharmacist attendants have embraced this opportunity, leading Developer5 to describe them as “quack-doctors”. This trend effectively circumvents the strict structured practices associated with rural health centres and undermines the effectiveness of associated SOP.

The third *practice*-related theme describes a reliance on informal traditional healer-driven diagnosis and treatment practices. Most PGs who could not secure pharmaceutical treatment for their children instead sought treatment from traditional African healers. PG3 explained “I go to African traditional herbal homes to treat sickness with herbal remedies especially when the prescribed drugs at health centre are too expensive for me to bear”. The RHCWs found this frustrating, e.g. RHCW1 complained “these patients when you tell them the cost of the drug/medicine they are supposed to take for their ailment they will not come back, instead they prefer to go to take native drugs from alternative medical outfits that use native African drugs to treat illnesses”. RHCW7 attributed this to a lack of education, remarking “For those of us who work in the village, the most people we work with do not have good knowledge of healthcare systems. So, we need to boost health education for rural people”.

The fourth *practice*-related theme describes a reliance on informal and clustered communication practices in Enugu State. A lack of formal communication was observed between rural health systems and urban health systems. PGs often find their way independently to urban teaching hospitals without referrals or any accompanying records. Developer6 noted “how many

references have I gotten from [rural health centres]? None, I mean zero, at best, those centres are just glorified maternity centres". The researchers witnessed this first hand when one rural woman with an advanced illness was brought to a consulting physician by her brother without any accompanying documentation. Developer6, the consulting physician, explained 'it is very strange that I had to attend to this woman without any previous records on what my juniors in the ladder have done, what 'things' I am I going to consider? How do I start?" Developer6 further elaborated "that kind of woman cannot see a specialist like me without formal referral from where she was first treated, where a record has been established stating the history of her sickness and records of the treatments administered on her before now". This reflects a growing frustration among urban clinicians about the growing practice of PGs in finding their way to urban hospitals without formal referrals.

3.6.4 Imbrication-related Themes

Theme	Description	Illustrative Quotes
Accumulated breakdowns in payment practices	The payment of RHCWs' salaries has repeatedly broken down, leading to frustration and a lack of trust	"…our salaries are not being paid to us (RHCW1); "…we are expected to report to work without any incentives (RHCW6); "Local governments in Enugu State are autonomous, so, it is their responsibility to pay the salaries of the RHCWs' (Facilitator2).
Accumulated personal and professional phone-related practices	RHCWs and PGS have become accustomed to carrying phones for unrelated personal and social practices	"my friend called me to ask which hospital I took my child to when she was having cough" (PG5); "…phones enable communication channel between us and our patients anywhere" (RHCW2).

Table 3-4: Imbrication-related themes, descriptions, and illustrative quotes

The first *imbrication*-related theme describes an accumulation of breakdowns in payment practices. RHCWs complained about a repeated lack of payment

of their salaries by the local government, arguing it had negatively affected their motivation to work. RHCW5 remarked “payments of our salaries is a problem, when you are not paid promptly the satisfaction and the zeal to do the job will not be there”. Central bodies argue this has nothing to do with them, e.g. Facilitator1 at the Ministry of Health explained “paying of the RHCWs is the responsibility of the Local Governments in Enugu State and not that of the State’s Ministry of Health”. In Nigeria, the states are responsible for providing the regulation and technical support to rural healthcare services but the local government-level is responsible for rural healthcare. Rural bodies suggest they are not given the funds to follow through on these payments, creating a circle of blame with no obvious sign of ending. Developer5 suggested the only way to resolve this was to consolidate the payment in one place, arguing “It is not just right to leave the funding of primary healthcare systems in the hands of the local governments, it should be the primary responsibility of the Federal Government”.

The second *imbrication*-related theme describes accumulated personal and professional phone-related practices. Many RHCWs and PGs are in the habit of carrying personal phones. This has increased their connectivity to one another, as described by PG6, who remarked “I can reach my friend with my mobile phone to ask of what to do about a particular sickness I feel my child is experiencing”. PGs also call RHCWs with queries, with several RHCWs noting they often received personal calls from worried PGs. The availability of personal phones also means PGs have independent access to third party health information, provided they have the literacy to browse the web. Despite PGs and RHCWs familiarity with phones, the recent addition of an

mHealth app is not as convenient as it seems. The main reason for this appears to be the need to carry an extra phone to run the app, which is in danger of loss, theft, or damage. RHCW1 explained, "I now have to carry this particular phone with me in conjunction with my personal phone, protecting them both is a challenge to me". Facilitator1 echoed this burden of responsibility on the part of RHCWs, "we had to introduce an MOU (Memorandum of Understanding), which is once you lose your phone you have to replace it". As a result, it was noted that a few RHCWs do not want to take the responsibility of carrying these additional professional phones for fear of having to replace them.

3.7 Discussion

This paper explores the factors that may influence the assimilation of mHealth technologies in rural contexts in developing countries. This research identifies several new issues for IS research in this space.

At the *social* level, the urban and rural healthcare contexts represent separate social worlds. The lack of highly trained workers is recognised as a significant challenge to healthcare in rural communities of developing countries (Naicker et al., 2009). In Africa, there are 2.3 healthcare workers per 1000 population, compared with the developed country like the Americas, which have 24.8 healthcare workers per 1000 population (Naicker et al., 2009). Most well trained healthcare workers prefer migrating abroad where they perceive to have better remunerations (Scheffler et al., 2009; Naicker et al., 2009; Stilwell et al., 2004), while some often times would opt to work in the better connected, better resourced urban centres instead of working in rural areas. In Enugu State, the perceived isolation and neglect of rural healthcare systems

has created a perceived collegiality among parents and guardians (PGs) and rural healthcare workers (RHCWs) in affected communities. That perceived isolation has also driven PGs and RHCWs to develop new practices and norms that build on localised experience and informal workarounds. This tendency of rural communities to find creative solutions to navigate the human resource crises in developing countries has been documented in existing literature (e.g Bergström, 2005; Werner, 1987). The perceived isolation of rural communities has also fed into an increasing emotional attachment (Pignot, 2016) between RHCWs and PGs that has helped to support a group that are otherwise neglected (Wilson et al., 2009; Katz et al., 2011). This creates challenges for centralised mHealth initiatives in these communities, as the individuals at the central health authority may not recognise subtle social structures or may be perceived as outsiders by rural dwellers.

At the *material* level, rural health centres lack the breadth and depth of appropriate materiality to be sufficiently enacted in healthcare delivery. Most RHCWs do not enjoy working in the rural health centres due to the lack of basic utilities, transportation, and security. Adequate medicines and electricity are often unavailable. Similarly, most roads in rural areas are unpaved and in disrepair, so restricting public transportation in favour of alternative modes that lend themselves to shorter journeys, namely; Okada (motor cycles) and Keke (tricycles). The threat of intruders means RHCWs are continuously watching for signs of danger, and thus leave them feeling unsafe in their workplaces. The structures/buildings are not functionally suitable to house a patient or a sick community member (Figure 4). The

significance of well-being and user satisfaction in an office building was highlighted in a socio-material study of cutting-edge projects in Austria (Ornetzeder et al., 2016). As pointed out by Orlikowski, "the [organizational studies] field has traditionally overlooked the ways in which organizing is bound up with the material forms and spaces through which humans act and interact [imbricate]" (Orlikowski, 2007: 1435). These observations of infrastructural deficiencies in rural health centres are consistent with findings from existing research in a range of developing contexts (e.g., Sanner et al., 2014; Manda and Herstad, 2015). Taken together, these limitations discourage RHCWs and PGs from using rural health centres extensively or even spending prolonged periods there, both of which are necessary for those centres to become properly entangled into the healthcare system. Thus, the enactment of mHealth technologies in those centres is likely to require greater development of ancillary material resources (e.g. Werner, 1987), e.g. medicines, infrastructure, technologies, guidelines.

At the *practice* level, the lack of material richness in rural health centres has caused a dominance of informal practices bypassing those centres. According to RHCWs, the formal diagnosis and treatment practices prevent them from offering immediate solutions to PGs' health problems. Specifically, the structured step-by-step approach in the SOPs seem lengthy and lead often to referrals which take a long time to manifest solutions. Instead those PGs gravitate towards informal diagnosis and treatment practices that can be performed with less delay. Many of these informal diagnosis and treatment practices are made possible because PGs can buy medicine directly from pharmacies without prescription. In addition, PGs treat ailments with herbal

remedies when they can't afford clinically approved medicines. These findings are consistent with existing literature (e.g. Ruebush et al., 1995; McCombie, 2002; Deressa et al., 2003). Further, there is little direct communication between rural and urban health centres. Instead, we noted clustered communication practices among rural stakeholders. This creates a lack of information about rural individuals in urban centres, which becomes particularly problematic given those rural dwellers may have to travel great distances to attend those centres (e.g. Larson and Fleishman, 2003; Mars, 2013). The communication or referral systems between the rural health centres and the urban centres is old-fashioned or non-existent (Ehiri et al., 2005; Ogunbekun et al., 1999; Asuzu, 2004; Abdulraheem et al., 2012). This breakdown in communication is delaying the development of rural healthcare centres (Asuzu, 2004), which may ultimately affect the assimilation of mHealth tool as anticipated.

At the *imbrication* level, the lack of social and material entanglement between urban and rural systems can be attributed to historic breakdowns in practices that could have acted to strengthen these connections. This is consistent with basic assumptions of socio-materiality, which assumes social and material elements are mutually generative (Leonardi, 2012). Breakdowns in payment practices have caused RHCWs to rely on other ways to earn an income in their community. This has eroded the authority of urban initiatives, particularly where tensions may be perceived between urban and rural interests. Indeed, before mobile technologies were made available to RHCWs for healthcare-specific reasons, those RHCWs and other rural dwellers had taken it upon themselves to acquire personal phones. Modern mobile phones

have a materiality which can be enacted into centrally prescribed medical practices. For example, it could be leveraged to support on-the-spot diagnosis and treatments from a specialist somewhere outside a rural context and/or facilitate referrals practices (Noordam et al., 2011). However, they also have a materiality that lends itself to greater informal communication and third party information access. The isolation of rural social worlds, the limited materiality of rural health centres, and the dominance of informal practices has contributed to a cycle of reliance on those informal practices. However, this means PGs have access to a range of information outside the control or guidance of health professionals. This is significant for future mHealth initiatives, as the sourcing of information from this unregulated space may hamper structured healthcare delivery processes in rural areas (Murray et al., 2003; Moreland et al., 2016).

3.8 Summary and Conclusion

The novel socio-material approach adopted sheds light on the reasons why mHealth introduction may fail to reach maturity and depth in developing countries. The study established a detailed thematic outlay of the socio-material features of rural healthcare systems that may impact the introduction of new technologies and practices. The emerging themes combine to tell a story of a structured but streamlined professional healthcare delivery system, with decentralised and peer-based practices increasingly filling in the gaps. A story of isolated rural social worlds where the extensive training, clinical best practice, and hierarchical structures of urban areas is not feasible. Instead, trained healthcare professionals are few and far between and communities of practice are distributed and informal. The materiality in rural healthcare

centres is not sufficient for deep enactment of the healthcare delivery guidelines introduced by the central health authorities, nor do those guidelines cover the needs of the community. Taken together, all of these forces mean the materiality of mobile technologies presents itself differently within the broader socio-material system or rural areas, i.e. those technologies lend themselves to web searches and informal information sharing among rural dwellers, rather than the automation, validation, and evaluation of centrally-authorised clinical best practice. Among other things, this identifies four novel key challenges for mHealth in rural areas of developing countries:

1) How do we design mHealth solutions that complement the existing materiality of rural areas, e.g. by minimising the need for travel where transport options are limited?

2) How do we design mHealth solutions that reinforce the connection to urban centres while still allowing rural healthcare workers the autonomy to offer immediate solutions?

3) How do we change practices, particularly those that have cultural origins that go against contemporary health treatment methods?

4) How do we avoid interference or destructive competition from unregulated information or health-related applications available on the web?

We also acknowledge two important limitations of this study. First, our research focused on a region in which technology-enabled guideline-driven treatment remains the priority mHealth concern. This problem is undeniably significant. Informal amateur-diagnoses and amateur-treatment practices,

both traditional and pharmaceutical, presents a danger when treatments are not measured, side effects are not known, and other treatments may be neglected. However, several other forms of mHealth initiatives exist, e.g. those focused on data gathering (Chang et al., 2011; Medhanyie et al., 2015) or those focused on remote diagnosis and treatment (Hufnagel, 2012; Knoble and Bhusal, 2015). We thus call for similar research on those alterative topics to compare results. Second, consistent with the exploratory nature of our study, the qualitative methodology, and the single-case design, we make no claims of statistical generalisability (Yin, 2013). Rather, the intention was to draw attention to important material and contextual elements that will add to understanding in this space (Patton, 1990; Maxwell, 1992). This understanding, as well as being of value in itself, can be used to underpin other forms of increasingly structured theorising (Weick, 1995; Mutch, 2013). Thus, we believe the themes identified should be used to inform future theorising that seeks to create more tightly bounded and predictive models.

Chapter Four

4. Understanding the Factors that Influence the Primary Appraisal of mHealth Tools in Developing Countries: An Exploratory Case-Study in Nigeria

4.1. Abstract

Shortages of health workers, infrastructural deficiencies, limited access to medical care are just a few of the many barriers to care in developing countries. The integration of smartphones and mobile devices into healthcare systems has been proposed to address some of the physical barriers to care and service delivery. These mHealth solutions extend the reach of medical care into rural areas of developing countries. However, it is not clear how mHealth solutions designed and tested in one developing region can be positively appraised for use in others. This study frames this problem using a coping theory approach based on an exploratory case-study to understand the factors that influence primary appraisal of a smartphone-enabled guidelines (mHealth tool) for accessing, classifying and eliciting treatment recommendation for sick children under the age of five by rural healthcare workers (RHCWs). Findings identified a set of factors that influence primary appraisal of an mHealth tool in a new context. These factors are the set of individual and social factors that governments, funding bodies and non-governmental organisations should consider before embarking on the introduction of an mHealth tool in rural communities of developing countries. It is envisaged that by understanding the factors that influence primary appraisal, that is, either as an opportunity or a threat, practitioners and organisations will support positive appraisal and minimise the occurrence of

negative ones when introducing mHealth tools – positivity of primary appraisal model. These findings have implications for theory, practice, and future research as explained in the concluding section of this paper.

Keywords: Healthcare; Developing Countries; Mobile Technology; Coping Theory; mHealth; Rural Healthcare Workers.

4.2. Introduction

The ubiquitous nature of mobile information technology (IT) presents an opportunity to stimulate developmental activities in rural areas of developing countries (Datta et al., 2005; Furuholt and Matotay, 2011). Mobile devices have the potential to overcome some of the physical challenges and infrastructural deficiency that hold back these areas (Aker & Mbiti, 2010; Lee, Levendis, & Gutierrez, 2012). This is due in part to the unique mobility and smaller infrastructural requirements when compared to landlines (Aker & Mbiti, 2010; Lee et al., 2012). The developmental paradigm surrounding mobile phones has shifted from one that simply reduces communication and coordination costs to one that could transform lives through transformative applications of mobile services (Kahn et al., 2010; Aker and Mbiti, 2010). One example is the integration of smartphones and mobile devices into healthcare systems to address some of the challenges to care and service delivery in rural areas of developing countries (Donner and Mechael, 2012; Free et al., 2013). The strategies of incorporating mobile technologies in healthcare services are collectively known as mobile health (mHealth) (Kahn et al., 2010; Donner and Mechael, 2012).

The use of mHealth tools can vary in focus (Eze et al., 2016b; Eze et al., 2018). First, mPrevention/Education tools provide preventive, advisory, counselling, and educational services (e.g. Hacking et al., 2016; Nhavoto et al., 2017). Second, mData-Collection tools are used to collect data that may inform other aspects of healthcare delivery (e.g Simon and Seldon, 2012; Kabuya et al., 2014). Third, mDiagnosis applications are used to support the diagnosis of particular conditions (e.g. Chib and Chen, 2011; Mavhu et al., 2017). Fourth, mTreatment apps are used to guide remedial healthcare interventions for specific patients (e.g. Alam et al., 2010; Hufnagel, 2012).

The potential of these mHealth tools to navigate some of the barriers to medical care in developing countries has prompted a number of initiatives by governments, non-governmental (NGOs), and research organisations to invest in innovative mHealth approaches to healthcare delivery. However, research has shown that most of these initiatives have struggled with deployment, particularly during the progression from pilot stages to large-scale nation-wide roll-out (Heeks, 2006; Chib et al., 2015b). Although many scholars have used various models, e.g., Venkatesh et al. (2003); Taylor and Todd (1995), and Rogers (2003) to understand users' adoption processes but a few have examined users' appraisal process before adoption or use. It is argued that understanding an individual's cognitive appraisal process which provides information about the individual's behaviours or emotions would help a researcher understand the individual's disposition (Hareli and Hess, 2010). This implies, that individual's behaviours or emotions influence individual's appraisal processes towards, for example, an IT occurrence in their environment (e.g. Beaudry and Pinsonneault, 2005; Wisniewski et al.,

2014). In a health context, scholars posit that a coping theory/framework can be effectively employed in the intervention, assessment or evaluation of an individual's psychological stress and coping responses (Lyon, 2000; Fadel and Brown, 2010). This study uses coping theory to explore perceptions around new mHealth initiatives, with particular attention to perceived threats and opportunities as appraisal outcomes. More specifically, we ask *what are the factors that influence the primary appraisal of an mHealth tool in a developing country*?

The rest of the paper is outlined as follows. Section 2 discusses the theoretical background of coping and appraisal as it applies to mHealth in developing countries. Section 3 describes an exploratory case-study approach based on the potential introduction of a new mHealth tool for assisting the treatment of sick children under the age of five in Nigeria. Section 4 presents the findings of the study, which are bound as an emerging explanatory model for the primary appraisal of mHealth tools in developing countries. Sections 5 and 6 discuss the findings in relation to existing studies and presents a summary and conclusions.

4.3. Primary Appraisal and Coping with New Technology

To understand primary appraisal and coping we turn to the theory by Lazarus and Folkman (1984) on *Stress, Appraisal and Coping* from the social psychology literature. Coping in Information Systems (IS) research is conceptualised as adaptation strategies, and this allows us to understand the individuals' behaviours that occur before, during, and after the implementation of a new technology (Beaudry and Pinsonneault, 2005), such as mHealth tool. Lazarus and Folkman (1984) assert that individuals employ

two-way processes to cope with a disruptive new IT occurrence, i.e., Appraisal and Coping.

4.3.1 Coping Theory

Coping theory is used to explore and understand the underlying relationships on how individuals respond to an IT occurrence in their environment (Beaudry and Pinsonneault, 2005; Bhattacherjee et al., 2017). Coping is defined as the "cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resource of the person [individual]" (Lazarus and Folkman, 1984: 141). 'Internal' demands are personal needs or requirements such as the desire to excel, perform or execute, and 'external' demands refer to those activities impacted or influenced by the external environment (Bhattacherjee et al., 2017; Beaudry and Pinsonneault, 2005). Coping is a significant concept in IS for theory and research on IT adaptation (Claggett, 2010; Fadel and Brown, 2010). Coping theory explains the processes by which individuals frame and respond to disruptive events in their environment/workplace, such as a new IT occurrence (Beaudry and Pinsonneault, 2005; Wisniewski et al., 2014).

IS scholars have applied coping theory in organisational settings to understand the individual cognitive responses to new IT in a work environment, three examples include: 1) In the context of an IT adaptation in a banking setting, Beaudry and Pinsonneault (2005), by building on the works of Lazarus and Folkman (1984) offered us an integrated model for understanding users adaptation to an IT occurrence in a workplace, known as Coping Model of User Adaptation (CMUA). In applying coping in IT banking settings, CMUA adopts a process-oriented approach to coping and outlined

four adaptation responses (Beaudry and Pinsonneault, 2005). 2) In the context of an IT avoidance in a security oriented setting, Liang and Xue (2009) used coping in conjunction with cybernetics to present us with an integrated processes theory of coping and variance theory known simply as the Technology Threat Avoidance Theory (TTAT). By applying coping and variance theories in IT business settings, TTAT adopts a process-oriented approach to coping and variance theories to explain the individual IT user's behaviour of avoiding 'threat' of malicious information technologies (Liang and Xue, 2009). 3) In the context of an IT appraisal and coping in a healthcare setting, Fadel and Brown (2010), utilised the CMUA model in a developed country environment to set the first step toward integrating theories of IS 'adoption and use' with coping theory by examining how adoption-related IS perceptions influence individual-level post-adoptive IS appraisal. These studies underline the significance of the application of coping processes in IS research to understand individuals' cognitive responses to the introduction of new IT in a work environment.

4.3.2 Appraisal

Appraisal is defined as the cognitive evaluation and classification of an IT encounter in its various aspects with respect to the individual's well-being (Beaudry and Pinsonneault, 2005; Lazarus and Folkman, 1984). Appraisal processes are mediated by the individual's reactions and in every situation each individual appraises differently (Lazarus and Folkman, 1987; Beaudry and Pinsonneault, 2005). In CMUA model, two types of appraisals of interest are identified in the study of coping process, namely, 1.) primary and 2.) secondary appraisal processes (Beaudry and Pinsonneault, 2005). It is argued

that these two processes interact and may occur simultaneously (Elie-Dit-Cosaque and Straub, 2011).

The process of 'primary appraisal' describes where individuals evaluate the importance of an event as a consequence of their situations and interests (Folkman et al., 1986; Beaudry and Pinsonneault, 2005). The outcome of such an evaluation is usually as either an *opportunity* or *threat* (Beaudry and Pinsonneault, 2005; Elie-Dit-Cosaque and Straub, 2011). For example, when a change occurs in an individual's workplace (e.g., introduction of an mHealth tool), the individual asks himself/herself, "What is at stake for me in this situation" (Beaudry and Pinsonneault, 2005: 495). The four outlined adaptation strategies in CMUA model (Beaudry and Pinsonneault, 2005) are: 1) Benefit maximising – when the new IT occurrence is perceived as an 'opportunity' and individuals feel they have 'high level' of control; 2) Benefit satisficing – when the new IT occurrence is appraised as an 'opportunity' but with a 'low level' of control; 3) Disturbance handling – when the new IT occurrence is perceived as a 'threat' and individuals feel they have a 'high level' of control, and 4) Self-preservation strategies – when the new IT occurrence is perceived as a 'threat' but with a low level of control. Individuals undertake the assessment of how much control they have over the new event and the opportunities or the threats it presents them in respect to their environment, and resources provided by their management (Beaudry and Pinsonneault, 2005; Nach and Lejeune, 2010). Individuals have high levels of control when they believe they have control over the event. High control users engage in 'problem-focused coping', for example, by expressing self-confidence in the ability to adapt themselves to the new environment or being

able to manipulate features and functionality of the new (mHealth) IT (Beaudry and Pinsonneault, 2005; Elie-Dit-Cosaque and Straub, 2011). Individuals have low levels of control when they believe they have insufficient control over the event, thus engaging in 'emotion-focused' coping in which they believe there is little or nothing they can do about this change (Beaudry and Pinsonneault, 2005; Nach and Lejeune, 2010).

However, how people positively cope in the context of mHealth in developing countries remains unclear. Against this background we offer a new context on how to understand the 'positivity' of primary appraisal, namely, primary appraisal of an mHealth tool. This study applies the coping process to understand the positive actions or activities that would influence the assimilation of an mHealth tool in the rural communities of developing countries. The next section discusses the positivity of primary appraisal.

4.3.3 Positivity of Primary Appraisal

Positivity of primary appraisal describes an individual's tendency to have a positive or optimistic attitude towards some new IT in their work-environment. Positivity describes a summative judgement of the extent to which positive (desirable) outcomes overcome negative (undesirable) outcomes (Lazarus and Folkman, 1984; Beaudry and Pinsonneault, 2005). Positive and negative outcomes in a primary appraisal process are regarded as 'opportunities' or 'threats' respectively (Claggett, 2010; Elie-Dit-Cosaque and Straub, 2011). 'Opportunity' refers to a situation that has been assessed as having 'positive outcomes' for the individual, invoking emotions of excitement and anticipation (Claggett, 2010; Bhattacherjee et al., 2017). For example, a 'strong task-technology fit' (Goodhue and Thompson, 1995)

could be considered by a user as an opportunity to improve his/her performance in a workplace (Beaudry and Pinsonneault, 2005; Fadel and Brown, 2010). 'Threat' refers to the individual's feeling or belief that the change may negatively affect him/her. This negative feeling could be referred to a situation where a loss (e.g., loss of power or position) or harm is anticipated and could be categorised by emotions of anger, fear or anxiety (Wisniewski et al., 2014; Bhattacherjee et al., 2017). To promote goal-oriented work attitudes and behaviours, organisations' actions must support those factors that foster positivity (Avey et al., 2010).

A number of factors could impact the positivity of primary appraisal for a new mHealth tool. Researchers have stressed the need to attend to social, cultural, and contextual factors of stress-coping (e.g. Chun et al., 2006; Aldwin, 2007). Social and cultural variations significantly influence the degree of positivity of primary appraisal for a stressful IT (e.g. mHealth tool) occurrence (Kuo, 2011; Newton and McIntosh, 2010). Following the transactional nature of Lazarus and Folkman (1984) coping theory, these factors, i.e., *individual'* and the *'social'* (environment) are viewed as being in a dynamic and mutual relationship (Elie-Dit-Cosaque and Pallud, 2010; Elie-Dit-Cosaque and Straub, 2011).

Individual factors' are internal behavioural or emotional factors affecting how the individual appraises a particular context or situation (Beaudry and Pinsonneault, 2005; Bhattacherjee et al., 2017). For example, research has shown that an individual's previous experience with technology has an impact on the way they perceive new technology in their environment (Hackbarth et al., 2003; Venkatesh and Morris, 2000). Specifically, innovative individuals

have been found to be positively predisposed to IT in their work environment (Lewis et al., 2003; Lee et al., 2007). That is, individuals' cognitive processes underline the basic tenants of an individual's reaction to a stressful event (e.g. new IT) (Miller and Kaiser, 2001; Krohne, 2002). This is especially true for the following reasons: first, individuals' 'cognitive skills' mediate the type of reaction they have towards an IT occurrence in their workplace (Beaudry and Pinsonneault, 2005; Fadel and Brown, 2010); second, 'cognitive appraisal styles' significantly impact on how individuals appraise and adapt to stressful situations (Elie-Dit-Cosaque and Straub, 2011). Thus:

Proposition 1 (P1). *Individual factors influence the positivity of the individual's primary appraisal of an mHealth tool in developing countries.*

'Social factors' are conceptualised in this paper as external factors that are outside the control of the user (or exceeding the resource of the person). Social factors are situationally, contextually or environmentally dependent (Mathieson, 1991; Beaudry and Pinsonneault, 2005). IS scholars posit that 'social factors' influence individual's primary appraisal (Elie-Dit-Cosaque et al., 2011; Bhattacherjee et al., 2017). 'Social factors' include for example, organisational mechanisms (e.g. training and resource support), peers support (e.g., from co-worker, family and friends) and environmental conditions (e.g. culture and working conditions) (Johnston et al., 2016; Terry, 1994). Findings show that social factors may deny an individual the opportunity to use IT even when the individual feels he/she could benefit from doing so (Ragu-Nathan et al., 2008; Claggett, 2010), for example, network coverage (e.g. Stanton et al., 2015). Thus:

Proposition 2 (P2). *Social factors influence the positivity of an individual's primary appraisal of an mHealth tool in developing countries.*

This allows a preliminary model to be developed representing high-level constructs that require deeper exploratory propositions (Figure 1).

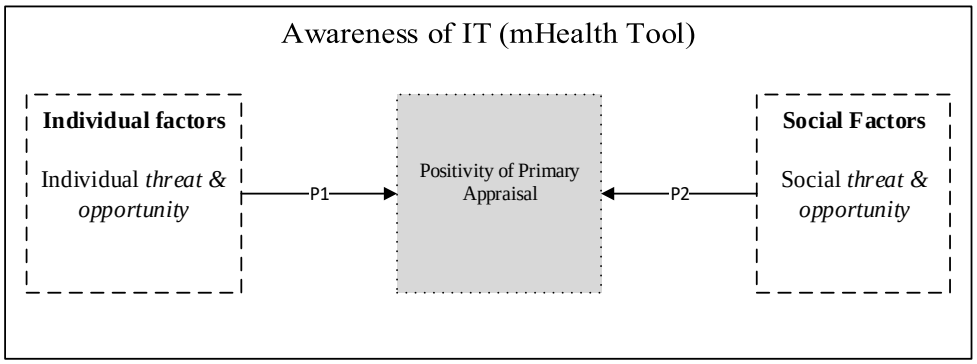

Figure 4-1: Preliminary/Sensitising Research Model

4.4. Method

4.4.1 Research Methodology

Grounded theory (GT) (Glaser and Strauss, 1967; Corbin and Strauss, 1990; Strauss and Corbin, 1998; Corbin and Strauss, 2014; Corbin and Strauss, 2008) techniques were applied in this study. GT techniques are appropriate in this study for three reasons: First, when theorising is exploratory (Glaser and Strauss, 1967; Gasson, 2004), as it is here, GT techniques helps researchers to generate, or discover a theory (Glaser, 2017). Second, GT uses a systematic set of procedures to inductively derive theory about a given phenomenon (Corbin and Strauss, 1990; Corbin and Strauss, 2008; Corbin and Strauss, 2014; Strauss and Corbin, 1998; Urquhart et al., 2010). In this way, GT encourages researchers to remain close to the studied environments and to develop an integrated set of theoretical concepts from their empirical data-sets (Charmaz, 2011; Urquhart, 2000). This technique not only helps

researchers to synthesize and interpret data, but helps also to show processual relationships in the analysis of data (Charmaz, 2011; Charmaz, 2014). This method refers to a continuous interaction between data collection and analysis (Urquhart et al., 2010). Third and most importantly, it has the advantage of generating theory deeply related to the evidence, resulting in a theory that is consistent with data (Urquhart et al., 2010; Urquhart, 1997).

4.4.1.1 Site Selection

The area selected for study was the Nsukka Local Government Area in Enugu State, in the South Eastern Region of Nigeria. This area was selected for two main reasons: (i) Poverty has historically been high, meaning infrastructural and cultural challenges are significant (ii) One of the researchers is from the area, meaning phenomena could be studied with high degree of access and immersion. These qualities accommodate a revelatory case-study; an approach suitable to explore domains that maybe too complex for other research methods (e.g., surveys or experimental) (Sarker et al., 2012; Jensen and Vatrapu, 2015).

The investigation explored the primary appraisal of an mHealth tool that was designed and developed for a country on the Eastern part of African continent. The mHealth tool's algorithms followed the clinical guidelines developed by WHO and UNICEF for rural healthcare workers to deliver health care services in remote rural areas of developing countries (Young et al., 2012). These guidelines are known as integrated Community Case Management (iCCM) assisted the administration of established region-specific iCCM guidelines by creating smartphone-enabled guidelines to assist the diagnosis and treatment of illness in children under the age of 5. The study adopts an

exploratory case-study approach (Yin, 2013) aimed to understand the primary appraisal processes that influence the assimilation of an mHealth technology for use in new areas of developing countries.

A purposeful sampling approach (Patton, 1990) was used to promote the selection of 'information rich' sources for this study (Ram and Khatri, 2005). Following Knoke (1994), interviewees/stakeholders were selected based on reputational and positional methods in the target communities in Nsukka Local Government Area. These were interviewees/stakeholders that occupy key roles, participate in key binding policy decisions, have the actual power to make changes, and have the important political relational power with other systems (Knoke, 1994) in the Enugu State healthcare delivery system. Specifically, the researchers engaged with four key groups of stakeholders in the rural healthcare delivery system (Eze et al., 2016b), specifically Parents/Guardians, Rural HealthCare Workers (RHCWs), Developers, and Facilitators. According to this classification, the Parents/Guardians (PGs) are individuals that help their children to receive preventative or curative care from the healthcare system; the RHCWs were those directly involved in healthcare processes; the Facilitators were those individuals or bodies that expedite or enable the development, implementation and delivery of mHealth processes, and the Developers were those responsible for building and maintaining the mHealth system.

4.4.1.2 Data Collection

Empirical data were collected between 2nd and 23rd September, 2016, and between 25th February and 25th March, 2017 in both Nigeria and Europe. Data collection exercises were conducted at the headquarters of Enugu State's civil

service, Ministry of Health (MoH), Enugu State University of Technology and Science Teaching Hospital (ESUT), Local Government Headquarters, health centres in the rural communities in Nsukka Local Government Area of Enugu State, Nigeria and a university in North-West Europe participating in an mHealth project in the area. Ethical approval was obtained in both the primary host institution of the researchers and a local university in Nigeria involved with the research initiative.

Table 1 represents a summary of the key data sources and roles. Data gathering involved, in-depth interviews, participant observation, and document/record analysis, field notes and photographs from clinics in the target rural communities. All interview participants had been exposed to a new mHealth tool for accessing, classifying and treatment of children under the age of 5. Interviews were conducted in Igbo or English languages and recorded (with informed consent) for subsequent analysis. All recordings were transcribed verbatim into English, along with the written notes from interviews. Contact time averaged 240 minutes for each group of stakeholders. Initial interview questions are available in the Appendixes D1 – D4. Additional documentation included the paper-based Standard Operation Procedure (SOP); paper-based facility registers, paper-based summary form, wall photographs of HIS related charts, graphs and paper forms. These documents were reviewed in order to get a background information about Enugu State's HIS and to validate data from interviews and observations.

Data sources	Role
8* interviews with seven Parents/Guardians (PGs)	**Mothers** – these are parents to the children under the age of five in the target community whose primary tasks amongst others is to take care of their children's health in their homes.
8* interviews with seven Rural Healthcare Workers (RHCWs)	**RHCWs** – these are trained healthcare workers working in the healthcare centres located in the rural communities. These are a mixture of nurses and those trained specifically to help in healthcare services. They are referred in some quarters by various names, such as, community healthcare workers (e.g. DeRenzi et al., 2012), health extension workers (e.g. Medhanyie et al., 2012), and local health workers (e.g. Ngabo et al., 2012). It is important to note that this group of workers involved in this study were highly educated. They all hold bachelor's degrees and have at least two years training in their roles as rural healthcare workers
8* interviews with six Facilitators	**Head of Service** – Head of the entire public service or public servants that work in Enugu State civil service. Responsibility include to make sure that all adapt appropriately in their workplace and working in order that they deliver on their mandate.
	Local Government Chairman – Chairman of the transitional committee of Nsukka Local Government. One of the 17 local governments in Enugu State.
	Health Data Manager – Head, Enugu State's Health Management System Officer. Work responsibility include, human resource officer, health information system officer and in-charge of the health accounts of the State.
	Provost of College of Medicine – Responsibilities include, train medical students, and support them through their medical training.
	Director Clinical Services – Facilitation of service delivery by all the clinical staff, the Doctors, the Nurses, the Medical Laboratory Scientists, the Pharmacies, the Therapists and all the other Medical or Healthcare Workers**.**
	Director, Primary Health Care (Local Government Services Commission) – Work responsibilities include the facilitation of national programmes at the local government levels.
8* interviews 8* interviews with six System Developers	**Principal Investigator** – the head of the IMPACT project. Lead the designing the app, and decides on what the app ultimately becomes.
	Software Programmer – Involves mainly in software development, software design, and user interface design, and usability analysis.
	Research Partner – lead collaborator representing IMPACT project. Makes contribution towards the designing and customising the app.
	Research Collaborator – Offers advice on the clinical aspects of the app design and development.
	Member of the Collaborator's Team – Former Director of Disease Control in the State's Health Ministry. Insights on challenges during guidelines developments.
	Former Director of Public and Primary Healthcare at the National level. Participated in writing the health policy and the health guidelines.
Field Notes From	Observations of PGs' homes, Edem-Ani, Alor-Unor, Ibagwa-Ani, Okpuje, and Okwutu health centres.
Medical papers & Photographs	Images of rural health centres, some pictures of the social actors, the paper-based Standing Operation Procedure (SOP); paper-based facility registers, paper-based summary form, wall photographs of Health Information Systems (HIS) related charts, graphs and paper forms.

Table 4-1: Data sources and interviewees

4.4.2 Analysis

Following GT techniques, the specificity of this method demands that analysis begins as soon as the first batch of data is collected (Corbin and Strauss, 1990; Corbin and Strauss, 2008). Thus, coding started soon after commencement of data collection exercise. GT coding process included three major types of coding, namely: through open, axial, and selective coding processes (Abraham et al., 2013; Orlikowski, 1993; Urquhart et al., 2010), as shown in Figure 3.

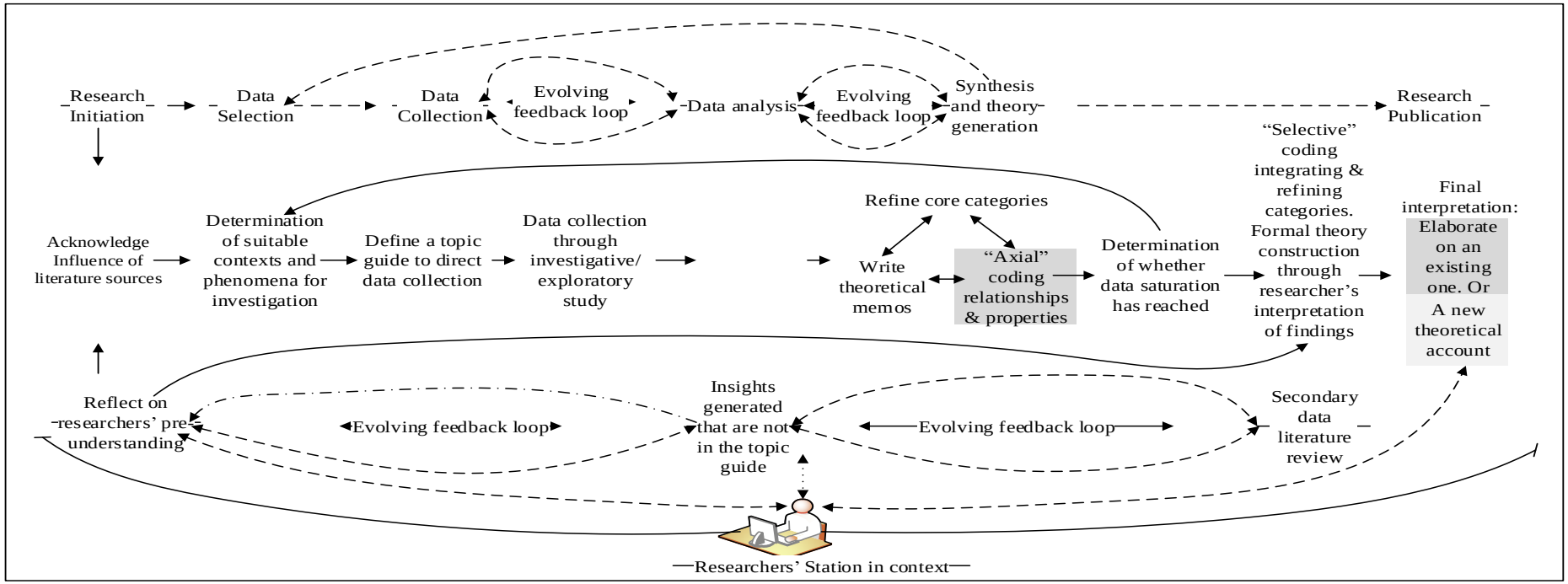

Figure 4-2: Research methodology

Adapted from Gasson (2004)

4.4.2.1 Open Coding

Open coding which is generally the initial stage of qualitative data analysis refers to classifying/breaking data into concepts that may explain important incidences or happenings about the phenomenon (Böhm, 2004; Gasson, 2004; Abraham et al., 2013). In order to stay deeply connected to the research topic we followed the line of questioning provided by Glazer (1978: 57) that is used in generating codes: 1) "What is this data a study of?" 2) "What category does this incident indicate?" 3) "What is actually happening in the data?" Open coding began with a 'line-by-line' analysis of the data (Lowe, 1996; Glaser and Strauss, 1967; Charmaz, 2006; Charmaz, 2014). Through this process, we created 35 codes that were given conceptual labels that related to 450 word-based data-sets from thirty-two interviews along with written notes (30 pages) from the interviews, and documentation. Subsequently, conceptually similar incidences were grouped together to form common themes (Corbin and Strauss, 1990). In open coding, we focused on the stakeholders' primary appraisal of the proposed mHealth tool for healthcare delivery in Enugu State. For example, we coded a portion of RHCWs' interview, i.e., "many people find it difficult to change the way they do things" as 'Habit', and a portion of Facilitators' interview, i.e., "the people who are not good with technology will be afraid of its introduction" as 'computer anxiety'. In this way, we exhaustively analysed the responses from stakeholders, namely: Parents, RHCWs, Facilitators, and Developers. Open codes were developed for each portion of the data-set as presented in Tables 2 and 3. The emerged codes from each data-set were subsequently compared against varying viewpoints as recurring themes emerge from the data for consistency.

4.4.2.2 Axial Coding

Axial coding refers to the comparisons of the emerging themes or subthemes to classify them into meaningful categories which enable the creation of a more hierarchical groupings (Abraham et al., 2013; Gasson, 2004). That is, it helps to fine-tune and differentiate themes or subthemes and lends them into other status or levels of classifications in relation to the data. Axial coding entails the search for relationships between coded concepts identified during open coding and by ensuring that the evolving interview instruments captured emerging constructs and relationships (Gasson, 2004; Gleasure, 2015). The iterations between the researchers and the data allowed the initial model to be expanded and delineated into a clear defined and well-articulated hypothesis-based model and the underlining processes. Following this technique, we related and combined codes to form themes representing sources of threat and opportunity appraisals towards mHealth assimilation. These themes fall under the 'causal conditions' category of Strauss and Corbin paradigm (Pandit, 1996; Bohm, 2004; Seidel and Urquhart, 2013). For example, we created relationship between the codes of 'habit', 'computer anxiety' and the effect of norms and cultural values to form the theme '*Perceived threat from process uncertainty'*.

4.4.2.3 Theoretical Memos

Theoretical memos are write-ups of ideas relating to codes and themes, and between themes themselves which ultimately form the basis for writing theory (Bohm, 2004; Gasson, 2004; Partington, 2000). Memos provide avenues to capture insights into the analysis process and contain clues to integration in so far as the researchers have systematically recognised the

properties of the ideas together with their dimensions (Strauss and Corbin, 1998). For example, the memo '*The inadvertent threat perceived by stakeholders with regards to changes that would affect habit/practice* alludes to the idea that for a programme such as the proposed introduction of an mHealth tool to be 'positively' appraised by the target communities, there is a need on the part of the programme initiators to design technological solutions that reflect local realities and needs (Kay et al., 2011b; Chib, 2013). Omitting memos and moving directly from coding to writing-up may greatly impact the conceptual detail and clear integration of ideas (Glaser and Strauss, 1967; Corbin and Strauss, 1990). Memos are 'store-house' of ideas (Strauss and Corbin, 1998). However constructs and relationships identified in theoretical memos must be supported by further data analysis or it would just speculation and not theory (Gasson, 2004).

4.4.2.4 Selective Coding

Selective coding is the integrating and refining of emerging core categories at the later stages of a coding process (Corbin and Strauss, 1990; 2008; 2014). Integrative procedure is the essential force in theory building or explaining phenomenon (Urquhart, 2000; Seidel and Urquhart, 2013). The refining process involves constant comparison between categories and data (Lowe, 1996). That is, moving up and down the levels of analysis and looking for traces of negative relationships which it might explain and incorporating relevant data up to a point where no more evidence is discovered (data saturation) (Andriopoulos and Lowe, 2000). It was at this stage that poorly developed categories were discovered and refined by revisiting data to fill-in the gaps. Subsequently, core categories were defined and labelled. At this

stage we realised that the two core categories resulting from axial coding were consistent with the classification that evolved from contemporary scholars' work in primary appraisals of technology application in organisations setting: 'Threats' and 'Opportunities' (Claggett, 2010; Connolly and Bhattacherjee, 2011; Wisniewski et al., 2014).

Potential inconsistency or misinterpretation of data during the coding processes were minimised in four ways. First, during coding, the emerging themes were discussed (by researchers) and robustly compared with insights generated that collaborated with secondary literature. Second, findings were made known to stakeholders as a form of 'venting' exercise, thus testing the validity and reliability of our interpretation (Borman et al., 1986; Miles and Huberman, 1994). This process is called 'member checking' by Mile and Huberman (1994). 'Member checking' is described by Lincoln and Guba (1985: 314) as "the most crucial technique for establishing credibility". This is because focus would be on the participants, during which time data and researcher's interpretation are taken back to participants to confirm its credibility (Creswell and Miller, 2000). Third, collaboration with stakeholders/participants who were actively involved as co-researchers further added to the credibility our accounts (Creswell and Miller, 2000). Fourth, data transcripts were revisited and recoded to set the final themes and constructs which reinforces the validity and trustworthiness of the research (Roberts et al., 2006). That is, revisiting transcripts during the coding and constructs framing processes helped to ensure trust and rigor in the method adopted. In the next section, we present the research findings regarding the

core categories resulting from the data analysis and the other major categories influencing them.

4.5. Findings and Theory Building

Our research identified the factors that influence the primary appraisal of mHealth tool in developing countries as represented by the refined model in Figure 4. The figure shows the categories and concepts that emerged as significant from the data. This process is proposed as initial creation of key concepts that describe the results of the primary appraisal as the initial step towards the adoption and implementation of mHealth tool in developing countries. We make no claim that the concepts presented here are exhaustive.

Proposition 1 was supported, as five constructs emerged relating to individual threat and opportunity appraisals:

1. *Perceived opportunity for improved speed and efficiency,*
2. *Perceived opportunity for improved reliability,*
3. *Perceived opportunity for simplicity of tasks,*
4. *Perceived threat from technical limitations, and*
5. *Perceived threat from process uncertainty.*

Proposition 2 was also supported, as five constructs emerged relating to social threat and opportunity appraisals:

1. *Perceived opportunity for new information and communication channels;*
2. *Perceived opportunity for improved healthcare outcomes in rural communities;*

3. *Perceived threat from lack of government support;*
4. *Perceived threat from lack of reliability of infrastructure, and*
5. *Perceived threat from social exclusion.*

The following sections describe the emerging constructs in the refined model, as well as the themes that characterised them.

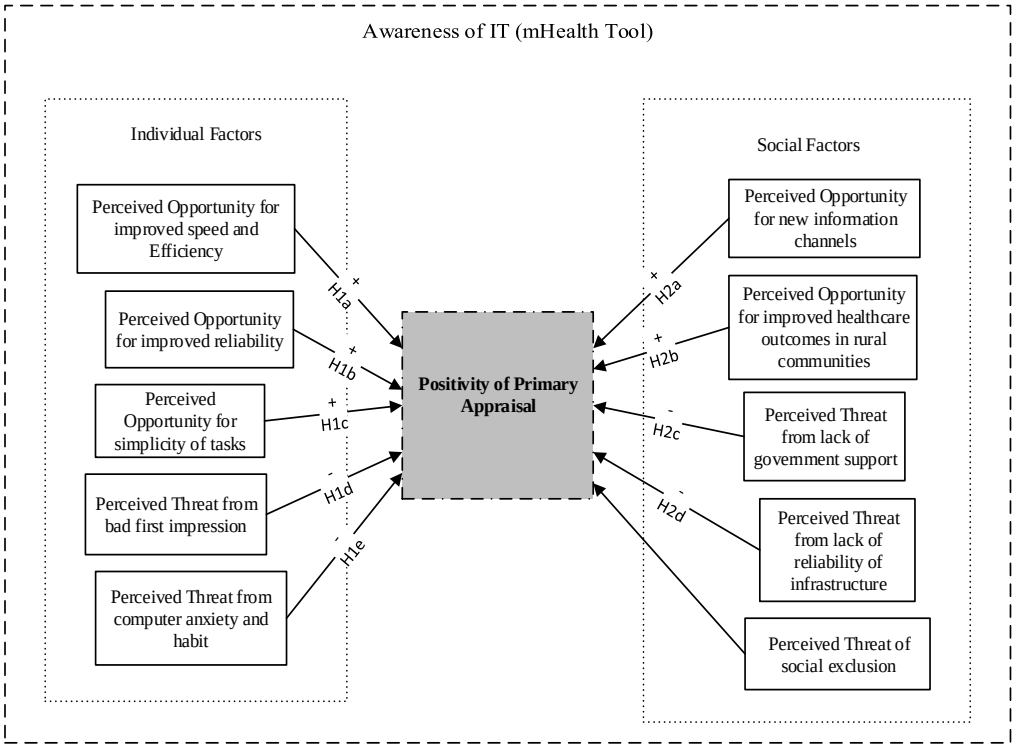

Figure 4-3: Refined research model

4.5.1. Positivity of Stakeholders' Primary Appraisal of an IT in their Environment

Positivity of primary appraisal was characterised by two independent/explanatory variables, illustrated in Table 1. These variables collectively explain the results of the influential role of the individual and social factors on the stakeholders' primary appraisal process – positive or negative. These are evident in their accounts of the expected perceived impacts of mHealth tool on 1) the performance of RHCWs

(primary users of the mHealth tool), 2) the reliability of results thereof from clinics, and 3) the lifesaving outcomes for the communities in general in the long run. The first variable (opportunity) suggests that positive appraisal would be greatest when stakeholders perceive that they have all they need and the conditions are perfect to support the use of the mHealth tool. For example, "if funding is provided for buying credits, I would say that we may not have any reason not to use mHealth tool" (RHCW2).

The second variable (threat) suggests that negative appraisal would be high when stakeholders expect perceived lack of favourable environmental conditions, resources or support that would be needed to facilitate the use of an mHealth tool in their workplace. For example, "lack of funding is the bane of a successful implementation of mHealth tool in this place" (Facilitator5). Implying that lack of funding would impede the successful use of an mHealth tool in Enugu State.

Construct	Explanation	Themes: Stakeholders believes that…
Positivity of primary appraisal.	The extent to which a stakeholder believes the new mHealth tool will improve conditions	• Stakeholders are reassured by resources that are being made available to make productive use of the new mHealth tool. • Stakeholders are concerned that key resources are missing and the impact of the new mHealth tool will ultimately not provide the expected value.

Table 4-2: Themes for stakeholders' positivity of primary appraisal

4.5.2. Emerged Constructs around the Individual and Social Factors

4.5.2.1. Emerged Constructs around the Individual

Five constructs emerged around the individual factors, the first of which is *perceived opportunity for improved speed and efficiency.* Three themes emerged around this construct, illustrated in Table 2. The first theme describes the potential for improving the rate at which stakeholders could perform basic tasks, e.g. "I believe it will make our job faster" (RHCW2).

The second theme concerns the potential to reduce costs associated with transferring health data to the MoH. Health data could easily be transferred via internet into the central database by the click of a button; a significantly simpler alternative to the current method of transporting hardcopies of records by road, e.g. “No more paying for transportation to all the places where you are required to send the data, so you just click a button and the data goes wherever” (RHCW5). The third theme describes an expected reduction in time spent by Parents/community members at the healthcare centres during diagnosis and treatment. Several stakeholders saw the use of the mHealth tool as a way of quickly going through the process of diagnosis and treatment in a much shorter period, e.g. “With this mHealth tool we will not be wasting too much time at the centre, since the tool will make them work faster” (Parent7).

In stakeholders’ terms *perceived opportunity for improved speed and efficiency* was seen as an important factor that would influence positive appraisal of the mHealth tool. Thus:

H1a. *Stakeholders’ perceived opportunity for improved speed and efficiency will result in a positive primary appraisal*

Constructs (Axial Codes)	Explanation (Theoretical Memos)	Themes: Stakeholders believe that by using the mHealth tool (Open Codes)
Perceived opportunity for improved speed and efficiency	The strategic opportunity perceived by stakeholders as regards efficiency and speed as opposed to using the paper methods	• There is a perceived opportunity for improved speed and efficiency for diagnosis and treatment among stakeholders • There is a perceived opportunity for improved speed and efficiency for capturing and sending (uploading) health data by stakeholders • There is a perceived opportunity for improved speed and efficiency for diagnosis and treatment time spent at rural healthcare centres among stakeholders
Perceived opportunity for improved reliability	The strategic opportunity perceived by stakeholders for an enhanced reliability on their diagnosis and treatment results by parents	• There is a perceived opportunity for improved reliability of diagnosis and treatment results among stakeholders • There is a perceived opportunity for improved reliability of results among stakeholders from rural healthcare centres • There is a perceived opportunity for improved reliability health data entries among stakeholders
Perceived opportunity for simplicity of tasks	The strategic opportunity perceived by stakeholders as regarding how their present practices could be made less burdensome	• There is a perceived opportunity for simplicity of diagnosis and treatment procedures among stakeholders • There is a perceived opportunity for simplicity of health data handling among stakeholders
Perceived threat from technical limitations	The inadvertent threat perceived by stakeholders with regards to the mHealth tool robustness	• There is a perceived threat from the technical limitation of mHealth is respect to task execution among stakeholders • There is a perceived threat from technical limitation of the features regarding other diagnosis and treatments among stakeholders • There is a perceived threat from technical limitation regarding the sturdiness of the mHealth tool among stakeholders
Perceived threat from process uncertainty	The inadvertent threat perceived by stakeholders with regards to changes that would affect habit/practice	• There is a perceived threat from process uncertainty for the inherent tasks among stakeholders • There is a perceived threat from process uncertainty in interaction among stakeholders • There is a perceived threat from process uncertainty when interacting with the community's values and norms among stakeholders

Table 4-3: Themes for each of the emerging constructs relating to individual factors

The second construct was the *perceived opportunity for improved reliability*, which manifested three distinct themes. The first theme described stakeholders' anticipation that the quality of diagnosis and treatment outcomes from rural health centres would improve e.g. "mHealth tool will help RHCWs in making better decisions resulting in improved quality of diagnosis and treatment" (Parent5). The second theme was stakeholders' perception that results from the new system would be more reliable, e.g. "It might bring changes, because right now from the way I am seeing things, people will tend to trust [have faith on] devices and people will trust being diagnosed with devices" (Parent2). The third theme describes RHCWs' anticipation that new systems could implement error-proof data entry forms for rural healthcare centres, e.g. "I know that using mHealth tool will help in reducing errors in our treatment" (RHCW6). Stakeholders were acutely aware that records are not always accurate; an issue that creates frequent and unwelcome uncertainty during the diagnosis and treatment process.

Improved reliability was seen by stakeholders as a significant factor that would influence positive appraisal for mHealth tools. Thus:

H1b. *Stakeholders' perceived opportunity for improved reliability will result in a positive primary appraisal*

The third construct was the *perceived opportunity for simplicity of tasks.* Two themes emerged within this construct. The first theme describes that most stakeholders believe an mHealth tool would make RHCWs tasks effortless compared with the existing paper format, e.g. "The app is easy to locate on the phone; you can easily use it. It is good, the guide is there for you" (RHCW7). For some, it referred to the easy understanding of their tasks when

using the mHealth tool, e.g. “it is easy for me to manipulate this tool, the app as I can say is very comfortable at our own level” (RHCW3). The second theme describes the simplification of data management for stakeholders, e.g. “Data recording is not needed. As you progress through the app, data is being saved and stored for you at the same time” (RHCW2). This appealed to stakeholders, for whom data recording was often a cumbersome secondary activity distracting them from core treatment and diagnosis responsibilities.

Perceived opportunity for simplicity of tasks was also identified. Stakeholders’ were enthusiastic about the possibility of an mHealth tool simplifying and improving their tasks. This was identified as a significant factor that would influence a positive primary appraisal. Thus:

H1c. *Stakeholders’ perceived opportunity for simplicity of tasks will result in a positive primary appraisal*

The fourth construct was the *perceived threat from technical limitations,* which manifested three themes. The first theme was the concern around the technical limitation features of the mHealth tool in performing the envisaged tasks. Stakeholders raised concerns regarding how well the mHealth tool performs the diagnosis and treatment tasks e.g. “if they have overwhelming failure in the app then that can put a lot of people off” (Developer6). This implies that a first-time user could be influenced to reject an application that is not performing as one anticipated. The second theme expressed concerns around the limited technical features of the mHealth tool regarding treatments e.g. “I feel that the app development should go further than the stage it is at now, for example, the issue of treatment is still being done manually” (Facilitator1). For others, it goes much deeper, they want the mHealth tool to

be used in treating adults, e.g. “I want the tool to be developed to include adults, like pregnant women” (RHCW4). That is, if mHealth tool could not be used to do these other activities that he/she would have wished it could do, then, he or she might negatively appraise it. The third theme expressed concerns around the technical limitations regarding the ruggedness features of the mHealth tool e.g. “the smartphone looks fragile and might break when it falls, so, one would like to use a tool that could break incurring damages from user” (Facilitator2).

Technical limitations was highlighted by stakeholders as one of the significant factors that would influence a negative appraisal for the mHealth tool. Thus:

H1d. *Stakeholders’ perceived threat from technical limitations will result in a negative primary appraisal*

The fifth construct was the *perceived threat from process uncertainty,* which exhibited three themes. The first theme explained the anxiety felt by stakeholders with regard to using computers, e.g. “I have not used a computer before, I do not know whether I can use it” (RHCW5). To some stakeholders the prospect of using technology evoked a deep emotion, e.g. “for some of us it will be hard you know, I feel too old now to start learning how to use computer, well we will see" (Facilitator6). The second theme describes the concern by stakeholders that mHealth introduction might alter current work practices, e.g. “People find it very difficult to change from their comfort zones, they feel uncomfortable to change to an unknown way of doing things” (Facilitator3). The third theme describes the effect of norms and cultural values that may negatively influence stakeholders’ behaviour towards the

mHealth tool, e.g. “people in rural communities liken technology as a sign that we are nearing the end of the world [end-time] due to their beliefs” (Facilitator1).

Process uncertainty was also identified by stakeholders as a convincing factor that would influence a negative appraisal for the mHealth tool. Thus:

H1e. *Stakeholder’s perceived threat from process uncertainty will result in a negative primary appraisal.*

4.5.2.2. Emerged Constructs around Social Factors

Five constructs emerged around the social factors, themes for which are illustrated in Table 3. The first construct was the *perceived opportunity for new information and communication channels,* which exhibited two themes. The first theme describes the new communication channels between stakeholders, e.g. “It will create communication between rural healthcare officers and patients regarding health-related matters” (RHCW6). For others, new information channels created more potential for supervision, e.g. “It will help open up conversation between rural healthcare officers and their superiors about their tasks” (Developer5). The second theme describes a new source of health information through the internet, e.g. “With the phone, people would be looking for diagnosis or treatment about ailments in the net” (Facilitator1).

Stakeholders identified *perceived opportunity for new information and communication channels* as a compelling factor that would influence positive primary appraisal of an mHealth tool. Thus:

H2a. *Stakeholders' perceived opportunity for new information and communication channels will result in a positive primary appraisal*

The second construct was the *perceived opportunity for improved healthcare outcomes in rural communities*, which displayed two themes. The first theme highlighted the impact such a healthcare delivery tool would have on rural community members, e.g. "It could create a happier community since this could mean that less children would be dying from childhood diseases" (Facilitator4). The general impression among stakeholders is that using mHealth tool in rural communities would encourage members to send their children for diagnosis and treatment, e.g., "Once they [Parents] know that we are using phone [mHealth tool], they would rush [avail of such opportunity] for it" (RHCW3). There is also the belief that the work ethic of stakeholders would improve tremendously as a result of mHealth introduction in Enugu State healthcare system. For example, stakeholders would be motivated to work in rural healthcare centres, e.g. "it would improve my confidence and I would be respected in my community for using mHealth tool" (RHCW1). The second theme concerns the 'reach' capacity of an mHealth tool, e.g. "Using mHealth tool by RHCWs is the best way to bring treatment to the rural communities" (Developer5). That is, the mHealth tool would help in extending healthcare services to rural community members into the healthcare systems.

Perceived opportunity for improved diagnosis and treatment was seen by stakeholders as a substantial factor that would influence primary positive appraisal of an mHealth tool. That is, positive response to the external impact

on the healthcare services that is quite different from internal (self) impact. Thus:

H2b. *Stakeholders' perceived opportunity for improved diagnosis and treatments will result in a positive primary appraisal*

The third and the most frequently discussed construct described the *perceived threat from lack of government support.* This construct is considered to be the most persuasive, as it emphasises the need for government approval and support for the mHealth implementation process. The nature of the support expected from government is varied. Government support significantly plays a central role in moderating the effect of negative appraisals. The first theme focused on the origin of the mHealth tool e.g. "You have to convince these policy makers seriously [persuasively] before they can buy-into it, we need to convince them that this [mHealth tool] belongs to them" (Facilitator1). This, suggests that for successful implementation of mHealth tool in Enugu State, policy-makers would need to be co-opted as partners in its introduction, for example, policy-makers would need to enact laws and regulations to afford the provision of healthcare via mHealth a legal status in the healthcare delivery system. The second theme refers to the concern around the consistency in policy implementation by successive governments, e.g. "One of the things I have seen is, you know somersaults, inconsistency in implementing policies and things they set out to do" (Developer5). Implying there is a lack of consistency on the part of governments regarding policy implementation. Often, a change of government means policies are reversed or tweaked in such a way as to suit the new government agenda. The third theme centred on the concern by stakeholders for the provision of adequate

financial resources. Stakeholders expect the government to provide financial support and the needed incentives to stimulate the use of an mHealth tool, e.g. “mHealth implementation could be jeopardised by lack of funds, and its sustainability depends on the availability of funds as well” (Facilitator4). The fourth theme describes the concern around the provision of training for users. For some, lack of training could mean not doing their tasks as expected e.g. “it is a new app that are going to have to be embedded within their daily work practices, and for this to work, they have to be trained properly on how to use it” (Developer2). For others, it has much deeper implications, e.g., “without good training, it may have a consequential effect on the continued use of mHealth for a long time after its introduction, the tool could be abandoned” (Facilitator5). The fifth theme is the concern expressed by stakeholders around the need for supervision during mHealth tool use. This theme stressed the importance of supervising users during use to make sure that the mHealth tool is used as anticipated, e.g. “they will also need a lot of supervision from their superiors to make sure they are doing the correct thing” (Facilitaor6).

Constructs	Explanation	Themes: Stakeholders believe that by using the mHealth tool
Perceived opportunity for new information and communication channels	The strategic opportunity perceived by stakeholders regarding other potential benefits of the mHealth tool	• There is a perceived opportunity for new information and communication channels among stakeholders – between RHCWs and Parents, with RHCWs, and RHCWs and their supervisors or superiors • There is a perceived opportunity for new information and communication channels through internet for Parents and community members at large
Perceived opportunity for improved healthcare outcomes in rural communities	The strategic opportunity perceived by stakeholders regarding the potential benefits of the mHealth tool	• There is a perceived opportunity for improved healthcare outcomes as mHealth tool introduction would lead to less under-five deaths • There is a perceived opportunity for improved healthcare outcomes in rural communities since healthcare services would reach the unserved
Perceived threat from lack of government support	The inadvertent threat perceived by stakeholders in regards to support from the government	• There is a perceived threat from lack of government support with regards to participation or partnering • There is a perceived threat from lack of government support by the creation of enabling policies for mHealth tool implementation and upscaling • There is a perceived threat from lack of government support for the provision of required or necessary funding for implementation and sustainability • There is a perceived threat from lack of government support to provide training for end-users • There is a perceived threat from the lack of government support in the areas of supervision and monitoring
Perceived threat from lack of reliability of infrastructure	The inadvertent threat perceived by stakeholders regarding infrastructural requirements	• There is a perceived threat from lack of reliability of infrastructure with regards to internet availability • There is a perceived threat from lack of reliability of infrastructure with regards to steady supply of power (electricity)
Perceived threat from social exclusion	The inadvertent threat perceived by stakeholders of being socially isolated as a result	• There is a perceived threat from social exclusion for doctors who might feel that their primary job is being taken away by the introduction of mHealth tool • There is a perceived threat from social exclusion for RHCWs who feel that it might mean the loss of their job

Table 4-4: Themes for each of the emerging constructs relating to social factors.

Perceived threat from lack of government support was viewed by stakeholders as the most significant factor that would influence the primary negative appraisal for mHealth tool. Thus:

***H2c**. Stakeholders' perceived threat from lack of government support will result in a negative primary appraisal*

The fourth construct was the *perceived threat from lack of reliability of infrastructure.* Stakeholders raised concerns around the impact of unreliable infrastructure. The first theme was the concern around the non-availability of internet which could hamper the use of the mHealth tool, e.g. "The external networks that could impact on the health care delivery as regards mHealth is internet availability" (RHCW2). Suggesting that in remote areas, the external input, such as poor internet connection could make mHealth use unworkable, being a characteristic feature, it could make people not be enthusiastic about mHealth introduction. The second theme centred on the need for a constant power supply e.g. "The epileptic nature of electricity supply…where people can't even charge their phones or PCs because they don't have light [power] is going to be a big problem for mHealth tool" (Parent2). Stakeholders are referring to the unreliable electricity supplies across Nigeria, which to them could jeopardise the opportunities afforded by mHealth.

Reliability of infrastructure was highlighted as one of the important factors that would influence the primary negative appraisal for mHealth tool. Thus:

***H2d.** Stakeholders' perceived threat from lack of reliability of infrastructure will result in a negative primary appraisal*

The fifth construct was the *perceived threat from social exclusion.* Stakeholders are concerned that mHealth introduction into Enugu State healthcare system could bring along with it such issues as social exclusion and class distinction. The first theme made reference to the anxiety that an mHealth tool will reduce their job security, e.g. “I am worried that it might make some of us redundant in our work place” (RHCW3). This perception stems from the deduction that using an mHealth tool could mean executing more tasks than one or more RHCWs at any given time, thus rendering some of them redundant. These redundant workers could be sacked or reassigned. The second theme focused on the job status of some stakeholders (e.g., doctors). For some, implementing mHealth technologies might mean losing the professional autonomy they have over diagnosis and treatment, e.g. “Some doctors may not accept it for given away their primary duty” (Developer6). These concerned stakeholders argue that diagnosis and treatments are at the core of their profession, so, why give it away to other stakeholders by way of mHealth technologies.

Perceived threat from social exclusion was identified as one of the factors that would influence a negative primary appraisal. Thus:

***H2e**. Stakeholders’ perceived threat from social exclusion will result in a negative primary appraisal*

4.6. Discussion

This paper explores the factors that influence stakeholders’ primary appraisal of mHealth technologies in rural contexts. The analysis in the previous section presents several important findings.

First, *opportunity* was found to play an important role in explaining the internal and external factors that positively (positivity) influence stakeholders' primary appraisal via five constructs. The *perceived opportunity for improved speed and efficiency* construct describes the stakeholders' opinions that captured the practical benefits that mHealth would have on healthcare delivery (e.g. Paina and Peters, 2011; Gurman et al., 2012). Such internal perception for an opportunity for improved speed and efficiency may lead to stakeholders positive appraisal of an IT tool and may ultimately influence intention to use (Beaudry, 2009; Claggett, 2010). Stakeholders' beliefs that using mHealth tool would result in improved quality data, diagnosis and treatment emanated from the *perceived opportunity for improved reliability* construct. These perceptions are consistent with existing literature (e.g. Akter et al., 2010; Chib et al., 2015b). Self-efficacy which emanates from the stakeholders' beliefs about their abilities emerged within the *perceived opportunity for simplicity of tasks* construct. Self-efficacy perception reflects an individual's internal beliefs in his/her own capabilities to perform a sequence of action to meet a given social demand (healthcare delivery) (Barbeite and Weiss, 2004; Ajzen, 2002). Self-efficacy has been found in literature to influence positive appraisal of an IT tool and intention to engage (e.g. Agarwal et al., 2000; Ajzen, 2002). This, specifically holds true for mHealth tool in research conducted by Xue et al. (2015) in Ethiopia. They posit that perceived behavioural control which could be aligned with self-efficacy can make individuals more motivated to perform a target behaviour (goal) (Xue et al., (2015). The *perceived opportunity for new information and communication channels* construct arose out of the

stakeholders' perceptions around these other 'things' that one could use the mHealth tool for. This positive influencing factor emerged from interacting with the material agency of mHealth tool (external material). One such activity is third party information access via the internet. Parents could access health information available in the Internet but this space is unregulated and may jeopardise the structured healthcare delivery processes meant for rural communities (Murray et al., 2003; Moreland et al., 2016). The other is the new communication channels between stakeholders created by the availability of these mobile tools. Patients could reach RHCWs through this tool, it facilitates communication amongst RHCWs and between RHCWs and their supervisors (e.g. Leon et al., 2012; Higgs et al., 2014). The *perceived opportunity for improved healthcare outcomes in rural communities'* construct emerged from the stakeholders' belief that healthcare services would reach the unserved in rural areas. That is, the positive external impacts of using an mHealth tool. These findings resonate with previous work demonstrating how perceived improvement in health outcomes could influence stakeholders' decision making process towards positively appraising an mHealth tool (Aranda-Jan et al., 2014; Miah et al., 2017).

Second, *threat* was found to play a significant role in delineating the internal and external factors that negatively influence stakeholders' primary appraisal of an mHealth tool through five constructs. The *perceived threat from technical limitation* construct emerged for the stakeholders' internal concerns around technical functionalities and limited capabilities (Lee et al., 2008; Lim et al., 2000) of the mHealth tool (Chang et al., 2013). First impression has been shown to influence the decision making process to either positively

(opportunity) or negatively (threat) appraise an IT tool (Kim et al., 2009; Nicolaou and McKnight, 2006). First impression is considered a significant factor in an appraisal process, since one may not get a second chance to test-out a particular IS tool (Frost et al., 2008; Reinecke et al., 2013). Limited capabilities were found to influence stakeholders' decisions to either positively or negatively appraise an mHealth tool. This finding resonates with evidence in literature regarding stakeholders' high expectation of an mHealth tool (Chang et al., 2013). The *Perceived threat from process uncertainty* construct emerged for stakeholders' internal perception of concerns around the fear of computers, pre-existing practices, and counter interactions with culture and norms. Computer anxiety arises out of the fear of computers when using a computer or fearing the possibility of using one in the future (Barbeite and Weiss, 2004; Shu et al., 2011). Findings in literature echo previous works demonstrating the influence of computer anxiety on primary appraisal that impacts intention (e.g. Venkatesh, 2000; Fagan et al., 2004). Habit as one of the perceived threats has been identified in previous works (Recker, 2014; Maier et al., 2015). Habit could be defined as an acquired or cultured behavioural sequences of acts to achieve a specific goal (Polites, 2005; De Guinea and Markus, 2009). In IS research pre-existing practice or habit is a critical predictor of technology use (Venkatesh et al., 2012; Polites, 2005). Cultural and social norms was found to influence stakeholders' decisions (e.g. Carter and Weerakkody, 2008; Srite and Karahanna, 2006). In the context of this study, culture could be defined as communicable knowledge produced across humanity's social life (Jahoda, 2012; Im et al., 2011). The perceived effect of culture and social norms have important conceptual similarity with

habit. In that vein, one could infer that since technology is generally used in cultural contexts, culture can be said to play a significant role in technology appraisal (Im et al., 2011). The *perceived threat from lack of government support* construct emerged for stakeholders' concerns around government support for mHealth intervention. This concern resonates with previous work showing the influence of government support on primary appraisal of an IT. For example, lack of support from governments (external to the user) in areas of promulgation of enabling policy, high level strategic planning and financial support have shown to inhibit implementation of mHealth in developing countries (e.g. Mechael, 2009; Leon et al., 2012). Funding shortages have been found to discourage users to continue with mHealth services (Chib et al., 2008; Chib, 2010). Absence of this support may lead to negative (threat) primary appraisal of an mHealth tool (Aranda-Jan et al., 2014; Leon et al., 2012). Support in areas of training and supervision has been shown to lead to positive or negative appraisals. Evidence of the need for these types of support is found in existing literature (e.g. Leon et al., 2012; Modi et al., 2015). The *perceived threat from lack of reliability of infrastructure* construct reflects the reality that the non-availability of power supply and internet access could pose negative influence to the successful implementation of mHealth in developing countries (Akter et al., 2010; Sanner et al., 2014). Threat appraisal of the reliability of infrastructure which is an external factor is particularly significant for stakeholders in rural communities where power outages and network coverages are more pronounced. The *perceived threat from social exclusion* construct manifested for stakeholders' concerns around the internal fear for technology and job loss as a result of introducing an

mHealth tool (Chang et al., 2013; Maeder, 2014). Some stakeholders expressed concern for the security of their jobs as the introduction of an mHealth tool might mean fewer workers would be required (Chang et al., 2013; Xue et al., 2015). Other stakeholders (e.g., Doctors) expressed concern over the possible change to the traditional way treatments are done (Malvey and Slovensky, 2014; Desai et al., 2016).For others, it could mean the loss of autonomy where a skilled professional is acting exclusively on the guidance of a specialist located at a remote area (Morrison et al., 2013).

4.7. Summary and Conclusion

The study developed a novel research model that describes how primary appraisal influences the introduction of an mHealth tool in a new context. In the model, the emergent constructs from both the individual and social factors combine to tell a story of how primary appraisal could positively or negatively affect mHealth introduction in rural communities of developing countries. The model presents a set of individual and social factors that governments, funding bodies and non-governmental organisations should consider before embarking on the introduction of an mHealth tool in rural communities of developing countries. At the individual level, the perceived opportunities for improved speed and efficiency, reliability of results, and simplification of tasks by the tool were seen on as possible motivating factors that would influence stakeholders to positively appraise a new mHealth tool. The perceived threats from the technical limitations of the tool's functionalities, and process uncertainty were seen by stakeholders to negatively impact the introduction of an mHealth tool. At the social level, the perceived opportunities for new information and communication channels and

improved availability of healthcare services would positively impact on the primary appraisal. Yet, the perceived threats from lack of government support, lack of reliable infrastructure, and the resultant social exclusion associated with the introduction of an mHealth tool were seen by stakeholders to negatively affect primary appraisal.

This research has several important contributions to research and practice. First, the model offers new perspectives for researchers into the primary appraisal processes and dynamics involved in the introduction of mHealth tools for new areas of developing countries. Second, the model offers a new way to understand how users arrive at their primary appraisal behaviour and thus can provide a useful framework through which we can incorporate adoption and resistance studies (Eze et al., 2016a). This contribution could be considered significant in modelling the factors that influence primary appraisal. Third, it is envisaged that by understanding the process of primary appraisal, either as an opportunity or a threat, practitioners and organisations will support positive appraisal and minimise the occurrence of negative ones when introducing mHealth tools. Fourth, this research contributes to the growing evidence that the cognitive processes can be broken down into internal and external components (e.g. Braver, 2012; Paradis, 2011; Aizawa, 2017; Wedgwood, 2006). The findings of this study were not without some limitations. First, the study made use of a single-case design, and thus make no claims of statistical generalisability (Yin, 2013). Second, the study was exploratory in nature. We therefore recommend a longitudinal study that could reveal other contributing factors that may arise due to re-appraisal processes, as users may re-evaluate and adjust their prior primary and/or

secondary appraisals (Beaudry and Pinsonneault, 2005; Bhattacherjee et al., 2017). Third, the research focused on technology-enabled guideline-driven treatment of the mHealth delivery service. Other forms of mHealth initiatives exist, e.g. those focused on data gathering (Chang et al., 2011; Medhanyie et al., 2015) or those focused on remote diagnosis and treatment (Hufnagel, 2012; Knoble and Bhusal, 2015). We, therefore, call for similar research on other delivery approaches in order to compare findings.

Chapter Five

5. Planning and positioning mHealth interventions in developing countries

5.1 Abstract

Objective: The objective of this paper is to develop a framework for the planning and positioning of mHealth interventions in developing countries.

Method: The description of the framework uses an illustrative case from Enugu State, Nigeria. Planning and positioning for this case included a number of interventions, including specific workshops, training sessions, and other attempts to socialise mHealth tools and canvass for local and regional support.

Results: The planning and positioning differentiates between interventions at two levels. First, we differentiate between interventions targeting *traits* and *states*, the latter being situation-specific. Second, we differentiate between *individual* and *social* interventions, the latter being resilient to personnel change. This creates a simple 2*2 matrix to lay out the portfolio of interventions in an mHealth project.

Conclusion: The framework offers support to governments, decision makers, and developers as they design an assemblage of mHealth interventions. This added clarity means the framework also helps to analyse 'as is' structures and behaviours. The framework further provides support for reflecting on projects, as interdependent goals in different quadrants can be assessed against specific interventions.

5.2 Introduction

mHealth is the application of mobile wireless technologies to support healthcare delivery (e.g., Kamsu-Foguem and Foguem, 2014). Existing literature has shown that mHealth can be used in many areas of healthcare services (e.g., Chang et al., 2011). Notable examples include improving the quality of data recording and data entry (e.g., Rajput et al., 2012; DeRenzi et al., 2011) and remote tracking of treatment and medication adherence (e.g., Haberer et al., 2010; Smith et al., 2012), to mention but a few.

These research streams have helped to highlight the potential of mHealth. Yet mHealth is not simply a matter of building IT; many related activities are required to harmonise goals, inform policy, and justify public investment (Chib, 2013; Chib et al., 2015b). This is challenging, as the various supporting interventions may be difficult to scope and may be interdependent on one another, thus difficult to evaluate in terms of quality and effectiveness (e.g., Mechael et al., 2010; Chigona et al., 2012). This study addresses this issue by presenting a framework to help plan, position, and relate supporting interventions. The next section describes the framework, based on a simple 2*2 matrix and a number of illustrative exemplar interventions. The final section presents implications of this framework for health policy and technology.

5.3 Planning and positioning framework

The first dimension for differentiating between specific interventions is whether they target *traits* or *states*. This differentiation is key to

understanding emotional and behavioural responses to a new IT (e.g., De Guinea and Markus, 2009; Jokinen, 2015). *Traits* refers to those aspects of personality that are comparatively stable over time and situations (environments) (Zellars et al., 2004; Allen and Potkay, 1981). Many personality theorists have conceptualised traits as the fundamental qualities, characteristics, or cognitive processes that operate or exist in an individual (Allen and Potkay, 1981; Luthans et al., 2007). *States* are defined as being situationally (environmentally) dependent, hence temporary in nature (e.g., Allen and Potkay, 1981). *States* can be internal or external, meaning they may arise because of the mood of the individual and/or the conditions to which they are being subjected at some point in time (Luthans et al., 2007; Zellars et al., 2004).

The second dimension for differentiating between specific interventions is whether the benefits of that intervention are lost if the participating individuals leaves the target system, i.e. whether the intervention is at the level of the *individual* or the *social*. At an *individual*-level, desired changes may include everyday activities (Barrick and Mount, 1991; Allen and Potkay, 1981), beliefs and attitudes such as hope, optimism, and self-efficacy (Luthans et al., 2007; Luthans et al., 2004), or goals and adjustments (e.g., Luthans et al., 2007). At a *social*-level, desired changes may include collective attitudes and beliefs (Yeo and Neal, 2006: 1089, leveraging the works of Bandura, 1998), shared processes and culture (Hill, 1982; Barsade, 2002), or even shared emotions (Schoenewolf, 1990: 50).

Just as designers increasingly understand the need to consider both *traits* and *states*, so many organisations recognise the need to balance *individual* and

social changes when attempting to improve outcomes (e.g., Barsade, 2002; Paulus and Nijstad, 2003). We apply the same logic when attempting to improve a healthcare system, as illustrated in Figure 5-1.

Intervention Methods		
Individual	Individual Traits	Individual States
Social	Social Traits	Social State
	Traits	States

Figure 5-1: Intervention Framework

The framework was informed by planning and positioning for an exploratory research initiative in Enugu State, in the South Eastern Region of Nigeria. This project focused on introducing an ICT-enabled mobile application to assist healthcare delivery for infants and young children under 5. This included a number of interventions focused on rural healthcare workers (RHCWs), mHealth application developers, parents, and both Local and State government officials. Ethical approval was obtained in both the primary host institution of the researchers and a local university in Nigeria involved with the research initiative.

5.3.1 Interventions targeting individual traits

Individual traits refer to inherent characteristics of an individual that differentiates him/her from another (Luthans et al., 2007; Allen and Potkay, 1981). These characteristics manifest in the personality traits of an individual. They are usually those stable and consistent responses of an individual to adapt to his or her environment (Allen and Potkay, 1981; Luthans et al.,

2007). There are five major types of individual personality traits usually known as the five-factor model (FFM) (Hurtz and Donovan, 2000; Roccas et al., 2002) that could influence how an individual responds to stressful situations (e.g. a new IT) in their environment. These individual personality traits vary in degrees of influence from low to high among different individuals.

First, the *openness-to-experience* trait measures personality characteristics such as broadmindedness, intellect, curiosity, cultured-ness and intelligence which are positive attributes towards learning experiences (Barrick and Mount, 1991; Roccas et al., 2002; Holton III, 2005). It is posited individuals who score high on these attributes tend to be open-minded, inspired, sensible, and intellectual (e.g., Roccas et al., 2002). This is important, as individuals with high openness to experience traits are more likely to learn and benefit from the training than those who are at low score (Barrick and Mount, 1991; Griffin and Hesketh, 2004). Those with high scores are also likely to be more adaptable to changing circumstances (George and Zhou, 2001; Griffin and Hesketh, 2004).

Second, *conscientiousness* is the extent to which an individual is reliable, persevering, hardworking, disciplined, deliberate, and/or achievement oriented (Holton III, 2005; Hurtz and Donovan, 2000). Conscientiousness is related to job performance since it measures those attributes which are significant factors for tasks accomplishment (Barrick and Mount, 1991). Individuals high in conscientiousness tend to be responsible, organised, meticulous and high motivation to learn (Roccas et al., 2002; Teng, 2008). Those in low levels of conscientiousness appear to be untrustworthy,

unorganised and irresponsible (Roccas et al., 2002; Teng, 2008; Widiger and Lynam, 1998).

Third, e*xtraversion* refers to an individual's propensity to experience positive emotions (e.g., Panaccio and Vandenberghe, 2012). These emotions include assertiveness, talkativeness, venturesome-ness and social poise (Zellars et al., 2004; Panaccio and Vandenberghe, 2012). Individuals with high extraversion traits are enthusiastic and joyful because they usually engage in more activities that help in overcoming stressful conditions (Zellars et al., 2004). This implies individuals that are low in extraversion tend to be introverts, aloof, and resigned (Widiger and Lynam, 1998; Roccas et al., 2002).

Fourth, *agreeableness* describes individuals who are compassionate, trusting, cooperative, and amenable-to-changes (Panaccio and Vandenberghe, 2012; Barrick and Mount, 1991). Individuals who score high in agreeableness are said to be good-natured and cooperative (Roccas et al., 2002; Barrick and Mount, 1991). Hence individuals with high agreeableness are likely to work together in a team to achieve a common goal, while those with low agreeableness tend to be antagonistic and inflexible (Roccas et al., 2002; Widiger and Lynam, 1998).

Fifth, *neuroticism* refers to individuals that have a tendency to experience distressful and nervous emotions easily, such as anger, anxiety, depression, and vulnerability (Zellars et al., 2004; Panaccio and Vandenberghe, 2012). High neuroticism individuals are prone to mal-adaptive coping strategies, leading to withdrawal or disengagement (Migliore, 2011; Panaccio and Vandenberghe, 2012). Individuals with low neuroticism are more likely to

bounce back from difficulties, stay in control, and withstand stressful conditions (Migliore, 2011).

We targeted *individual traits* in two notable ways. First, rural healthcare workers and supervisors were educated on the basic standard of digital or IT literacy and the mHealth tools fit for future healthcare delivery needs. This helped increase the participants' *openness to experience* and reduce *neuroticism* around the use of IT in healthcare more broadly. Second, local government officials were made aware of the current issues regarding mHealth as a healthcare delivery support tool. Perceived blind-spots around the use of the mHealth tool were thoroughly explained in an effort to enable a credible foundation for mHealth. This increased *conscientiousness*, not only as it concerns some new mHealth solutions, but for the Enugu State healthcare system more broadly.

5.3.2 Interventions targeting individual states

Individual states occur when situational internal or external conditions cause us to deviate from our typical traits. These states often result from emotional reactions to events in a workplace or environment which trigger atypical behavioural responses (Panaccio and Vandenberghe, 2012; De Guinea and Markus, 2009). For example, an individual's first encounter with new IT may cause them to form a disproportionally favourable/unfavourable perspective (De Guinea and Markus, 2009; Panaccio and Vandenberghe, 2012), as will each subsequent satisfying or unsatisfying interaction (Panaccio and Vandenberghe, 2012; De Guinea and Markus, 2009). The extent of this emotional reaction is moderated by individual dispositions, yet the presence of the influence is nonetheless consistent (Zellars et al., 2004; De Guinea and

Markus, 2009; Panaccio and Vandenberghe, 2012). For example, positive moods moderate the relationship between extraversion and achievement (Roccas et al., 2002; Zellars et al., 2004; Panaccio and Vandenberghe, 2012), while negative moods moderate the relationship between neuroticism and retirement (Zellars et al., 2004; Roccas et al., 2002; Panaccio and Vandenberghe, 2012).

The most important *individual state* we targeted was *neuroticism*. First, rural healthcare workers and supervisors were required to socialise with mHealth tools in a workshop setting to reduce tool-specific anxiety. This provided individuals with a sense of what it would be like to use the mHealth app as part of their roles in the community. Second, rural healthcare workers and supervisors were asked to engage in role-playing scenarios to learn from each other while acting in a role as a patient or a healthcare worker and vice-versa. This helped participants imagine how other people might respond to different illness or sickness scenarios, allowing them to begin mentally preparing in a safe environment.

5.3.3 Interventions targeting social traits

Social Traits describe shared values and belief systems that help individuals to cooperate to accomplish one or several goals (e.g., Luthans et al., 2004). We apply Hofstede's (e.g., , 1983; 1993) framework on cultural dimension to understand social traits. This framework describes five independent dimensions that helps to explain the management structure of a social group (i.e., an establishment, organisation, community, or country). Put differently, "The collective programming of the mind that distinguishes one group or category of people from another" (Hofstede and McCrae, 2004: 58).

Power-distance describes the extent to which the less powerful in a social group anticipate and agree that power is distributed equally among members (Hofstede and McCrae, 2004; Hofstede et al., 2005; Hofstede and Hofstede, 2005). It is a measure of *'dependence'* with a given social group (Hofstede et al., 2005; Hofstede, 1983), meaning low power-distance implies less dependency on leaders.

Individualism-collectivism refers to the degree to which individuals are concerned with their own interests relative to the larger social group (Hofstede and McCrae, 2004; Hofstede et al., 2005). Individualistic groups tend to encourage individuals to focus on themselves and their immediate family, while collectivistic groups encourage loyalty to shared interests (Hofstede and Hofstede, 2005; Migliore, 2011).

Masculinity-femininity draws on the historic generalization that "men are supposed to be assertive, tough, and focused on material success; women are supposed to be more modest, tender, and concerned with the quality of life" (Hofstede et al., 2005: 519). Thus, masculine cultures encourage assertiveness and competition, while feminine cultures encourage cooperation and gentleness (Hofstede and McCrae, 2004; Hofstede et al., 2005).

Uncertainty-avoidance describes the level to which members of a social group or system accept unknown or uncomfortable situations (Hofstede and McCrae, 2004; Hofstede et al., 2005; Hofstede, 1983). This cultural dimension is related to cultural anxiety, similar to the neuroticism trait, meaning it often manifests as collective nervous energy (Hofstede and McCrae, 2004; Hofstede et al., 2005).

Long-term-short-term represents the level to which members of a social group or organisation are consciously manoeuvred to accept delayed remunerations or compensations (Hofstede and McCrae, 2004; Hofstede et al., 2005). This means traditionally that short-term oriented social groups among others demand quick results for inputted efforts, while, long-term oriented social groups want future dispensed returns on investment (Hofstede et al., 2005).

We targeted *social traits* in two ways. First, we canvased for financial support from the local government authority and ministry of health to make resources available for rural healthcare workers. This was done to nurture *collectivism* and *femininity* to encourage a sense of responsibility for vulnerable individuals on the periphery of the healthcare system. Second, we sought to educate individuals from the local government authority and ministry of health regarding the *long-term* benefits of the accurate health data enabled by mHealth tools. This further acted to minimize *uncertainty avoidance* by creating a clear return of investment for new technologies and reasoning out the potential for future projects.

5.3.4 Interventions targeting social states

Just like individuals, groups can take on atypical qualities in specific situations. For example, where power-distance is low, learning a new skill in a traditional instructor/teacher situation is viewed as impersonal, so creating tensions between otherwise cooperative members and increasing competitiveness (Hofstede et al., 2005; Hofstede, 1983). Conversely, where power-distance is high, teachers are expected to outline learning processes clearly; failure to do so may feed into collective anxiety and generate increasing *uncertainty-avoidance* (Hofstede and Hofstede, 2005). Another

example occurs in culturally feminine social groups, wherein teachers typically prefer to praise a weak student in order to encourage him/her, rather than openly praising a good student (Hofstede et al., 2005). However, breaking this norm by extolling excellence might lead to jealousy and increasing individualism (Minkov, 2008; Hofstede et al., 2005). These examples show how shared culture can change once a scenario is encountered for which the existing culture is poorly equipped. Thus, the scenarios must be managed to avoid breakdowns that threaten the consistency of the group over time.

The *social states* of interest in the illustrative case concerned tensions between long-term and short-term time orientations. The culture in Enugu State is largely long-term, with strong sense of connection to the local history and many individuals committed to improving conditions in the future. Yet the attitudes towards the mHealth tool were short-termist, often concerned with cost and challenges presented by the transition. Hence, demonstrations were made for healthcare managers to make them aware of the new practices facilitated by mHealth tools. This included the quality of diagnosis and treatment, as well as the ability to reach those living in hard-to-reach areas of rural communities. Additionally, rural healthcare workers were shown how new processes increased adherence and created less paper and more consistent records. This was an obvious contrast to existing paper-based tools that allow users to skip questions and create large piles of partially complete records.

5.4 Implications for health policy and technology

This study presents a novel intervention framework for the introduction of mHealth in developing countries. The framework differentiates interventions according to four quadrants. First, interventions targeting *individual traits*. These interventions seek to improve individual's abilities, job knowledge, and skills as they relate to an mHealth tool. Second, interventions targeting *individual states*. These interventions seek to improve crucial situations that would otherwise drown out desirable individual traits with emotionally-charged destructive uses an mHealth tool. Third, interventions targeting *social traits.* These interventions seek to improve the culture in which individuals are delivering healthcare using an mHealth tool. Fourth, interventions targeting *social states*. These interventions seek to avoid scenarios that create tensions in the healthcare culture and cause social systems to break down around an mHealth tool.

This particular study makes three important contributions to health policy research. First, the framework provides support for the analysis of the 'as is' of current practice in a target system. Positioning the existing interventions using the framework could help governments, decision makers, and programme developers better achieve their goals. For example, we may imagine a scenario where a government is planning a new malaria treatment and have decided that individuals or social groups lack *openness-to-experience* or exhibit *neuroticism*. The framework prompts two important analytical questions (i) are these traits or are they states, i.e. are these qualities that individuals possess across a range of scenarios or do they arise solely in related healthcare-specific situations? (ii) are there social qualities that also

need to be considered, i.e. do elements of local culture (persistent or situational) threaten the effectiveness of a new mHealth tool? This is important, as there may be macro-level issues that limit individual's willingness to engage with new practices, e.g. excessive *power-distance* or collective *short-termism*. Incomplete diagnosis of the problem can have serious consequences, as demonstrated by previous researches, for example, the study by Xue et al. (2015). In that study, they investigated the reasons behind healthcare providers' resistance to using telemedicine from a threat-control perspective. They concluded that the perceived threat originated from three major cognitive sources: 'reduced autonomy', 'anxiety', and 'cost'. However, our framework would have helped spot other factors that may have contributed significantly to the resistance of healthcare providers to telemedicine. For example, in the *states'* quadrants where the situational internal or external conditions may have accentuated the deviations from individual or social group traits of the healthcare providers.

Second, the framework offers support to governments, decision makers and developers during the planning and positioning of mHealth initiatives. To take the previous hypothetical example, if high *power-distance* has been identified as a problematic social trait, then some intervention(s) need to be designed to address this. Thus, the framework pushes governments, decision makers, and programme developers to design assemblages of interventions more holistically. The benefits of such a holistic approach were observed in previous researches, for example, by Yardley et al (2015). In that study, the digital intervention process utilised went beyond just assessing acceptability, usability, and satisfaction, but allowed the system developers to build-in a

deep understanding of the psychosocial context of users and their views of the behavioural elements of the intervention. Furthermore, in that study, the programme planners applied the *social group* modelling process to assist in overcoming obstacles to adaptation. That is, the telling of stories or recounting testimonials from other successful users which improves the sense of connectedness with their own self-reported (*individual*) progress towards using same to achieve their own goals.

Third, the framework provides a way of relating different assessments, both to each other and to project-level goals. Put differently, the framework encourages governments, decision makers, and programme developers to evaluate projects against the collection of individual and social traits and states. Equally importantly, it encourages governments, decision makers, and programme developers to evaluate the impact of each individual intervention according to the corresponding quality and quadrant. Building on the running hypothetical example, if an intervention was designed to increase *long-termism*, e.g. healthcare experts were invited to discuss the long-term gains of new malaria treatment practices, the framework reminds governments, decision makers, and programme developers to evaluate the intervention accordingly – did it increase *long-termism*. This is important, as many interventions will have multiple benefits, meaning their success or failure can be somewhat ambiguous. For example, a study by Zakumumpa et al (2017) in Uganda described how sustaining and expanding antiretroviral treatment scale-up programmes in a resource-limited setting required adaptations and modifications to the traditional delivery models to meet the overwhelming increase in treatment demand. This they achieved by aligning the available

resources in a resource-constrained setting to antiretroviral treatment interventions where health facilities made a number of adjustments in order to promote *long-term* sustainability of the programmes. However, our framework provides clarity when evaluating such interventions, as project-level priorities can be used to separate must-have outcomes from other nice-to-have benefits.

Chapter Six

6. Conclusion

This chapter brings together findings from previous chapters and relates them to the overarching thesis objective. Section 6.1 explains the social and technical factors that influence the assimilation of mHealth tools in developing countries. Section 6.2 highlights the major contributions of the studies. Section 6.3 presents the challenges involved in undertaking immersive research in developing countries. Section 6.4 describes aligning past-focusing and future-focusing theoretical perspectives. Section 6.5 presents aligning policy-level and practice-level theoretical perspectives. Section 6.6 describes the implications for practice. Section 6.7 explains the implications for research and theory and section 6.8 presents the limitations of this thesis.

The thesis objective is *to create a more socially and technologically holistic understanding of the factors that influence the introduction of mHealth tools into rural areas of developing countries*. To achieve this objective, four studies were conducted. Three studies aligned horizontally as shown in Figure 6-1, i.e., a *review-focused study*, a *past-focused study*, and a *future-focused study*, and a fourth study that is *policy-focused* and aligned vertically from the others.

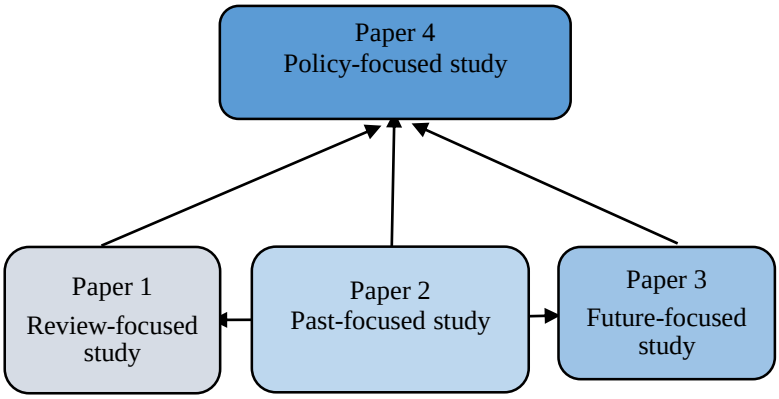

Figure 6-1: Thesis conceptual structure

First, the *review-focused study* was conducted to understand how different stakeholders currently participate and interact in mHealth delivery processes. In order to conduct this study, the researcher searched each of the leading academic databases that typically publish IS research, namely the AIS Electronic Library (AISel); Science Direct & Web Science; JSTOR; Academic Search Complete & Scopus; OCLC FirstSearch; and Google Scholar to gather literature. A set of 108 papers were retrieved after results were filtered with an evolving set of search terms. The study proceeded to analyse and code these 108 papers according to the stages of mHealth delivery described by the reviewed studies. The review then explored how the identified stakeholders participate and interact in an mHealth delivery process. Equally important, the review identified two key areas of neglect in existing research, specifically the interaction between Patients and the interaction between System Developers and all other stakeholders.

Second, the *past-focused* study was conducted to understand what worked and what did not during the implementation and use of mHealth technologies,

and why. This study utilised an interview framework and research instruments that were grounded on the themes that emerged from the *review-focused* study for data gathering (Appendix C). Data gathering involved interviews, participant observation, document/records analysis, field notes, and photographs from clinics in the rural communities. Thirty-two interviews were conducted with contact time averaging 240 minutes for each group of stakeholders, namely, the Patients, RHCWs, Developers and Facilitators. Interviews were conducted in Igbo or English and later transcribed verbatim into English language for analysis. This study adopts an exploratory case-study approach (Yin, 2013) using the socio-material of Leonardi's (2012; 2013) perspective as a guiding theoretical lens. Findings described a problematic disconnect between regional and central health systems, based on accumulated differences in attitudes, facilities, and cultural norms. This disconnect suggests mHealth tools may not be used as intended unless system developers can properly engage with regional users.

Third, a *future focused* study was conducted to understand the factors that influence the primary appraisal of the different stakeholders that would be involved in the future application of mHealth technologies in a rural context in developing countries. This *future-focused* study also utilised an interview framework and instruments that was grounded on the themes that emerged from the *review-focused* study (Appendix D). Data gathering involved interviews, participant observation, document/records analysis, field notes, and photographs from clinics in the rural communities. Stakeholders/interviewees were selected based on the reputational and positional methods as proposed by Knoke (1994), i.e., the stakeholders that

occupy key roles, participate in key binding policy decisions, have the actual power to make changes, and have the important political relational power with other systems.

The findings of this study were captured in the form of the perceived factors that would positively influence primary appraisal of an mHealth tool. These factors showed that much of individual appraisal was influenced by perceptions of systematic constraints and opportunities, rather than just personal impacts.

Fourth, the *policy-focused* study was conducted to develop a framework for the planning and positioning of mHealth interventions in developing countries. In order to conduct this *policy-focused* study, the researcher leveraged the five-factor model (FFM) of individual traits and Hofstede's framework on cultural dimension to understand how we can plan and position mHealth interventions. This study built on empirical findings from the two previous studies to establish a framework for the planning and positioning of an mHealth intervention in rural areas of developing countries. This framework helps project designers to consider the different aspects of a project and how one intervention may support others.

6.1 Social and Technical Factors that Influence the assimilation of mHealth tools in Developing Countries

This thesis identified a number of social and technical factors that influence the assimilation of mHealth tools in developing countries (Figure 6-2). Each of the four segments in Figure 6-2 illustrates the factors that were uncovered

by the four studies undertaken i.e. Review-Focused, Past-Focused, Future-Focused and Policy focused studies.

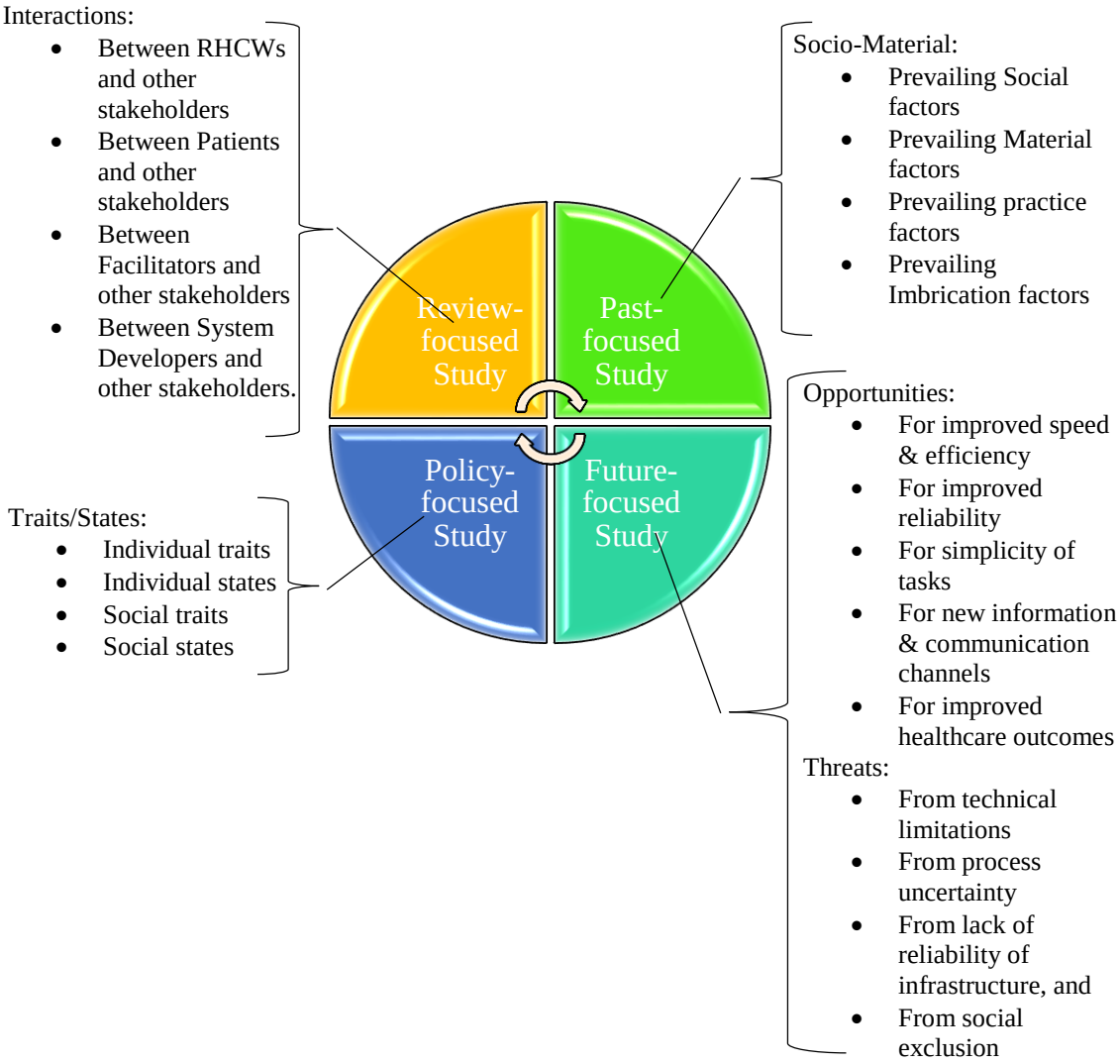

Figure 6-2 - Social and Technical Factors that Influence Assimilation

In the review-focused study (Figure 6-2 - interactions), it was found that the social factors that influence the assimilation of mHealth tools in developing countries include the understanding of how the different stakeholders (i.e., Patients, RHCWs, Facilitators, and System Developers) participate and interact in mHealth delivery process. First, the existing literature overlooks the development and analysis of systems relevant to Patient-to-Patient

interactions. Information around peer-based knowledge plays an important role when assimilating new technology since patients are the primary beneficiaries of mHealth tools interventions. Their opinions or input should contribute to what and how mHealth tools are designed and developed in the future. It has been revealed that observations and discussions around patients bring support to others through peer-based exchange of information and counselling (Chang et al., 2011) during the assimilation of mHealth tools. Second, findings also show that there exists a profound under representation of System Developers interactions with potential end-users, which is an important interface to elicit tool design requirements. During design and development, the existence of interactions between System Developers and end-users of technological tools (e.g., mHealth tools) would help spot issues early and allow innovative solutions to problems that might jeopardise assimilation (Brown, 2008; Brown and Wyatt, 2010).

In the past-focused study (Figure 6-2 – social-material), the prevailing cultural differences, cultural and social practices and imbrications were shown to affect the manner in which mHealth tools could be assimilated. It is posited that integrating new technologies (e.g., mHealth tools) as cultural artefacts initiates deep cultural interactions which affect assimilation or accommodation of that particular technology (Zhang, 2007; Straub et al., 2001). That is, during the technology assimilation process there are strategies adopted by stakeholders that are specifically influenced by specific cultural tendencies in rural areas of developing countries.

In the future-focused study (Figure 6-2 – opportunities & threats), it was shown that, first, the resultant healthcare outcome is a significant indicator

that influences the assimilation of mHealth tools in the rural areas of developing countries. For example, Thakur et al. (2012) suggest that good innovations, i.e., those that bring beneficial outcomes are assimilated while others that do not are rejected. Second, government supports which include the provision of funds for sustainability of mHealth tools helps facilitate the assimilation process. For example, lack of government support in strategic areas, such as high level strategic planning and financial support have been shown to inhibit implementation of mHealth in developing countries (Mechael, 2009; Leon et al., 2012). Third, a number of technical factors were seen to influence the assimilation of mHealth tools in the rural areas of developing countries. These technical factors arose out of the use of mHealth tools, which include opportunities for, i) improved reliability of healthcare services; ii) improved speed and efficiency of services; iii) improved simplicity of tasks, and the opportunity for new information and communication channels through the use of mHealth tools. These perceived opportunities are evidenced in literature, for example, "opportunity to make decisions, realisation of the usefulness of cell phones" (Chib et al., 2015b: 19). Fourth, it was shown that there were threats emanating from: i) technical limitations, process uncertainty, and the lack of reliable infrastructure in rural, which influence the assimilation of mHealth tools in developing countries. These perceived threats echo the end-users' high anticipation of what mHealth tools could do, for example, limited technical functionalities and capabilities are known to have influenced users' assimilation of mHealth tools in a negative way (Chang et al., 2013).

In conducting the policy-focused study (Figure 6-2 – traits/states), it was important to close the loop on holistic thinking by developing a framework for the planning and positioning of mHealth interventions in developing countries. In designing and fine-tuning the portfolio of mHealth interventions in developing countries, the simple 2*2 matrix created from the policy-focused study provides the necessary clarity when evaluating such interventions as project-level priorities can be used to separate must-have outcomes from other nice-to-have benefits. For example, targeting individual/social traits and states was shown to help in fine-tuning the portfolio of mHealth tools interventions in rural areas. Thus implying that the portfolio of interventions should be based on a deep understanding of the target population, i.e., targeting the Traits or States of the individuals or social groups.

The social and technical factors identified in this thesis are by no means an exhaustive list of the factors that could influence the successful assimilation of mHealth tools in developing countries. However, these are the social and technical factors that governments, funding bodies and non-governmental organisations should consider before embarking on the introduction of an mHealth tool for assimilation into the health systems in rural communities of developing countries.

6.2 Studies' Level Major Contributions

Overall, this thesis encompasses four studies that are deeply connected to one another and in the story they captured as a whole. These studies make four major contributions to IS research.

First, the lens developed in the review study provides a useful (and reusable) means of sense making for the diverse body of research in mHealth related studies. This lens therefore helps to assess the current state of research on the application of mHealth tools in developing countries. It aids in determining what is already known about this innovative approach to healthcare delivery. Most importantly, in conducting this study, it helps to place each reviewed study in the context of its contribution in achieving the thesis objective. In knowing what is currently happening in an area of study (i.e., mHealth care delivery processes), it assists in developing a firm foundation for a further progression of knowledge and enable theory creation in that area (Webster and Watson, 2002; Bandara et al., 2015). Evaluating current studies in a specific area helps to reveal 'gaps' in the studies and point the way to fulfil the need for further research in that direction (Webster and Watson, 2002).

Second, a contribution is made in developing a high-level practice view of IT involvement in health in developing countries in the *past-focused* study (see Figure 6-3). This helps to identify the specific challenges that are preventing rapid change in developing countries. Many of these challenges are already documented, e.g. challenges relating to the lack of supporting technologies (e.g., internet availability and power supply), lack of trained healthcare professionals (e.g., doctors), lack of stocks (e.g., medicine), and the impact of culture or norms (e.g. entrenched practices) (e.g., Andersson, 2012; Varshney, 2014a). This practice view allows researchers to bring these challenges together as they appear in context.

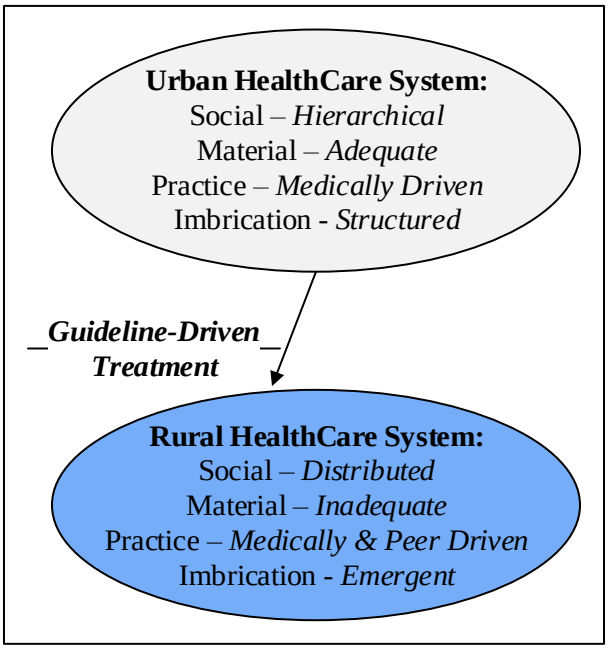

Figure 6-3 - High level practice view of IT involvement in health in developing countries

Furthermore, in conducting this *past-focused* study, it helps us to understand how prevailing social structures, material features, and health-related practices influence the assimilation of mHealth technologies in rural areas of developing countries. In other words, in identifying what decisions worked in a particular situation in the past and what did not might give us insights on how to approach issues for the future.

Third, the modelling of the factors that influence primary appraisal in IS research in the *future-focused* study presents a contribution. Prior to the work done in this thesis, to the author's knowledge, there had been little or no work done in modelling primary appraisal of mHealth artefacts. Indeed, the construct of primary appraisal has received limited attention in IS research. More broadly, the base-models that were considered during this study, for example, the CMUA by Beaudry and Pinsonneault (2005) did not clearly

model appraisal of an IT only adaptation (Fadel and Brown, 2010; 2012; Connolly and Bhattacherjee, 2011). Of particular interest to the larger IS community may be the sensitising model represented in Figure 6-4.

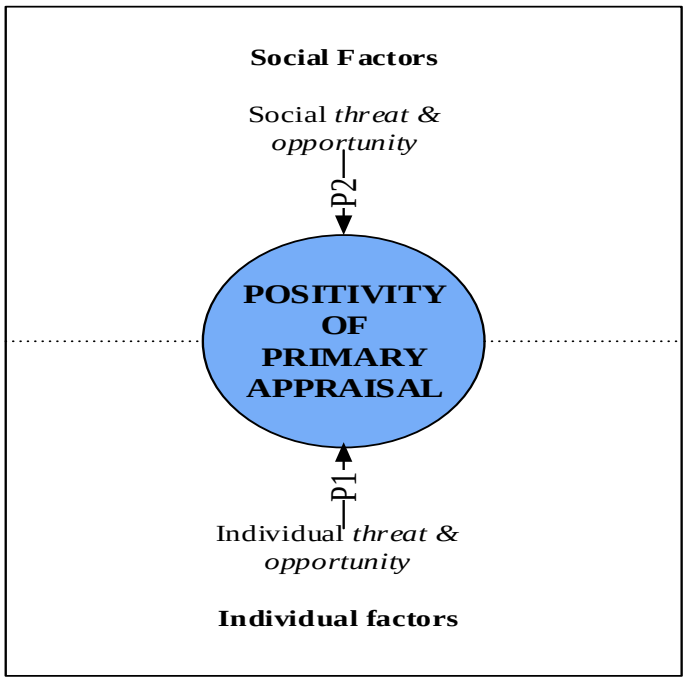

Figure 6-4 - Sensitising Research Model

Fourth, this thesis made another contribution in developing a framework for the planning and positioning of mHealth interventions in developing countries. In designing and fine-tuning the portfolio of mHealth interventions in developing countries, the simple 2*2 matrix created in the *policy-focused* study provides the necessary clarity for such projects. The framework differentiates between two levels of interventions. First, the level that seeks to improve an individual's abilities, job knowledge, and skills as they relate to an mHealth tool. Second, the level that is situation specific, which seeks to improve situations that would otherwise cause social systems to break-down around an mHealth tool. These are a set of mutually reinforcing interventions

portfolio that could be strategically put together for the purpose of achieving a community's healthcare goals by using an mHealth tool. There are also several higher-level cross-study themes that emerged in relation to the thesis objective. These are discussed separately in subsequent sections.

6.3 Undertaking immersive research in developing countries

In the course of conducting this thesis, there were challenges that are worth sharing to help prepare researchers who may be interested in mHealth in developing countries. Interviewing is a socially engineered activity and requires both the researchers and the interviewee to play active role during the process (Qu and Dumay, 2011; Roulston, 2011). This study identified three important considerations for an interviewing process.

First, getting the best out of such an encounter requires more than just being competent in the interview methods or the type of research instruments deployed. Specifically, in qualitative research such as this thesis, the biases/dispositions of the research participants influence both data gathering and the process of interpreting meaning into what they have to say (Shah, 2004). This challenge is felt even more when the research being conducted cuts across different organisational and regional cultures as in this thesis. It is posited that "not all cultures are equally talkative and expressive. Some are much more so …, while others are taciturn and may even use silence as an integral part of their language, especially in formal meetings" (Qu and Dumay, 2011: 251). It is critical that the researcher/interviewer recognises when to ask follow-up questions and also to be able to read meanings into hidden messages.

Second, it was discovered that often times, stakeholders in positions of authority would want research to be conducted in their own chosen location/s without due consideration to the research objective. That is, research activities can get side-tracked and entangled with other agendas. This may not permit the possibility of the maximum degree of immersion that is required of a researcher in a case study. This immersion enables the researcher to elicit the required information during data collection and interpretation in a particular area. In an IS project (e.g., IT in healthcare), powerful stakeholders may exert influence which could affect a project negatively if not managed appropriately (WHO, 2005). It was observed in this study that this could be managed through continuous diligence and explicit reference to academic standards to get the support needed to complete the research.

Third, it was observed that translating research instruments prepared in English into a local language presented significant challenges. For example, explaining participant consent forms required translating the crucial contents into the local language for some of the participants/interviewees to understand. Sometimes the use of local language may not convey the exact meaning as intended in a foreign language. This difficulty was noted by Amerson and Strang (2015: 588) when they stated that "all words are not completely translatable into another language".

In conclusion, to be able to conduct a study of this nature, it requires that:

- The researcher must be conscious of the influential impact of culture at two important stages of research activities (i.e., the data gathering and the analysis. This finding reinforces earlier findings by Shah (2004).

- The researcher must familiarise oneself with the environment, understand the people and be accepted. Achieving these goals requires patience and resources.
- The researcher must be able to understand the hidden meanings or body language during the interview process. The ability to communicate (including hidden messages due to body cues) is a powerful tool to generate value from qualitative data gathering. It is the lubricant, facilitating the building of trust and rapport. Being able to communicate with participants in their local language is beneficial in research of this nature.

6.4 Aligning past-focusing and future-focusing theoretical perspectives

Aligning the past-focused and future-focused perspectives allow us to understand what happened in the past and ensure we do not repeat the same mistakes again. It helps us to leverage the positives, and derive inspirations from certain activities or events to stay motivated for the future. Past experiences, activities or issues hold much information that may impact the introduction of any IT into any environment (e.g., De Guinea and Markus, 2009; Moore and Benbasat, 1991).

This thesis further demonstrates the dependence of past experiences and expectations for the future. The reasons for this interdependence includes the accumulated socio-material features of rural healthcare systems that may impact the introduction of new technologies and practices. This thesis identified existing historic cultural practices that go against contemporary health treatment methods being used in rural communities. For example, the

application of African traditional methods to illness treatment in rural communities. This understanding would help us to devise ways to avoid or minimise these practices from inhibiting the future introduction of an mHealth tool in rural health centres.

This interdependence between past and future is because the extent and the manner to which social actions enact material technologies is moderated by coping processes (Leonardi, 2007; Leonardi et al., 2012). The introduction of a new artefact into a health system in a new context requires the end-users not only to adapt with the artefact's material features but to also to learn to cope with the ways through which that artefact manages processes or procedures. A similar conclusion was arrived at by Pickering (2010) when he alluded to the human coping strategies during stormy weather in the book titled 'The Mangled Practice'. He posits "Much of everyday life, I would say, has this character of coping with material agency, agency that comes at us from outside the human realm and that cannot be reduced to anything within that realm" (Pickering, 2010: 6). In health systems contexts, the *material* includes the existing technical infrastructures and the mHealth application (smartphone-enabled), which in this study is designed to assist the assessment and classification of illnesses (e.g. Malaria, Diarrhoea, and Pneumonia of children between the age of 2 months and 5 years in a developing world context). The *social* includes the healthcare workers (HCWs), patients, developers, government agencies, norms, standards, shared intentions and expectations, and the other non-material components of this system. Socio-material enactment of IT requires social actions that develop practices, yet not all technologies are embraced equally (Beaudry and Pinsonneault, 2005).

The introduction of an mHealth tool to a new context introduces new *materiality* that prompts a change in the socio-material *practices* binding the system. During this process of change, the simple building blocks of the mHealth tool are *imbricated* to fit with the goals, needs, and expectations of *social* actors. Yet the extent of this *imbrication* depends on the extent to which these *social* actors actually adopt the system, i.e. "ultimately, people decide how they will respond to a technology" (Leonardi, 2011: 151). Thus, the *imbrication* of new *practices* ultimately reflects the coping process of the *social* actors involved, which include different *primary appraisals* and *adaptation strategies*.

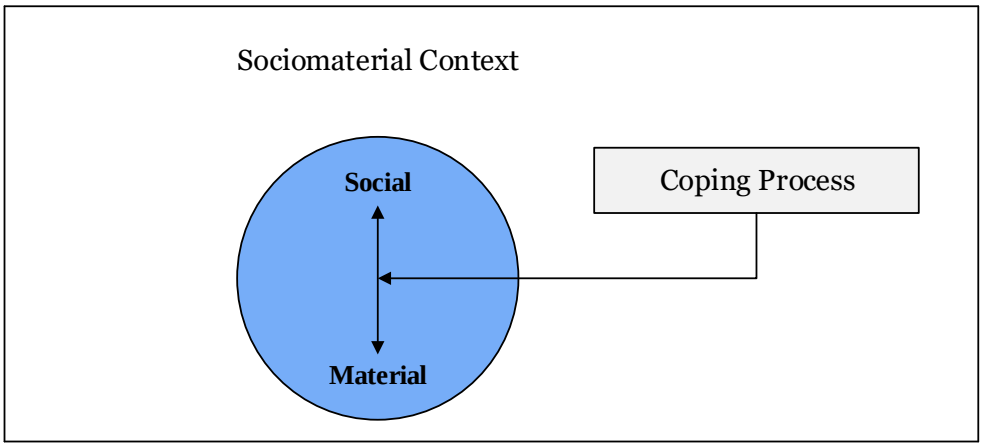

Figure 6-5 - A combined view of socio-materiality and coping

Individuals' or social groups' coping strategies are engrained in the socio-material systems in which they work or live (Bandura, 1998; Panaccio and Vandenberghe, 2012) (Figure 6-5). These coping strategies are emotionally constructed (Jokinen, 2015; Steinhardt and Dolbier, 2008). The emotional concepts *Traits* and *States* are believed to underlie the user's emotional response to IT use (De Guinea and Markus, 2009; Jokinen, 2015). Targeting individual or social groups' *traits* or *states* through events (e.g. workshops,

training sessions, awareness campaigns) during the introduction of an mHealth tool could influence their emotional response towards positive appraisal.

6.5 Aligning policy-level and practice-level theoretical perspectives

There is a perceived disconnect between the governments, policy makers, programme planners and the healthcare workers/people in the rural areas of developing countries (WHO, 2018a; Gupta, 2016). Often times, what is being actualised on the ground in rural areas by the administrators is not what the policies envisioned (Gupta, 2016; NRHA, 2013). Also, historically, what policy makers say about healthcare being a priority is not always reflected in their budget allocations in support of healthcare delivery services (Panagariya, 2014). One example identified in this thesis was the lack of drug stocks in health centres in rural areas. It has been shown that the scope of mHealth for treatment compliance could be limited in areas where access to healthcare services and drug stocks are inadequate or non-existent (Mechael et al., 2010). This implies that treatment compliance is often sub-optimal in developing countries (Osamor and Owumi, 2011). Therefore, the strengthening of the healthcare system is significant as a whole for the success of mHealth technologies for treatment compliance (Mechael et al., 2010; Kahn et al., 2010). The successful scale-up and sustainability of mHealth applications in healthcare systems in developing countries is deeply tied to enabling policies on the ground to support their growth and maturity (e.g., Mechael et al., 2010; e.g., Kahn et al., 2010; Segato and Masella, 2017).

More broadly, specific practices and treatments are only effective if they can be linked to overarching policies (e.g., Mechael et al., 2010; Kahn et al.,

2010). Typical challenges from the lack of overarching policy include the liability and accuracy of health information and security issues (e.g., Mechael et al., 2010; Kahn et al., 2010). This is significant, because as mHealth deployment becomes a more formalised feature in developing countries, policies and legislation are needed to define liability when delivering health information via text, voice, video etc. For example, the absence of these types of policies on the ground was experienced in Thailand, where the lack of telemedicine policies deterred the scale-up of mHealth applications relating to emergency cases in that country (Mechael et al., 2010). These policies or legislation should be designed to govern its use and how to curb malpractices. These policies are crucial for the scalability and sustainability of such services (Mechael et al., 2010; Donner and Mechael, 2012).

Research by Hyder et al. (2010) examined the perspectives and attitudes of policy-makers in regards to the utilisation and impact of research findings in healthcare in developing countries. Their findings cited some key barriers to evidence-based policy-making, which include:

i. Poor communication and dissemination of research and policy-makers, lack of technical capacity in policy processes, as well as the influence in political context.
ii. Policy-makers had a variable understanding of economic analysis, notion of equity and burden of disease measures, and were vague in terms of their use in national decisions.
iii. Policy-makers' recommendations regarding strategies for facilitating the uptake of research into policy included improving the technical capacity of policy-makers, better packaging of research results, use

of social networks and institutionalization of an evidence clearinghouse function in ministries of health.

There are two important messages drawn from these, first, there is a need for evidence based research to reflect what the current practice is on the ground in regards to healthcare delivery services in rural areas to inform policy. It is suggested that the connection between the policy makers and the realities on the ground in rural areas could be strengthened by a continuous collaboration with lawmakers or the inclusion of stakeholders through the formation of an interdisciplinary regulatory body (Panagariya, 2014). This type of body could help policy makers to be aware of policy-oriented research findings that could be leveraged in policy decision making and ensure that policies envisioned are implemented. Second, researchers would want their research findings to be reflected as soon as possible in new policy formulation by policy makers but experience has shown that this is not always the case. It is posited that research evidence is only one of the factors that influence or originate policy, the other factors may include the governments' vision, political challenges, and resource constraints to mention but a few (Al-Riyami, 2010).

6.6 Implications for practice

The findings of this thesis have significant implications for mHealth design and its introduction in developing countries. First, practitioners should focus on the interaction between community members (e.g., Patients) in relation to how mHealth technologies could be assimilated being are the ultimate beneficiaries of this type of initiative. This is because the peer-based information (gathered from community members) around mHealth tools

could play an important role on or when introducing new technologies (e.g., Lou et al., 2005).

Second, practitioners should also focus on developing interactions between System Developers and other stakeholders, particularly with Patients and Healthcare Workers. The absence of these relationships may be limiting the effectiveness of mHealth initiatives (e.g., Brown, 2008; Brown and Wyatt, 2010). For example, enhanced relationships between Systems Developers, Patients and Healthcare workers could provide developers to increased empathic towards the direct and indirect users of their systems. This could result in improvements in the design, development and potential success of mHealth tools. Furthermore, fostering new partnerships amongSystem Developers would help to foster a more collaborative development approach which has the potential to result in the development of new innovative open source platforms for use in low-income settings (e.g., Istepanian and Woodward, 2016).

Third, practitioners should allow significant time to immerse the development team in the surroundings prior to implementation. This could help implementers or programme planners understand and manage the deep rooted practices or cultural beliefs that could undermine the application of mHealth technologies in healthcare delivery. In a study by Busse et al. (2014) in Ethiopia, relationship building was alluded to as one of the important outcomes of allowing teams time to understand and appreciate different cultures during programme initiatives. One of their findings showed that the teams learnt a lot about Ethiopian cultural practices in health delivery (Busse et al., 2014).

Fourth, the introduction of mHealth tools into healthcare delivery systems is still relatively young, therefore to articulate its impact we need more research to understand their effectiveness. Practitioners may need to concentrate more at this stage on the causal relationship between the introduction of mHealth technologies and health impact indicators, instead of just the process or procedural improvements (e.g., Chib, 2013).

Fifth, practitioners should focus on the modelled factors of primary appraisals, specifically what experiences produce various appraisal results. In other words, by understanding the process of primary appraisal, that is, either as an opportunity or a threat, practitioners or organisations will enable those factors that influence and inspire positive appraisal while minimising the occurrence of negative ones when introducing mHealth tools.

Sixth, this thesis developed a framework that could offer support to government, decision makers and developers on the planning and positioning of mHealth interventions. That is, a framework that could help practitioners in the designing and packaging of mHealth interventions to best achieve the desired impacts. For example, the framework could help practitioners, governments or policy makers to enact the desired policies that are needed for sustained implementation programmes. Additionally, the framework could provide support for the analysis of the 'as is' of current practice in some target system. Furthermore, and most importantly, the framework provides practitioners with a way of relating different assessments, both to each other and to project-level goals. That is, a framework for reflection on the impacts made in engaging any mHealth intervention process.

6.7 Implications for research and theory

This thesis presents a number of challenges. First, how can we design mHealth solutions that complement the existing materiality of rural areas? Furthermore, how do we minimise, for example, the desire to travel to urban areas in search of better care? This could help protect the very poor who may not be able afford the resources to travel to the urban areas in search of healthcare. Second, how can we design mHealth solutions that reinforce the connection to urban centres while still allowing rural healthcare workers the autonomy to offer immediate solutions? This challenge emanated from the perceived problems attributed to the existing diagnosis and treatment guidelines by the rural healthcare workers. Third, how can we change those practices with cultural origins that go against contemporary health treatment methods? This is particularly significant since it was shown in the findings that the by-passing of rural healthcare centres to engage in self-diagnosis and treatments by community members could be damaging.

Fourth, this thesis' findings show that an mHealth tool could help extend the reach of healthcare services into hard-to-reach areas. However, the fear of the destructive impact of an unregulated web is real. So, how can we avoid the interference or destructive competition from unregulated information or health-related applications available on the web when using an mHealth tool? This is important because the sourcing of information from this space may hamper structured healthcare delivery processes in rural areas (e.g., Murray et al., 2003; Moreland et al., 2016).

Fifth, the problem is, how can we design mHealth tools that could mitigate the cultural and infrastructural challenges in rural areas of developing

countries. For example, this thesis identified the irregular power supply as one of the infrastructural requirements that is holding back improvements in Nigeria. There is a documented infrastructural deficit in many developing countries which is hindering growth prospects (e.g., Pushak and Briceño-Garmendia, 2011; Khavul and Bruton, 2013).

6.8 Limitations and future research

The findings from this thesis have several limitations. These may have emanated from the limitations of empirical observations which might include, first, only studies written in English language were included in the review study. This may have inadvertently excluded inputs from some literature written in local languages.

Further, this thesis makes no claims of statistical generalisability (Yin, 2013) following the exploratory single-case design and qualitative method used. This is because, in case study research, the researcher has no control over independent variables or events which may limit the validity of any conclusion (Cavaye, 1996; Gable, 1994). Moreover, even though case study research may establish relationships between variables, it may not always indicate the causation direction (Cavaye, 1996). For example, Enugu State might differ from other regions because it does not have iCCM integrated in the health system. This implies that the sociocultural environment may be significantly different from other regions currently running iCCM. Thus, there might be a need for a transitional period where various tensions may emerge.

Second, this thesis focused on a region in which technology-enabled guideline-driven treatment remains the priority mHealth concern. This is because of the following important reasons:

(i) the people who live in remote and hard-to-reach areas are known to engage in informal amateur-diagnoses and amateur-treatment practices (e.g., Bennadi, 2013; Parulekar et al., 2016);

(ii) the direct use of drug-stores and traditional methods when ill present a danger when treatments are not measured, side effects are not known, and other treatments may be neglected (e.g., Abdullahi, 2011; Oyebode et al., 2016).

(iii) the use of drug stores without doctors' prescriptions are rampant (e.g., Lawan et al., 2013; Chipwaza et al., 2014).

Meanwhile, the other forms of mHealth initiatives include, e.g. those directed mainly towards healthcare data gathering efforts (e.g., Chang et al., 2011; Medhanyie et al., 2015) or those designed for remote diagnosis and treatment (e.g., Hufnagel, 2012; Knoble and Bhusal, 2015). Research is needed to further investigate these other forms of healthcare delivery services.

Finally, a longitudinal study is recommended as a further study design. This particular design could reveal other contributing factors that may arise due to re-appraisal processes, as users re-evaluate and adjust their prior primary and/or secondary appraisals (Beaudry and Pinsonneault, 2005; Bhattacherjee et al., 2017). To fully understand and leverage the opportunities offered through computerised information decision support system on handheld devices, it is important that we comprehend how the user and the handheld technology become entangled (Andersson, 2012). For example, perceptions

regarding the impact of network coverage which may hinder mHealth introduction in Nsukka might change positively with time and so, may not be an important factor in the future.

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Appendices

A. How can mHealth Applications that are developed in one area of the developing world be adapted for use in others?

A1 Abstract

The quality of healthcare in developing countries remains a critical issue, due in part to the limited infrastructure and resources available. The development of mHealth systems has been proposed as a possible solution. These systems extend the reach of medical care into rural areas by integrating smartphones and other mobile devices. Yet it is not clear how mHealth solutions designed and tested for use in one developing region can be adapted for use in others. This research-in-progress study frames this problem using a sociomaterial/coping perspective. A case study is proposed to extend and refine this model.

A2 Introduction

'Health' is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1948). The World Health Organisation (WHO) highlights through this definition that 'health' is capital for everyday living, and includes physical abilities, social resources and accompanying social skills (WHO, 2017). In the Universal Declaration of Human Rights (1948), health is considered a fundamental human right and as such, an essential component of human development which is necessary for both personal and national economic growth. However, in resource-poor countries many people still do not have access to the basic health services

several decades after the declaration (TO, 2003). This development has led to high prevalence of diseases and morbidity in many developing countries.

Several factors inhibit the performance of health care in developing countries. Limited infrastructures and shortage of health workers, estimated at approximately 800,000 for the African continent (Scheffler et al., 2009), are just two of the many barriers to health care. The burden of disease and its impact on livelihood and economic productivity are significant for developing countries (Kahn et al., 2010). However, the transformative role of mobile devices can enable health care delivery and assist clinical decision-making to where it is most needed (Robertson et al., 2009b). These mobile devices have the potential to lower the physical barriers to care and service delivery, fortify the weak system management and defective supply systems, and improve unreliable communication (Kahn et al., 2010). Yet, existing research demonstrates that adapting a decision support tool (*in this case, a mobile health solution*) for use in a new context is a complex and challenging task, due to the financial implications, management interests, users acceptability, and fit for purpose (Afarikumah, 2014; McCosh, 2001). Developing countries present different contexts in terms of cultural (Avgerou, 2008; Varshney, 2014a), behavioural (Avgerou, 2008; Varshney, 2014a), regulatory (Varshney, 2014a; Afarikumah, 2014), and technological contexts (Avgerou and Walsham, 2001; Varshney, 2014a). As a result, the process of implementing an mHealth system must be closely linked to the social processes of the area involved (Avgerou and Walsham, 2001; McCosh, 2001). Therefore, system developers must take these details into consideration in a given context (Varshney, 2014a; McCosh, 2001). Thus, the

objective of this research is *to understand the social processes involved and the factors that influence the adaptation of an mHealth decision support tool in a new context*.

A3 Sociomateriality/Coping Perspectives

A substantial body of research has been conducted on the adaptation of IT for different contexts through the lens of sociomateriality (Cecez-Kecmanovic et al., 2014). Seminal studies describe: the interweaving of human and material agencies (Leonardi, 2011), the constitutive entanglement of social, cultural and material environments (Orlikowski, 2007), and the duality of human versus technological agency (Barad, 2003). Therefore, sociomateriality (Figure A1) is significant in that it points out the social and the technical interdependency of users and tools in an ecosystem (Cecez-Kecmanovic et al., 2014).

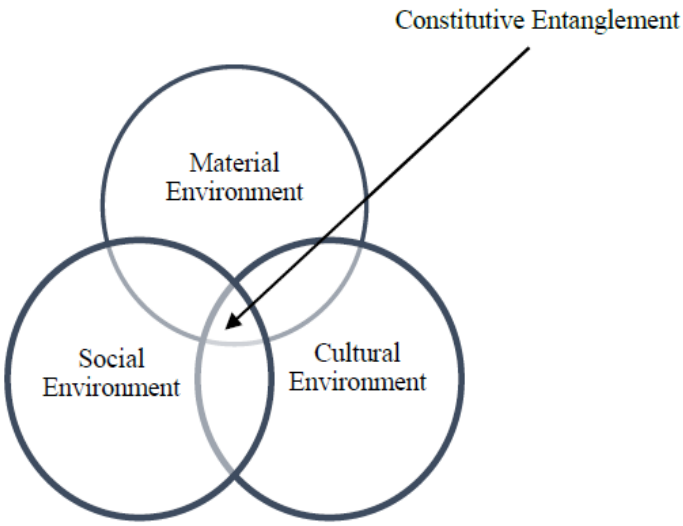

Figure A1- Constitutive Entanglement and Sociomateriality (adapted from Orlkowski, 2007)

The socialmaterial enactment of IT requires social actions that develop practices (Cecez-Kecmanovic et al., 2014), yet not all technology are

embraced equally (Beaudry and Pinsonneault, 2005). Therefore, to investigate these actions, coping theory will be used in this study to understand how individuals cope with an existing mHealth decision making tool being adapted for use in their context. The coping perspective (Figure A2) deals with the particular coping strategy employed by the user in the adoption process (Beaudry and Pinsonneault, 2005). Coping theory describes how people's adaptation behaviours emerge from a series of appraisal processes (Claggett, 2010). As a result, the introduction of a new information technology comes with adjustment, for example, how the new artefact will fit into the existing process and what resources will be involved, in addition to which people will be performing what roles (Claggett, 2010).

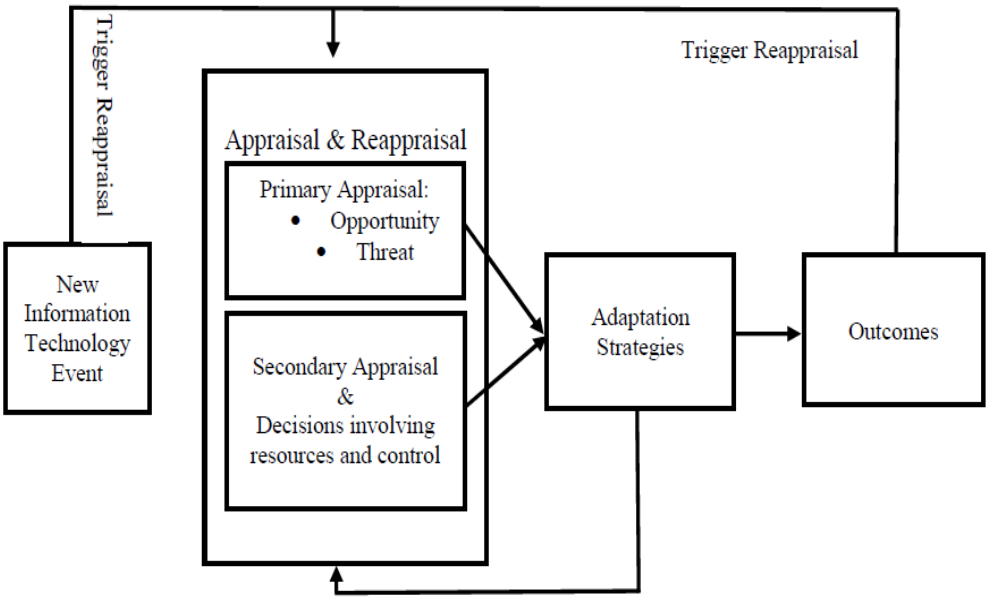

Figure A2 - Coping Adaptation Model (Claggett, 2010)

The embedding of a coping perspective in a sociomaterial lens is represented in Figure A3. The extent and manner to which social actions enact material technologies is moderated by coping processes. In mHealth contexts, the material represents the mHealth application (smartphone-enabled), which is

typically designed to assist the assessment and classification of illnesses (e.g. Malaria, Diarrhoea, Pneumonia, and/or neonatal infections of children under the age of five in a developing world context). The social is a combination of health care workers, patients, developers, government agencies, norms, standards, shared intentions and expectations, and any other non-material components of this system.

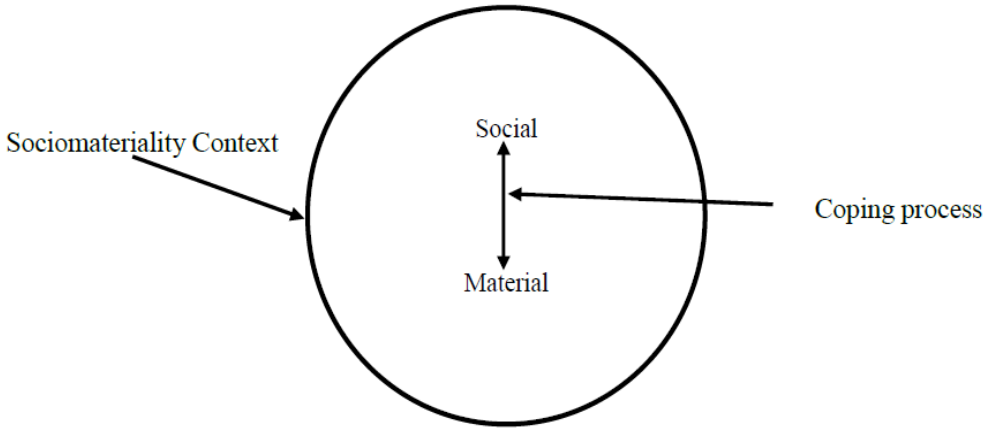

Figure A3 – A combined view of sociomateriality and coping

A4 Proposed Method

This study will adopt an explanatory case-study approach (Yin, 2013) aimed to help understand the social processes involved and the factors that influence the adaptation of an mHealth decision support technology for use in new areas of developing countries. The investigation will explore the entanglement of an existing mHealth decision support tool (material) for use in a new 'social' context, which includes community health care workers, patients, developers, government agencies, and environmental inputs such as cultural and regulatory policies.

The study will be conducted in Enugu State, in the South Eastern Region of Nigeria. The health system in Nigeria is decentralised into a three-tier

structure: the federal; the state, and the local government-level. Currently, all three levels are involved in the major health functions: - including service provision and financing. The federal-level is specifically responsible for policy and technical support to the overall health systems, inter-national relations on health matters, and the provision of health services through the tertiary and teaching hospitals and national laboratories. At the state-level, ministries of health are responsible for the regulation and technical support provided to primary health care services. The local government-level is responsible for the primary health care, which is organised through the ward. Health care provision in Enugu State is dispensed through seven health districts. Each of the health districts serves up to a maximum of three of the seventeen local government areas within the state. There are six district hospitals, thirty-six cottage hospitals and three hundred and sixty-six primary health care centres and other health facilities that include private health clinics, faith-based facilities and non-profit establishments.

A total of fifteen health care workers will be recruited from five health care centres/facilities in the local communities to use smartphones-enabled with the decision support guidelines for accessing, classifying and eliciting treatment recommendation for sick children under the age of five. Following Patton (1990), a purposeful sampling approach will be used to promote the selection of 'information rich' cases for this study. A qualitative approach will be used for data gathering, namely: in-depth interviews, participant observation, and document/record analysis. Data analysis will focus on exploring the types of adaptation strategies and sociomaterial practices

manifested in the context, as well as the relationships between those strategies and practices.

A5 Expected Contributions

The study is expected to develop a novel model that will describe the process by which coping strategies influence the sociomaterial enactment of an existing, yet adapted mHealth decision support artefact in a new context. This model will offer a new perspective for researchers into the processes and the dynamics involved in the adaptation of mHealth decision support artefacts for new areas of developing countries. Thus, providing researchers with the means to seek out ways through which human activities and IT capabilities work together in a new context.

Further, this study will identify the types of sociomaterial practices involved when existing mHealth decision support artefacts are adapted for use in new areas in developing countries. This makes an important contribution to research because it will help in the identification and articulation of scalable or generalizable patterns of sociomaterial enactment in mHealth scenarios.

Finally, this study will articulate the role of coping appraisal in the implementation of mHealth decision support artefacts. This contribution will offer a new way in understanding how mHealth users adapt their behaviours, thus providing a new perspective for integrating adoption and resistance studies for researchers. Additionally, it is envisaged that by understanding the process of primary appraisal, that is, either as an opportunity or a threat, organisations will support positive appraisal and minimise the occurrence of negative ones when introducing mHealth decision support artefacts.

Furthermore, by understanding secondary appraisals, i.e., in high or low control situations, organisations will motivate workers to seek the low control approach that accommodates the short-comings discerned in mHealth decision support artefacts.

A6 Acknowledgement

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B. Adapting an mHealth Tool for use in a Different Developing Country: A Sociomateriality/Coping Perspective

B1 Abstract

The performance of health care systems in developing countries has been limited by shortages of infrastructure and health care workers. The integration of smartphones and mobile devices into healthcare systems has been proposed to address these physical barriers to care and service delivery. These mHealth solutions extend the reach of medical care into the rural areas of the developing countries. However, it is not clear how mHealth solutions designed and tested in one developing region can be adapted for use in others. This research-in-progress study frames this problem using a sociomaterial/coping approach based on an explorotory case-study. Preliminary findings identify a range of social actors and technologies influencing adaptation, as well as negative primary appraisals in terms of both knowledge and effort. These findings has implications for theories, practice, and future research as explained in the concluding section of this paper.

Keyword:- Health Care; Developing Countries; Mobile Technology; Sociomateriality; Coping Theory; mHealth.

B2 Inroduction

Aaa Health is a fundamental human right and as such, an essential component of human development which is necessary for both personal and national economic growth (WHO, 2017). However, in resource-poor developing countries many people still do not have access to the basic health services several decades after the declaration made by the World Health Organisation

(TO, 2003). This has led to high prevalence of disease and morbidity in many developing countries (Anyangwe and Mtonga, 2007; Kahn et al., 2010), resulting in a vicious cycle of poverty as preventable or treatable conditions undermine many people's livelihoods (Kahn et al., 2010).

Several factors inhibit the performance of health care systems in developing countries. Limited infrastructures and shortage of health workers, estimated at approximately 800,000 for the African continent (Scheffler et al., 2009), are just two of the many barriers. However, it is argued that the transformative role of mobile devices can enable health care delivery to where it is most needed (Robertson et al., 2009a). These mobile devices have the potential to lower the physical barriers to care and service delivery, fortify the weak system management and defective supply systems, and improve unreliable communication (Kahn et al., 2010). This has prompted a number of initiatives to develop novel mHealth tools (mobile health solutions) for specific regions (e.g. Sene PDA in Ghana (West Africa), Afarikumah 2014). Yet the practicalities of these tools being used across contexts remains unclear, as research indicates that mHealth tools that are designed in one context may not be fit for purpose in another (Varshney, 2014a; Afarikumah, 2014). Developing countries present different cultural, behavioural, regulatory, and technological contexts, meaning, the process of implementing an mHealth system must be closely linked to the social processes of the area involved (Avgerou and Walsham, 2001; Varshney, 2014a). Thus, the objective of this research is *to understand the social and technical factors that influence the adaptation of an mHealth tool for a new context*.

The rest of the paper is organised as follows. The next section introduces sociomateriality and coping concepts, followed by a description of how coping impacts on the enactment of sociomaterial practices. Following this, the research approach is outlined. Preliminary findings from the first set of interviews are then presented, which identify a range of social actors and technologies influencing adaptation, as well as negative primary appraisals based on the additional knowledge and effort required. The paper concludes by considering the future directions for study and anticipated contributions.

B3 Theoretical Background

B3.1 Sociomateriality

The academic discipline of Information Systems (IS) is concerned with the study of people, process, and technology (Orlikowski and Iacono, 2001; Alter, 2003). Sociomateriality is a meta-theory that conceptualizes each of these as inseparable and deeply related (Orlikowski and Scott, 2008; Orlikowski, 2007).

The concept of *materiality* is preferred to 'technology', as the latter creates the impression there are some objects, artefacts or devices out there that do things, and therefore ignore these objects, artefacts or devices only come to reality when manifested in practice (Suchman, 2007; Leonardi et al., 2012). *Materiality* is understood to be "the arrangement of an artefact's physical and/or digital materials into forms that endure across differences in place and time and are important to users" (Leonardi et al., 2012: 31, p. 31). That is, the combination of material and form, and not solely the material out of which a technology is formulated (Leonardi et al., 2012). It is posited that using the

word technology alone in practice gives the impression of a specific type of hardware or software that can be used to augment work process, and this leads to researchers remaining fixated on the adoption and diffusion periods without giving recognition to the fact that IT infuses all aspects of a projects' life (Linderoth and Pellegrino, 2005; Orlikowski and Iacono, 2001; Orlikowski, 2007). As a result, studies (Orlikowski, 2000; Volkoff et al., 2007; Leonardi, 2007) have used terms like 'material' properties in their description of technology in order to capture that aspect of technology that is inherently related to it and not just as part of the social context in which it is being used (Leonardi et al., 2012). It is being argued that technology exercises material agency when humans engaged with its materiality in pursuit of their goals (Leonardi et al., 2012). Therefore, material agency is defined "as the capacity for nonhuman entities to act on their own, apart from human intervention" (Leonardi, 2011: 148, p., 148). That is, "material agency is activated as humans approach technology with particular intentions and decides which elements of its materiality to use at a given time" (Leonardi et al., 2012: 42, p., 42).

The concept of *social* is preferred to 'people' to capture the variety of social actors involved in a system, including individuals, groups, institutions, norms, perceptions, etc. [12, 28]. Put differently, everything in a system that is not *material*. Different *social* actors interact differently with different *material* artefacts (Orlikowski, 2007; Gherardi, 2012), meaning they adapt these tools differently to suit their organizational structures and environmental properties (Ulmer and Pallud, 2014). As a result, technologies are understood only in relation to the meanings attributed to them and the

ways in which people interact with them. Thus, *sociomateriality*, the fusion of the two words (social and materiality) describes that materiality is shaped through social processes, understood and used within a social context, and social action is made possible as a consequence of materiality (Leonardi, 2013; Leonardi, 2012). Therefore, sociomateriality "represents that enactment of a particular set of activities that meld materiality with institutions, norms, discourses, and all other phenomena we typically define as "social" (Leonardi et al., 2012: 34). It describes what happens when humans (social) and things (material) interact in practice without ignoring the impact of either of them on one another (Leonardi, 2013; Leonardi et al., 2012; Orlikowski and Scott, 2008). Consequently, in adopting the term sociomateriality, it aims to overcome the shortcomings associated with treating the social at the expense of the material or vice versa (Orlikowski and Scott, 2008; Leonardi et al., 2012). Additionally, we gain significant insights in practice as "it shifts the unit of analysis from materials and forms to the development or use of materials and forms" (Leonardi et al., 2012: 34).

The concepts *practice* and *imbrication* are preferred to 'process' as these emphasize the dynamic and evolving state of a system. The word 'practice' is understood in sociomateriality context to mean the space in which the social and the material imbricate (Leonardi et al., 2012; Leonardi, 2011). That is where material and social agencies are activated in response to one another. That is, "it is not so much what materials … symbolise within social action that matters but their constitutive agentic effects within the entangled networks of sociality/materiality" (Pels et al., 2002: 2, p. 2). The metaphor of *imbrication* "enables IS scholars to conciliate the organisation and technology

mutually shaping nature: thus, the structure between individuals…, and technologies… evolve as a sociomaterial creation" (Ulmer and Pallud, 2014: 4, p. 4). This describes how the social and material mingle in flexible situations, i.e., how practices are created and maintained. Further, this *imbrication* is the result of *social* agency, which is "typically defined as the ability to form and realise one's goals" (Leonardi et al., 2012: , p. 35).

There are various positions on this duality (social and materiality) that allow for different theorising approach to the study of sociomateriality in IS. It is understood from the writings of Orlikowski (Orlikowski, 2007; Orlikowski, 2010; Feldman and Orlikowski, 2011), building on the works of Barad (Barad, 2003; Barad, 2007) and Latour (Latour, 1992; Latour, 2005), that social and material are inseparably related. Much of Orlikowski's argument are hinged on the *agential realism* developed by Barad. That is, "there is no social that is not also material, and that there is no material that is not also social" (Orlikowski, 2007: 1437, p., 1437). For example: Barad argues that "phenomena do not merely mark the epistemological inseparability of 'observer' and 'observed'; rather, phenomena are ontological inseparability of agentially intra-acting 'components" (Barad, 2003: 815). Latour's work on actor-network theory made a similar argument that there nothing inherently different between the material and the social. That was why he included nonhumans in an attempt to understand the social and in fact, he designated human and nonhumans as 'actants' in the lingo of Actor Network Theory (ANT) (Latour, 2005). These research streams' conceptualisation of sociomateriality "makes a distinctive move away from seeing actors and objects as primary self-contained entities that influence each other… either

through impacts… or interactions… away from discrete entities of people and technology… to composite and shifting assemblages" (Orlikowski and Scott, 2008: 455, p., 455). That is, humans or technology (entities) have no intrinsic properties, but obtain form, characteristics and abilities through constitutive entanglement (Orlikowski and Scott, 2008). In effect, entities, people and technology have no intrinsic boundaries but are relationally manifested in practice (Cecez-Kecmanovic et al., 2014).

This study adopts Leonardi's point of view, which is grounded on substantialist (non-relational) ontology or critical realism approach. The substantialist ontology "takes as its point of departure in the notion that it is *substances* of various kinds… that constitute the fundamental units…, self-subsistent entities, which come "preformed," and only then to consider the dynamic flows in which they subsequently involve themselves" (Emirbayer, 1997: 282-283, pp. 282 - 283). That is, entities, be it humans (social) or things (material) exists as separate and self-contained entities that interrelate and affect each other in practice (Cecez-Kecmanovic et al., 2014). Building on the works of Alistair Mutch (Mutch, 2002; Mutch, 2010; Mutch, 2013) and Faukner and Runde (Faulkner and Runde, 2012; Faulkner and Runde, 2013) it is difficult to operationalise the empirical constructs in agential approach due to the interlocking of the social and material (Leonardi, 2011; Leonardi, 2012). As a result, it is argued that critical realism offers a realistic foundation upon which the study of sociomateriality should be anchored, especially as it relates to the studies of technology and organising (Leonardi, 2013). In effect, this approach assumes the inherent distinction between human and material agencies but at the same time recognising the outcomes that ensures

during their interlocking in practice (Leonardi, 2011). Both social and material agencies show capacity for action but differ in terms of intentionality (Leonardi, 2013; Leonardi et al., 2012). Material agency is devoid of intention, as materiality does not act on its own to realise its objectives and thus, it is operationalised when for example, technology takes action that has no human (social) direct control (Leonardi, 2012). Although they differ in terms of intentionality, they are both equally important in shaping one's practice and their respective contributions are qualitatively manifested in different ways (Leonardi et al., 2012).

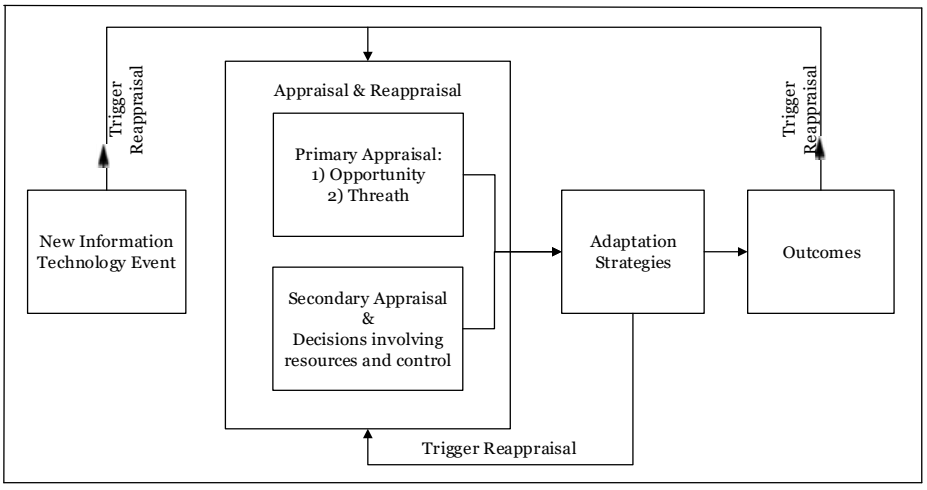
B3.2 Coping Theory

Many theories are used to study IT adoption, e.g., the technology acceptance/unified theory of acceptance and use of technology (TAM/UTAUT) (Davis, 1989; Davis et al., 1989), innovation diffusion theory (IDT) (Rogers, 1993), the theory of planned behaviour (TPB) (Taylor and Todd, 1995), and the task-technology fit (TTF) model (Goodhue and Thompson, 1995). However, these appraoches typically focus on rational and discrete acts of technology by sociomateriality. Thus, this study adopts a coping approach. Coping is defined as the "cognitive and behavioural efforts to manage specific external and/or internal demands that are appraised as taxing or exceeding the resource of the person" (Lazarus and Folkman, 1984: 141, p., 141).

The coping perspective (Figure 1) deals with the particular coping strategy employed by the user in the adoption process (Beaudry and Pinsonneault, 2005). Coping theory describes how people's adaptation behaviours emerge from a series of appraisal processes (Claggett, 2010). The introduction of a

new information technology in an organization might need some organizational adjustment, for example, how the new artefact will fit into the existing process and what resources will be involved, in addition to which people will be performing what roles (Claggett, 2010). That is, the primary appraisal of the new technology by the users are the assessment of the likely consequences of the introduction of this tool as regards its importance and relevant to their organisation at this present situation from their personal perspectives (Lazarus and Folkman, 1984; Beaudry and Pinsonneault, 2005). This results in questions like *"what is at stake for me in this situation?"* (Beaudry and Pinsonneault, 2005: 495, p., 495). The two probable outputs of primary appraisal are described as: 1) challenges (opportunity), perceived as having a positive outcomes and 2) threat, perceived as having negative outcomes (Beaudry and Pinsonneault, 2005). That is, challenges bring excitement and expectation on the part of the 'user', while threats bring harm, anger, or fear (Claggett, 2010).

Figure 1 – Coping Adaptation Model (Claggett, 2010)



The users also undertake the assessment of their control or resource/management control, usually described as the secondary appraisal, over this new tool (Beaudry and Pinsonneault, 2005; Claggett, 2010). That is, users' assessment of how much control they have over this new tool and the adaptation opportunities available to them in respect to the resources provided by the management. Questions around this appraisal focus on *"what is to be done about this situation?"* (Claggett, 2010: 202, p., 202). Furthermore, the secondary appraisal includes: the work related control that offers the users a sense of control over their tasks/jobs; self-control, which gives the user a feeling that they can adapt themselves to the new situation, and technology control describes the feeling of the users that they can influence the functionality and features of the new IT (Claggett, 2010; Beaudry and Pinsonneault, 2005). These controls could be classified as high or low over the user's perceived opportunity or threat. High control in respect to "an Opportunity" leads to 'benefit maximising' that involves a problem-focused behaviour towards 'Task', 'Technology' & Self 'and low, leading to 'benefit satisficing' that involves limited problem and emotional-focused behaviour, while, in respect of "a Threat", high control leads to 'disturbance handling' that involves emotion and problem focused behaviours and on low control that leads to 'self-preservation' that involves emotion-focused behaviours (Beaudry and Pinsonneault, 2005).

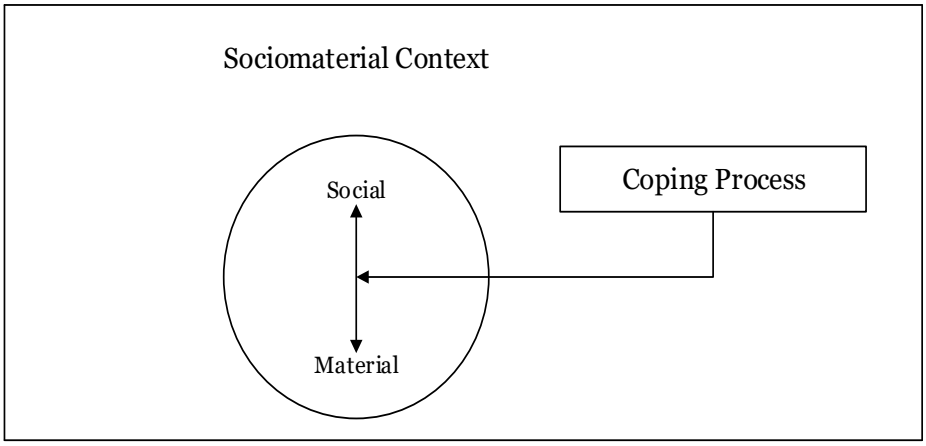
Furthermore, the changes and the dynamics may result in a process that involves the continuous appraisal, reappraisal and the triggers of the ever-changing user-environment relationship (Lazarus and Folkman, 1984). That is, that triggers emanating from the users' environment cause reappraisals of

the ‘situation’ as a result of the continuous change in primary and secondary appraisal processes (Claggett, 2010). The change agreement may arise specifically as a result of users’ adaptation strategies that increases understanding of the change-object or changes in outcomes such as performance. For example, outcomes that resulted in users’ “change of their skills, knowledge, beliefs, attitudes, aspirations and work commitments (Beaudry and Pinsonneault, 2005: 494).

B3.3 The impact of coping on a sociomaterial systems

Aaa The embedding of a coping perspective in a sociomaterial lens is represented in Figure 2. The extent and manner to which social actions enact material technologies is moderated by coping processes. In mHealth contexts, the material will likely include existing technical infrastructures and the mHealth application (smartphone-enabled), which in this study is designed to assist the assessment and classification of illnesses (e.g. Malaria, Diarrhoea, and Pneumonia of children between the age of 2 months and 5 years in a developing world context). The social will likely include healthcare workers (HCWs), patients, developers, government agencies, norms, standards, shared intentions and expectations, and any other non-material components of this system. Sociomaterial enactment of IT requires social actions that develop practices, yet not all technologies are embraced equally (Beaudry and Pinsonneault, 2005).

Figure 2 – A combined view of sociomateriality and coping



The introduction of an mHealth tool to a new context introduces new *materiality* that prompts a change in the sociomaterial *practices* binding the system. During this process of change, the simple building blocks of the mHealth tool are *imbricated* to fit with the goals, needs, and expectations of *social* actors. Yet the extent of this *imbrication* depends on the extent to which these *social* actors actually adopt the system, i.e. "ultimately, people decide how they will respond to a technology" (Leonardi, 2011: , p., 151). Thus, the *imbrication* of new *practices* ultimately reflects the coping process of the *social* actors involved, which may include different *primary appraisals*, *secondary appraisals*, and *adaptation strategies*.

B4 Methodology

This study adopts an exploratory case-study approach (Yin, 2013) aimed to understand the social processes involved and the factors that influence the adaptation of an mHealth technology for use in new areas of developing countries. The investigation will explore the adaptation of an existing mHealth tool, originally developed for use in Malawi, for use in in Enugu State, in the South Eastern Region of Nigeria. The tool assisted the administration of established region-specific integrated community case

management guidelines by creating a mobile application to assist the diagnosis and treatment of illness in children under the age of 5. The environment in Enugu State does not currently comply with the same community case guidelines, meaning the sociotechnical environment may be significantly different from that of Malawi.

A purposeful sampling approach is used to promote the selection of 'information rich' cases for this study (Patton, 1990). Data gathering involves, in-depth interviews, participant observation, and document/record analysis. Interviewees are selected based on reputational and positional methods in the target communities (Knoke, 1994). Data analysis focuses on identifying the types of *social* and *material* actors involved, key *practices*, and signs of *imbrication*. Also, while it was not possible to observe *secondary appraisals* and *adaptation strategies* (the app has not yet been introduced), data gathering sought to identify signs of *primary appraisals* from different *social* actors.

Following Strauss and Corbin (Strauss and Corbin, 1998), an open coding approach is used to categorise the texts by identifying the portion of the responses from the interviewee that answer the research questions and categorising them into codes.

B5 Preliminary Findings

B5.1 Data Collection

Aaa Three face-to-face interviews have been conducted in January 2016, see Table 1. The focus of these interviewees was to ascertain an initial impression of what the users think about the proposed mHealth artefact. The first

individual was a community health worker who is to be involved in the introduction of the new mHealth tool for accessing, classifying and treatment of children under the age of 5. The community health worker works in the clinic located in Edem rural community. She works in the company of eight other community health workers. The second individual is a Data Manager that works at the State Ministry of Health – he manages the data-base, makes sure that the data collected in the data base are in the correct format, and he also helps in the training of the HCWs on how to use the data collection app. The third individual is the EA, who acts as a representative of the Governor on matters concerning the communities they represent.

Interviewee	Role
Community health worker	Works in the clinic located in Edem rural community with seven other community health workers
Data Manager Ministry of Health	Responsible for the data collected in the database are in the correct format, and also helps in the training of HCWs on how to use the data collection app
Executive Assistant to the Governor of Enugu State	Acts as a representative of the Governor on matters concerning the communities they represent

Table 1 – Interviewees

Codes relating to *social* that emerged are three in number. First, the health care workers (HCWs) – these are the group directly involved in providing health care, which include the CHWs; nurses; midwives; doctors, and consultants (experts). The second code is the Ministry of health, these include the people responsible for providing or building the applications: the commissioner for health; the head of departments in the health ministry, data manger/developer, statisticians; recorders and other health officials. The third code is the Government Officials that provide the resources or the enabling

laws/rules that govern health matters; these include the State Governor, Local Government Chairmen, Executive Assistants to the Governor, and the Policy makers in the State's legislature.

Two codes emerged related to the *material* features of the system. The first code was the *material* features of the network. The MoH in Enugu State implemented a data-entry application in 2015 called the national health mobile information systems (NHIS), a system that enables health data to be quickly transferred from the communities to a central database in the Ministry of Health Office. Community health workers have found that both the speed and accessibility of this network are important for that system. For example, the community health workers interviewed pointed out that sometimes she finds it difficult to upload data due to connectivity problems. The second code was the *material* features of the phones to be used for this project.

The codes that emerged in relation to *imbrication* are 1) the comfort-ability issues in respect of the existing mobile software, and 2) the tendency to carry phones as a result. To make the community health workers understand the usability of the app, they were trained on how to collect and transport data to the central database of the health ministry. However, the community health worker was of the opinion that although they were, most of them including her, did not initially understand how to use the app properly, and thus required more training. This was collaborated by the Data manager when he said, "most of the community health workers were not properly trained on how to use the app". He equally added that "the age of the community health workers constituted a problem, as the younger workers are better with technology, and that transferring of trained a trained worker to a new location creates the

added problem of having to train another – which happens often". The second code, the tendency to carry phones created another problem – "keeping the phone safe in case of theft".

Primary appraisals codes that emerged are the effort related threat, and the knowledge threat. The effort related threat code alluded to the added work schedules, which by implication arose because of the introduction of the new information technology. The knowledge related threat arose as a requirement on the part of the community health worker to learn how to use the app in data collection and transporting.

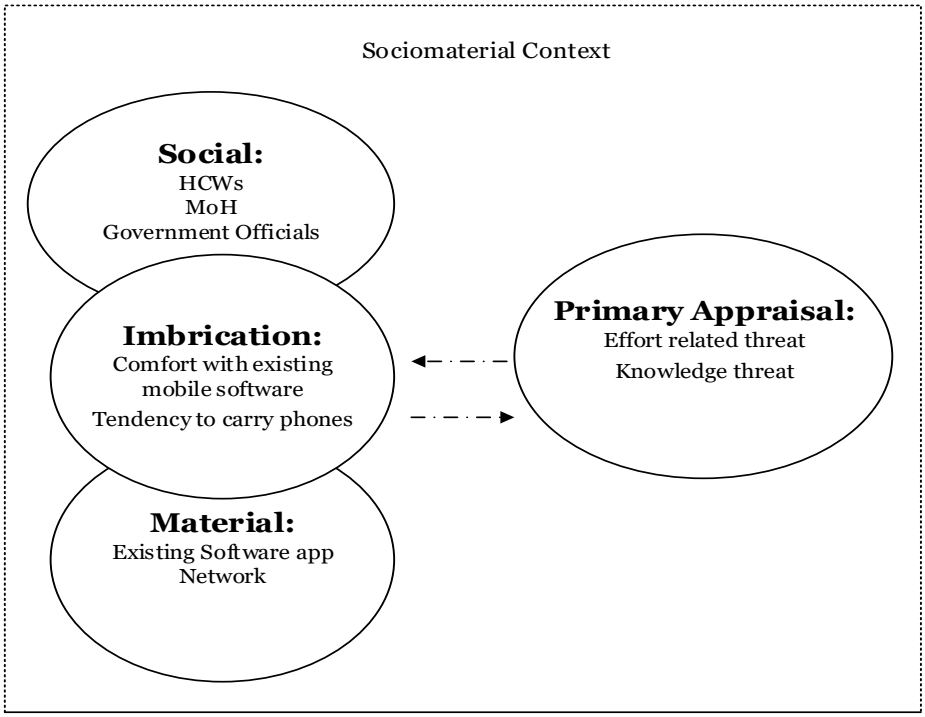


Figure 3 – Emerging Research Model

Category	Codes	Themes
Social	HCWs	1. Community health workers 2. Nurses 3. Midwives 4. Doctors 5. Consultants
	Ministry of Health	1. Commissioner for health 2. Head of Department 3. Data Manager/Developer 4. Statistician 5. Recorders 6. Other health officials
	Government official	1. State Governor 2. Local Government Chairman 3. Executive assistant to the Governor 4. Policy Makers
Material	Phones	1. Features - Button size 2. Number of functionalities
	Network	1. Accessibility 2. Speed
Imbrication	Comfort with existing mobile software	1. CHCWs have been trained to use existing mHealth apps for data collection 2. Existing relationship between social and material
	Tendency to carry phones	1. Safety of the phone 2. Prevention of damage
Primary appraisal	Effort related threat	1. Added work schedules/processes 2. May not be respected if not using it
	Knowledge threat	1. Need for training to operate the mHealth tool 2. Difficult to understand and use

Table 3 - mHealth Utilization Coding table

B6 Future Direction and Anticipated Contributions

The study expects to develop a novel model that will describe how coping strategies influence the sociomaterial *imbrication* of an existing mHealth artefact in a new context. In addition to the interviews performed already, interviews are planned with a total of up to fifty HCWs will be recruited from five communities; Edem, Ibagwa, Alor-Unor, Okpuje, and Okutu health care centres/facilities to use smartphones-enabled with the guidelines for accessing, classifying and eliciting treatment recommendation for sick

children under the age of five. This will allow a refined model offering a new perspective for researchers into the processes and the dynamics involved in the adaptation of mHealth artefacts for new areas of developing countries. Thus, providing researchers with the means to seek out ways through which human activities and IT capabilities work together in a new context.

Further, this study will identify the types of sociomaterial *practices* involved when existing mHealth artefacts are adapted for use in new areas in developing countries. This makes an important contribution to research because it will help in the identification and articulation of scalable or generalizable patterns of sociomaterial *imbrication* in mHealth scenarios.

Finally, this study will articulate the role of coping appraisal in the implementation of mHealth artefacts. This contribution will offer a new way in understanding how mHealth users adapt their behaviours, thus providing a new perspective for integrating adoption and resistance studies for researchers. Additionally, it is envisaged that by understanding the process of primary appraisal, that is, either as an opportunity or a threat, organisations will support positive appraisal and minimise the occurrence of negative ones when introducing mHealth artefacts. Furthermore, by understanding secondary appraisals, i.e., in high or low control situations, organisations will motivate workers to seek the low control approach that accommodates the short-comings discerned in mHealth artefacts.

C. Reviewing mHealth in Developing Countries: A Stakeholder Perspective

C1 Abstract

Infrastructural deficiencies, limited access to medicare, and shortage of health care workers are just a few of the barriers to health care in developing countries. As a consequence, the burden of disease and its impact on the livelihoods and the economic productivity of people are staggering. mHealth has been extolled as one possible solution to overcoming these challenges, yet discussion of mHealth systems is often limited to specific tasks and user groups. To address this, we adopt a stakeholder perspective and analyze existing research on the mHealth process in developing countries. Specifically, we focus on three key stakeholder groups, i.e. healthcare workers, patients, and system developers. We perform an in-depth analysis of 60 peer-reviewed studies to determine the extent to which different mHealth stakeholder interactions are researched, and to identify high-level themes emerging within these interactions. This analysis illustrates two key gaps in existing mHealth research. First, while interactions involving healthcare workers and/or patients have received significant attention, relatively little research has looked at the role of patient-to-patient interactions. Second, the interactions between system developers and the other stakeholder groups are strikingly under-represented. We conclude by calling for more mHealth research that explicitly addresses these stakeholder interactions.

C2 Introduction

The uptake of mobile technology in developing countries has been remarkable (Sife et al., 2010; Meso et al., 2005). This development has led governments, non-governmental organisations, and practitioners to exploit its potential to extend developmental activities to the poor rural communities who are mostly in the developing countries. Many factors are known to hinder health care delivery in developing countries, including infrastructural deficiencies (Xiao et al., 2013; Avgerou, 2008) and limited access to medicare and health care workers (Scheffler et al., 2009). Mobile technologies have been touted as a 'silver bullet' to address these issues by improving the management of health services, supply chains, and communication (Kahn et al., 2010). Strategies based around the use of such mobile technologies are collectively referred to as mobile health (mHealth)(Kahn et al., 2010; Petrucka et al., 2013). mHealth describes the utilisation of wireless technologies to transmit and enable various health data contents and services which are easily accessible through mobile devices such as mobile phones, smartphones and other mobile devices (Bakshi et al., 2011; Kamsu-Foguem and Foguem, 2014). Consequently, a role has been identified for mHealth in developing countries across a range of contexts, for example as an incremental extension of ongoing eHealth developments in urban areas (Varshney, 2014b; Mars, 2013). The advantages of mHealth are brought into focus in rural areas where there is little or no conventional healthcare infrastructure available (Jimoh et al., 2012; Varshney, 2014b). In these areas, mobile devices have the potential to be rapidly deployed as a means of improving health interventions (Dammert et al., 2014; Petrucka et al., 2013),

preventing communicable diseases (Piette et al., 2012; Varshney, 2014b) and improving the health literacy of patients and of health care workers (Ajay and Prabhakaran, 2011; Varshney, 2014b). The relatively nascent nature of this phenomenon has resulted in limited meta-analysis of these studies, meaning it is difficult to determine areas of convergence and oversight (Chib, 2010; Chib et al., 2015a). The objective of this study is to identify and synthesise existing research, to better understand the interaction of the mHealth stakeholders across the mHealth process. This paper is organised as follows: Section 2 presents the methodology for the sampling/review process; Section 3 presents the findings; Section 4 discusses the contributions, implications, and limitations of the study.

C3 Method

C3.1 Data Gathering

Literature was gathered from leading academic databases, namely the AIS Electronic Library (AISel); Science Direct & Web Science; JSTOR; Academic Search Complete & Scopus; OCLC FirstSearch; and Google Scholar. Search adopted a subjective, hermeneutics-based, and dialogical approach to the identification of relevant results (Boell and Cecez-Kecmanovic, 2014), based on an evolving set of search terms. First, a set of synonymous terms for mHealth was used, e.g. “mHealth”, “m-Health”, “mHealth Care”, “mHealthcare”, “Mobile Health Care”, and “Mobile Healthcare”. A brute force search of papers within each of the databases mentioned returned a large number of papers (N>1 million), hence search terms were instead used in conjunction with context-related terms, specifically “in developing countries”; “in low and middle income countries”;

"in low resource settings"; "in poor countries"; and "least developed countries" (e.g. "mobile health care in developing countries"). Papers were retrieved for each combination until the depth of search ceased to provide relevant results. This process reduced the initial set of 192 papers to 60 papers. Once the sample of literature was collected, a set of exclusion criteria was applied as part of title and abstract review. First, literature predating 2010 was excluded. This was done because the rapidly evolving capabilities of mobile devices could have made it misleading to compare studies of mHealth systems from before this period, so compromising the internal consistency of the sample. Second, only literature written in the English Language was included. Third, studies not using mobile devices specifically for health-related activities were excluded. Fourth, only peer-reviewed research was considered from journals, conferences or workshops. Fifth, mHealth studies that focused on technologies that did not include the following were excluded: mobile phones, smartphones, and tablets. This was done because other studies have adopted different definitions of mHealth that include, for example, mobile clinics. Sixth, studies must be focused on developing countries.

C3.2 Coding of Sample Literature

Previous research has suggested that healthcare delivery should be considered as a process (MacIntosh et al., 2007; Minkler and Wallerstein, 2011). The first commonly documented stage of this process is *prevention and education*, which allows interventions to be made before individuals become seriously ill (Piette et al., 2012; Chandra et al., 2014). The second stage is *data collection*, which allows healthcare workers a means of understanding the needs of individuals and detecting issues quickly (DeRenzi et al., 2011;

Zhang et al., 2012). The third is *diagnosis*, wherein healthcare workers determine the cause of an individual's deterioration (Knoble and Bhusal, 2015; Surka et al., 2014). The fourth is *treatment*, as healthcare workers act to address the deterioration through various medicines, surgeries, etc. (Knoble and Bhusal, 2015; Alam et al., 2010). Each of these stages is thus mapped to the analysis of mHealth in this study, i.e. mPrevention/Education, represents the use of mobile health (mHealth) for preventive, advisory, counselling, and educational purposes; mData-Collection represents the use of mHealth applications to collect data that may inform other aspects of healthcare delivery; mDignosis represents the use of mHealth applications for the diagnosis of specific conditions, and; mTreatment represents the usage of mHealth systems to guide remedial healthcare interventions for specific patients. With the process conceptualized, the actors involved may then be considered. Considering the stakeholders of a system has been identified as integral to the design development and implementation of mHealth solutions(Donaldson and Preston, 1995; Sanner et al., 2012). This is true of most healthcare contexts, wherein different groups can possess varying perceptions, attitudes, skill-sets, and behaviors (Akter et al., 2013; Clarkson, 1995). The first stakeholder group describes those involved in providing healthcare, i.e. the health care workers (HCWs) (Varshney, 2014a; Kay et al., 2011a) (medical doctors, medical specialist, nurses, midwives, laboratory technicians and community health workers). The second group describes individuals receiving healthcare, i.e. patients (P) (including those who may benefit from preventative care). The third stakeholder group describes those individuals responsible for building the mHealth system, i.e. system

developers (SD). Interaction flows for each of these stakeholder groups are considered between that group and the knowledge base (KB) enabled by the system, e.g. health care workers to knowledge base (HCWtoKB), between that group and other groups, e.g. SD to HCW (SDtoHCW), and within members of that group, e.g. health care workers to health care workers (HCWtoHCW). These interactions are illustrated in Figure B1.

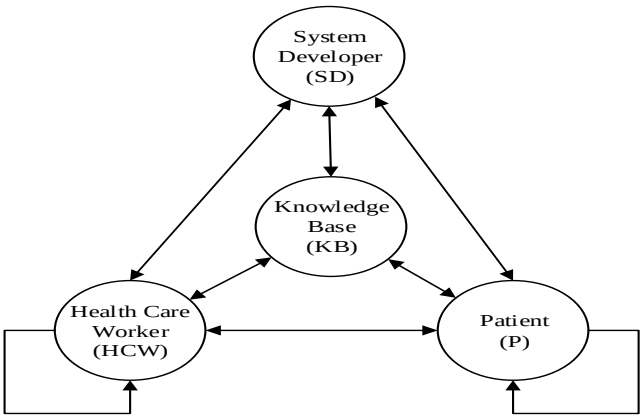


Figure B1 – A Stakeholder view of mHealth

C4 Results

C4.1 A Health Care Worker Perspective

Stakeholder Interaction	mPrevention/Education	mData-Collection	mDiagnosis	mTreatment
HCW-HCW	26	28	22	23
HCW-P	41	45	34	35
HCW-KB	43	46	32	33
HCW-SD	5	5	5	3

Table B1 - Focus of papers at each stage of mHealth process for health care workers' interaction

C4.1.1 Interactions between Health Care Workers and Health Care Workers

The interactions between HCWs were studied extensively across all four stages of the mHealth process. Among the literature addressing mPrevention/Education, most discussion centered upon the difficulties of providing training to scarce HCWs, who often struggle to make time for workshops due to real-world pressures and the practical demands of resource-poor settings (Hufnagel, 2012; Mars, 2013). This presents an important challenge, as contact with healthcare workers is necessary to reduce the sense of isolation experienced by rural doctors in developing countries (Mars, 2013; Pimmer et al., 2014). Discussion around mData-Collection, and mTreatment frequently combined the two, focusing on the potential for distant experts to make use of remote specialization and resources to transfer their findings and diagnosis back to HCWs in the developing countries via SMS or email to inform Patient treatment (Pimmer et al., 2014; Chib and Chen, 2011).

C4.1.2 Interactions between Health Care Workers and Patients

The interactions between HCWs and Patients were extensively studied across all four stages of mHealth. This range of studies demonstrated numerous benefits to health delivery when mHealth systems were introduced. In terms of data-Collection, there is evidence equipping HCWs with mobile data collection tools improves Patients' data collection time when compared to paper-based practices (e.g. Knoble and Bhusal, 2015; Zhang et al., 2012). This enables more efficient data reporting (Jimoh et al., 2012; Vélez et al., 2014), and subsequently a reduction in reporting/submission time (Madon et al., 2014; Vélez et al., 2014). These data can then be stored in shared reserves,

e.g. a national repository (Danis et al., 2010; Ngabo et al., 2012) to be used by other health officials in diagnosing the Patients ailments or monitoring the state of the Patient from anywhere in the world (Zargaran et al., 2014; Ezenwa and Brooks, 2013).

C4.1.3 Interactions between Health Care Workers and Knowledge Base

The interaction between HCWs and KB was also extensively studied across all four stages of mHealth. In terms of mPrevention/Education, studies suggest that gaining access to some established KB or health information repository can enhance or improve HCWs' knowledge even when residing in a resource-poor settings (Pimmer et al., 2014; Chang et al., 2012). Studies demonstrated a willingness among HCWs to gather and transmit collected Patient data to national repositories or databases (Alam et al., 2010; Varshney, 2014a). There is also evidence these HCWs are willing to refer to such centralized systems to guide their diagnoses and treatments at the point-of-care in developing countries (Hufnagel, 2012; Alam et al., 2010).

C4.1.4 Interactions between Health Care Workers and System Developers

The interaction between HCWs and SD was the least well-represented across all stages of the mHealth process. Ensuring continuous use of mHealth systems by health care workers is often a key determinant of their success (Vélez et al., 2014; Akter et al., 2013). Thus, collaborative design processes are undertaken between HCWs and the SDs to minimize adoption issues at various parts of the mHealth process (Vélez et al., 2014; Akter et al., 2013). This is illustrated in case studies of rural setting in developing countries, where feedback provided from HCWs to the SDs led to significant functional changes in applications (Knoble and Bhusal, 2015; Vélez et al., 2014).

Collaborative design and implementation processes with HCWs have also been used to ease tensions around the introduction of mHealth systems (Ngabo et al., 2012; Vélez et al., 2014).

C4.2 A Patient Perspective

Stakeholder Interaction	mPrevention/ Education	mData-Collection	mDignosis	mTreatment
P-HCW	41	45	34	35
P-KB	22	21	15	17
P-SD	3	3	3	3
P-P	1	1	-	-

Table B2 - Focus of papers at each stage of mHealth process for Patients' interactions

C4.2.1 Interaction between Patient and Health Care Worker

The interaction between Patients and HCWs were commonly studied across all the four stages of mHealth process. In terms of mPrevention/Education, studies documented the opportunity afforded Patients to reach out whenever they had emotional problems or felt like talking to a HCW (Chandra et al., 2014; Chang et al., 2011). Such findings are part of a broader theme where mobile technology enables Patients to feel connected to remote HCWs (Simon and Seldon, 2012; Bakshi et al., 2011), as part of which Patients' data can be collected and stored as personal health records. Such data are available to the individual to HCW responsible to the Patient in the future, allowing ongoing care to accumulate (Simon and Seldon, 2012; Hufnagel, 2012).

C4.2.2 Interaction between Patients and the Knowledge Base

Interactions between Patients and the KB were less salient in discussions of the mHealth process, though still extensively researched. Discussions addressing mPrevention/Education described systems where Patients can

send SMS questions to a KB, then receive automated SMS messages on their cell phones that provides information and reminders for their self-care (Piette et al., 2012; Simon and Seldon, 2012). Patients have also been equipped with wearable devices to keep track of parameters such as blood pressure, pulse rate, temperature, weight, blood glucose are stored as relevant data in the knowledge base (Simon and Seldon, 2012; Hufnagel, 2012).

C4.2.3 Interaction between Patients and System Developer

Table B2 illustrates that interactions between Patients and SDs were not widely considered. Of the studies that explored this aspect of mHealth, the most popular subject matter was the potential for Patients to amass perceptions of poor quality of service, which is identified as an key threat for the spread of mHealth systems (Akter et al., 2013; Varshney, 2014a). It is argued that five variables: i) satisfaction, ii) confirmation of expectations, iii) perceived usefulness, iv) perceived service quality and v) perceived trust determine Patients' continued intention to use an mHealth system (Varshney, 2014a).

C4.2.4 Interaction between Patient and Patients

Only a single study in the sample explicitly addressed interactions between Patients. That study (Chang et al., 2011) focused upon mPrevention/Education and mData-Collection. In particular, observations from an initiative in Uganda found that Patients could be trained to care for other Patients to allow (1) greater health support for fellow Patients (2) greater opportunity for HCWs to attend to other high-priority responsibilities in their daily schedules. It is noted that this approach of Patient training leads to

changes in information-seeking among the broader Patient population, who become more likely to turn to these peer health care workers (PHCWs) for care than to conventional HCWs (Chang et al., 2011).

C4.3 A System Developer Perspective

Stakeholder Interaction	mPrevention/Education	mData-Collection	mDignosis	mTreatment
SD-P	3	3	3	3
SD-HCW	5	5	5	3
HCW-KB	5	8	5	5

Table B3 - Focus of papers at each stage of mHealth delivery for System Developers interactions

C4.3.1 Interaction between System Developer and Patients

The interaction between SD and Patients were not broadly studied in the sampled literature. Exceptions to this included exploration of mData-Collection centered on the security of Patients' health information, where SDs enable personalized health monitoring that helps patients gain confidence around the security of their treatment (Hufnagel, 2012; Varshney, 2014a). Interactions at other stages of the mHealth process highlighted SDs' ability to detect usability issues amongst different cadre of Patients, e.g. in how youths or elderly Patients interact with technology (Varshney, 2014a). Several studies note that such difference must be considered in the design and developments of mHealth applications (Aggarwal, 2012; Varshney, 2014a).

B4.3.2 Interaction between System Developer and Health Care Worker

The interactions between SDs and HCWs were also infrequently studied in the sampled literature. Studies highlighted SDs' need to understand the reality of the conditions under which HCWs in the developing countries operate, particularly when diagnosing and treating conditions (Knoble and Bhusal,

2015; Ngabo et al., 2012). Research also documented the implications when SDs fail to consult with the HCWs, whose collective buy-in is often essential for a system to gain traction (Vélez et al., 2014).

C4.3.3 Interaction between System Developer and Knowledge Base

As with other System Designer-related interactions, interactions between system designers and the KB were also studied infrequently in the sampled literature. Amongst the literature addressing mPrevention/Education, much of the discussion focused on the development of new technologies that continuously improve health outcomes and quality of life, or that will offer solutions to emerging problems in the future(Matheson et al., 2012; Ashar et al., 2010). In the same vein, the concept of "grafting" is being recommended as a new perspective on information infrastructure, wherein new solutions must be 'grafted' onto existing resources and local interested parties (Sanner et al., 2014).

C5 Discussions and Conclusion

This review analysed research according to a stakeholder perspective that defined HCWs, patients, and SDs as key groups, as well as a stage-based perspective defining four key stages of the mHealth process, namely mPrevention/Education, mData-Collection, mDignosis and mTreatment. Initial sampling for the review identified 192 peer reviewed journals, conferences and workshops papers. This sample was reduced to 60 eligible studies based on exclusion criteria, these 60 papers were then coded along the stakeholder and stage-based perspective. This review has made five significant contributions to IS research.

First, a contribution is made in the form of the two dimensional lens used to analyse the literature. This lens provided a useful, reusable means of sense-making for the diverse body of research in this space, revealing several important high-level trends in the analysis and design of mHealth systems in developing countries. Among these trends was a triangulated meta-level investigation of the potential of mobile phones to transform health care delivery services in resource-poor settings (Kay et al., 2011a; Hufnagel, 2012), to address heterogeneous information needs in rural communities (Akter et al., 2013; Ngabo et al., 2012), to boost information penetration in areas where access to health information is limited (Ezenwa and Brooks, 2013; Littman-Quinn et al., 2011a), and to provide real time collaborative and adaptive interventions (Nchise et al., 2012; DeRenzi et al., 2011).

Second, a balanced focus of mHealth was observed across each of the stages of the mHealth process. Several of the sampled papers report findings from pilot studies in which the maturity and reach of system implementation was limited, meaning many issues of integration and scale may yet emerge. However, the fact that mHealth efforts represent a proportional breadth of activities means that the value of each stage can be observed and discussed. For example, in India mPrevention/Education interventions that targeted the metal health of teenage girls between the ages of 16-18 years from urban slums resulted in 62% of users feeling more supported (Chandra et al., 2014). The demonstrable success of these types of initiative paves the way for subsequent holistic endeavours in comparable contexts.

Third, analysis of the literature showed that interactions around HCWs are extensively researched. This makes sense, given these stakeholders are likely

to be the most intensive, or direct users of mHealth systems. Thus, understanding these stakeholders is essential to understanding their mental model, cultural biases, and tacit expectations of a new system (Norman and Draper, 1986; Dearden, 2008). Given mHealth systems will involve significant new practices for these HCWs (e.g.Jimoh et al., 2012; Florez-Arango et al., 2011), it is important for scholars and designers to understand the existing practices users may already have in place (Bødker, 2000; Kaptelinin and Nardi, 2006).

Fourth, although the role of Patients is generally well-researched, there is a significant oversight in terms of the design and analysis of system-relevant Patient-to-Patient interactions. This is a significant shortcoming for the body of knowledge around mHealth, as peer-based observation, discussion, and referral plays an important role when introducing new systems (Jasperson et al., 2005; Lou et al., 2005). The single paper that studied this stakeholder interaction (Chang et al., 2011) suggests this is no less relevant for mHealth in developing countries, demonstrating that when Patients are trained to cater for other Patients it brings support to others through peer-based exchange of information and counselling.

Fifth, but perhaps most importantly, analysis of existing literature revealed a significant under-representation of research studying SDs' interactions with other stakeholders. Recent advances in system design have shown that the manner in which SDs interact with potential users is key to eliciting good requirements, spotting issues early, and allowing creative solutions to be presented for complex situated problems (Buchanan, 1992; Brown and Wyatt, 2010). This under-representation may be limiting the effectiveness of

mHealth initiatives by inadvertently creating design contexts where SDs have limited capacity to empathise with Patients and HCWs. Based on these findings, we call for future research that focuses specifically on 1) the interaction between SDs and other stakeholders and 2) the critical peer-based information exchange, referral, and knowledge sharing that happens between Patients. Addressing these gaps will be crucial to increasing cultural sensitivity and allowing mHealth systems to reach the poorest and most remote regions.

C6 Acknowledgement

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D. Past-Focused Research Instruments

D1. RHCWs Research Instruments

What is your current role in the health care delivery system?

What groups or persons do you interact with in the workplace?

What institutions, bodies or establishments do you interact with in the health care delivery systems?

What are your discourses or conversations with these persons, groups and institutions?

How much do you understand about the various other people and groups involved in health care delivery systems?

What physical premises and locations do you interact with or you feel are relevant to health care delivery?

What modes of travel exist between these different premises and locations?

What PCs or Mobile devices exist or do you feel are relevant in health care delivery systems?

What guidelines/procedures exist in software applications or paper-based tools in health care delivery systems?

What external networks and utilities are involved or impact in health care delivery system?

What does your work/task entails?

In what capacity do you engage with persons, groups or institutions earlier mentioned?

How do use the different hardware, software or paper-based systems available to you in taking care of your child?

What training did you receive on the existing guideline/procedures in software applications, or paper-based tools explained earlier in executing your tasks?

How much experience do you have with the existing different guidelines explained earlier in executing your tasks?

Are you getting comfortable or uncomfortable with the different people, groups or institutions you interact with the course of executing your tasks?

Have the technology or tools with which you interact with other people and groups changed overtime?

How do you think the travel infrastructure in Enugu State has changed over time?

D2. PGs Research Instruments

What role do you occupy in your family?

What groups or persons do you interact with in obtaining health care for your family?

What institutions do you interact when in search of health care?

What are your discourses or conversations with these persons, groups and institutions?

How much do you understand about the various other people and groups involved in health care delivery?

What physical premises and locations do you interact with or you feel are relevant to health care delivery?

What modes of travel exist between these different premises and locations?

What PCs or Mobile devices exist or do you feel are relevant in health care delivery systems?

What guidelines/procedures exist in software applications or paper-based tools in health care delivery systems?

What external networks and utilities are involved or impact in health care delivery?

What does your tasks entail in taking care of your child's health?

In what capacity do you engage with persons, groups or institutions earlier mentioned?

How do use the different hardware, software or paper-based systems available to you in taking care of your child?

What training did you receive on the existing guideline/procedures in software applications, or paper-based tools explained earlier in treating your child?

How much experience do you have with the existing different guidelines explained earlier in the treating of your child?

Are you getting comfortable or uncomfortable with the different people, groups or institutions you interact with the course of treating your child?

Have the technology or tools with which you interact with other people and groups changed overtime?

How do you think the travel infrastructure in Enugu State has changed over time?

D3. Facilitators Research Instruments

What is your role in Enugu State Administration (be it in health, legislature, network services, governance etc.)?

What groups or persons do you interact with in your role?

What institutions do these persons or groups belong to?

What are your discourses or conversations with these persons, groups or institutions about health care delivery systems?

How much do you understand about the various other people and groups involved in Enugu State health care delivery systems?

What physical premises and locations do you interact with and/or do you feel are relevant to Enugu State health care delivery?

What modes of travel exist between these different premises and locations?

What PCs or Mobile devices exist in Enugu Sate health care delivery systems?

What guidelines/procedures in software applications or paper-based tools exists or do you feel are relevant in Enugu State health care delivery systems?

With which of the different guidelines or procedures in hardware, software, and paper-based tools described earlier are you mostly involved in its use in Enugu Sate health care delivery systems?

What external networks and utilities are involved or impact on Enugu State health care delivery systems?

What does your work/task as a facilitator entail/s in Enugu State health care delivering health systems?

How do you use the different hardware, software, and paper-based systems in facilitating Enugu State health care delivery systems?

How much experience do you have performing the tasks required in your role?

How much experience do you have with the different tools and technologies you are required to use in your role?

Are you getting comfortable or uncomfortable with the different people, groups, or institutions you interact with in your role?

Have the technologies or tools with which you interact with different people and groups changed over time?

How do you think the travel infrastructure in Enugu State has changed over time?

D4. System Developers Research Instruments

What is your current role in the IMPACT project?

What groups or persons do you interact with in this project?

What institutions do you interact with for this project?

What are your discourses or conversations with these persons, groups, and institutions?

How much do you understand about the various other people and groups involved in the project?

How much do you foresee the cultural differences being a challenge in this project?

What physical premises and locations do you feel are relevant to the project?

What modes of travel exist between these different premises and locations?

What existing PCs or Mobile devices are relevant to this project?

What existing guidelines/procedures in software applications or paper-based tools do you feel are relevant to the project?

With which of the different hardware, guidelines/procedures in software applications or paper-based tools described earlier are you mostly involved in its/their development?

What external networks and utilities are involved or impact on this project?

What does the development of an mHealth tool process entail?

In what capacity do you engage with persons, groups, organizations or institutions in the development of an mHealth tool?

How do you use different hardware, software, and paper-based systems in the development of an mHealth tool?

Where has this new Health app been used before?

How did the users find the Health app in the place/context described earlier?

How much experience do you have performing the tasks required in your role as a health systems developer?

How much experience do you have with the different tools and technologies you are required to use in your role?

Are you getting comfortable or uncomfortable with the different people, groups, or institutions you interact with in your role as a health system developer?

Have the technologies or tools with which you interact with different people and groups changed over time?

How do you think the travel infrastructure in Enugu State has changed over time?

E. Future-Focused Research Instruments

E1. RHCWs Research Instruments

How do you feel about this new mHealth app?

To what extent do you think that this new app would have a positive impact on your work practices?

To what extent do you think that this new app would have a positive impact on co-workers' work practices?

To what extent do you think that this new app would have a negative impact on your work practices?

To what extent do you think that this new app would have a negative impact on co-workers' work practices?

To what extent do you believe this new app would be part of a broader positive/negative trend in healthcare delivery in Enugu State?

To what extent do you intend to explore different features on this new app?

What, if any, other things do you think this new app could do for you?

What, if any, challenges did you face connecting to the internet?

To what extent do you see this new app changing the way you perform your duties?

To what extent do you think you can perform your duties using this new app without outside help?

What, if any, challenges did you face when trying to get familiar using this new app?

Is there any reason why you would avoid using this new app in the future?

How do you feel after using this new mHealth app?

After using this new app, to what extent do you think that it would have a positive impact on your work practices?

After using this new app, to what extent do you think that it would have a positive impact on co-workers' work practices?

After using this new app, to what extent do you think that it would have a negative impact on your work practices?

After using this new app, to what extent do you think that this new app would have a negative impact on co-workers' work practice?

After using this new app, to what extent do you believe it would be part of a broader positive/negative trend in healthcare delivery in Enugu State?

E2. PGs Research Instruments

How do you feel about this new mHealth app?

To what extent do you think that this new app would have a positive impact on the way your child would be assessed at the health centre?

To what extent do you think that this new app would have a positive impact on fellow parents in your community?

To what extent do you think that this new app would have a negative impact on fellow parents in your community?

To what extent do you think that this new app would have a negative impact on fellow parents in your community?

To what extent do you believe this new app would be part of a broader positive/negative trend in healthcare delivery in Enugu State?

To what extent do you think that healthcare workers would like to explore the different features on this new app?

What, if any, other things do you think this new app could do for rural healthcare workers?

What, if any, challenges do you think that rural healthcare workers would face connecting to the internet?

To what extent do you see this new app changing the way rural healthcare workers perform their duties?

To what extent do you think that healthcare workers can perform their duties using this new app without outside help?

What, if any, challenges do you think that rural healthcare workers would face when trying to get familiar with using this new app?

Is there any reason why you think that rural healthcare workers would avoid using this new app in the future?

How do you feel after using this new mHealth app?

After using this new app, to what extent do you think that it would have a positive impact on healthcare practices in Enugu State?

After using this new app, to what extent do you think that it would have a positive impact on rural healthcare workers' practices?

After using this new app, to what extent do you think that it would have a negative impact on health practices in Enugu State?

After using this new app, to what extent do you think that this new app would have a negative impact on rural healthcare workers' practices?

After using this new app on your child/children, to what extent do you believe it would be part of a broader positive/negative trend in healthcare delivery in Enugu State?

E3. Facilitators Research Instruments

How do you feel about this new mHealth app?

To what extent do you think that this new app would have a positive impact on the way you want children to be assessed in Enugu State?

To what extent do you think that this new app would have a positive impact on fellow facilitators in Enugu healthcare system?

To what extent do you think that this new app would have a negative impact on fellow facilitators in Enugu healthcare system?

To what extent do you think that this new app would have a negative impact on fellow facilitators in Enugu healthcare system?

To what extent do you believe this new app would be part of a broader positive/negative trend in healthcare delivery in Enugu State?

To what extent do you think that rural healthcare workers would like to explore the different features on this new app?

What, if any, other things do you think this new app could do for rural healthcare workers?

What, if any, challenges do you think that rural healthcare workers would face connecting to the internet?

To what extent do you see this new app changing the way rural healthcare workers perform their duties?

To what extent do you think that rural healthcare workers can perform their duties using this new app without outside help?

What, if any, challenges do you think that rural healthcare workers would face when trying to get familiar with using this new app?

Is there any reason why you think that rural healthcare workers would avoid using this new app in the future?

How do you feel after using this new mHealth app?

After using this new app, to what extent do you think that it would have a positive impact on healthcare practices in Enugu State?

After using this new app, to what extent do you think that it would have a positive impact on healthcare workers' practices?

After using this new app, to what extent do you think that it would have a negative impact on health practices in Enugu State?

After using this new app, to what extent do you think that this new app would have a negative impact healthcare workers' practices?

After using this new app, to what extent do you believe it would be part of a broader positive/negative trend in healthcare delivery in Enugu State?

E4. System Developers Research Instruments

How do you feel about this new mHealth app?

To what extent do you think that this new app would have a positive impact on the way you want children to be assessed in Enugu State?

To what extent do you think that this new app would have a positive impact on fellow developers in Enugu healthcare system?

To what extent do you think that this new app would have a negative impact on fellow developers in Enugu healthcare system?

To what extent do you think that this new app would have a negative impact on fellow developers in Enugu healthcare system?

To what extent do you believe this new app would be part of a broader positive/negative trend in healthcare delivery in Enugu State?

To what extent do you think that rural healthcare workers would like to explore the different features on this new app?

What, if any, other things do you think this new app could do for rural healthcare workers in Enugu State?

What, if any, challenges do you think that rural healthcare workers would face connecting to the internet?

To what extent do you see this new app changing the way healthcare workers perform their duties?

To what extent do you think that rural healthcare workers can perform their duties using this new app without outside help?

What, if any, challenges do you think that rural healthcare workers would face when trying to get familiar with using this new app?

Is there any reason why you think that rural healthcare workers would avoid using this new app in the future?

How do you feel after using this new mHealth app?

After using this new app, to what extent do you think that it would have a positive impact on healthcare practices in Enugu State?

After using this new app, to what extent do you think that it would have a positive impact on rural healthcare workers' practices?

After using this new app, to what extent do you think that it would have a negative impact on health practices in Enugu State?

After using this new app, to what extent do you think that this new app would have a negative impact rural healthcare workers' practices?

After using this new app, to what extent do you believe it would be part of a broader positive/negative trend in healthcare delivery in Enugu State?