

**A Context-Aware m-Health Application
Towards a Design Model for Developing Rural Areas**

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**A Context-Aware m-Health Application:
Towards a Design Model for Developing Rural Areas**

Proefschrift

ter verkrijging van de graad van doctor
aan de Technische Universiteit Delft,
op gezag van de Rector Magnificus prof. Ir. K.C.A.M. Luyben;
voorzitter van het College voor Promoties,
in het openbaar te verdedigen op
woensdag: 16, november, 2016 om 12:30 uur

Door

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For Jesus, Mary and Joseph

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List of Acronyms

| | |
|--------|--|
| ADR | Action Design Research |
| BMs | Business Models |
| CDIs | Critical Design Issues |
| CSFs | Critical Success Factors |
| DSR | Design Science Research |
| ICT | Information Communication Technology |
| ICT4D | Information Communication Technology for Development |
| MoH | Ministry of Health |
| MTN | Mobile Telephone Network |
| NGOs | Non-Governmental Organization |
| PHC | Primary Health Care |
| PNFPs | Private Not For Profit |
| PRA | Participatory Rural Appraisal |
| PRSP | Poverty Reduction Strategy Papers |
| RCDP | Rural Community Development Program |
| SEs | Social Entrepreneurship |
| SMS | Short Message Service |
| STOF | Service, Technology, Organizational, Finance Framework |
| UBOS | Uganda Bureau of Statistics |
| UCMB | Uganda Catholic Medical Bureau |
| UMMB | Uganda Muslim Medical Bureau |
| UMU | Uganda Martyrs University |
| UNMHCP | Uganda National Minimum Health care Package |
| UOMB | Uganda Orthodox Medical Bureau |
| UPFORD | University Partnership for Outreach Research Development |
| UPMB | Uganda Protestant Medical Bureau |

UTL

Uganda Telecommunication Ltd

VHTs

Village Health Teams

WHO

World Health Organization

1. Chapter 1. The Case for a Context-Aware Model

1.1 Introduction

ICT4D artifacts are used in developing countries and communities with the hope of attaining development goals, for instance, to improve access and delivery of healthcare for poor communities. For instance, telecentres have been used in poor communities to enable affordable access to ICT services, such as printing, photocopying or access to the Internet (Madon et al, 2009). Computers and information systems have also been used in social sectors, such as government and healthcare to improve efficiency and transparency (Fraser et al, 2005; Schuppan, 2009). The mobile phone has also been used to improve access to market prices for farmers and to provide money transfer services to the unbanked (Crandall & Kieti, 2013; Donner & Tellez, 2008). However, there are continued ICT4D project failures due to sustainability challenges (Heeks, 2002; Tongia and Subrahmanian, 2006; Dada, 2006; Best and Kumar, 2008) and these frustrate development efforts. Kingsbury et al (2008: pg. 12) define development as “the process by which people and states outside the industrialized world attempt to improve their conditions of life through material and social means.” This change is holistic, and covers economic, social, cultural and political aspects of life. Development is a response to poverty, which is a state of ill-being of a person or community that lacks the fundamentals for a minimum standard of well-being and life, for instance, material (income, food, shelter) or social (healthcare, education, information) resources (Kanellopoulos, 2010).

It is also known that ICT4D projects fail to attain development objectives because of failure to achieve sustainability. Thus, this research is motivated by sustainability failures as these affect development objectives and therefore poor communities most (Heeks, 2008). There are three kinds of failure in ICT4D projects: (1), total project failure where a project fails to achieve implementation or fails shortly after implementation, (2), partial failure (a project was implemented but major goals were unattainable) and (3), sustainability (a project registered initial success, but collapsed after donor funding was pulled out). It is generally agreed that lack of empirical research and evaluation is the primary reason for continued sustainability challenges (Heeks, 2002; Tongia and Subrahmanian, 2006; Dada, 2006; Best and Kumar, 2008). Empirical research helps researchers and ICT4D stakeholders understand what works and what does not work in a developing context. In Design Science, this is described as a gap between the “natural laws” that govern an innovation and the “natural laws” that govern the context in which innovation operates (March and Smith, 1995). ICT in organizational have advanced in design and implementation. However, this is not the case with ICT4D and development-oriented contexts. It has been recognized that the field of ICT4D needs the field of development studies to understand (Heeks, 2010; Schuppan, 2009; Lucas, 2008; Prakash and Rahul De’, 2007). Although a few studies have applied development theory (livelihood and capabilities approaches) to ICT4D (Chapman, Slaymaker and Young, 2003; Duncombe, 2006; Kleine, 2010), only the livelihood approach has been used to understand the information and communication needs in a developing context (Chapman, Slaymaker and Young, 2003; Duncombe, 2006). This approach uses the livelihood framework as an analytical tool to understand what affects the poor, including their information and communication needs. On the other hand, the capabilities approach was used to assess the contribution to development after ICT4D use. However, the gap this study is looking at is understanding the context.

With the highest levels of poverty (70% of the world's poor is rural), rural areas as social contexts in developing economies present a unique development context for ICT4D designers (Wiggin and Proctor, 2001; Willis, 2005; Dercon, 2009; IFAD, 2011). Rural areas are economy spaces that are associated with dispersed patterns of population, scattered communities with varying levels of access to local services and markets and therefore experience unequal levels of development compared to urban areas (Halfacree, 1993; Grimes, 2000). While designers are coming from the modern technologically driven economies, rural areas are traditional and subsistence-driven economies (Tongia and Subrahmanian, 2006). Therefore, the rural context is particularly foreign to ICT4D designers, hence the gap between their designs and the context of application.

Notably, poverty and development are multi-dimensional and can be approached from the sectors of education, health, economic, social-political and social-cultural domains of society. However, this research focuses on the social dimension, and in particular, on healthcare and mobile service innovations referred to as m-Health, intended to improve healthcare delivery and access. As a technology that is widely available in developing countries, ICT4D designers are now opting to develop innovations that incorporate mobile phones. However, despite the use of a technology that is considered appropriate because it is widely available (Heeks, 2008), m-Health innovations experience the same sustainability challenges as all ICT4D (Kahn, Yang and Kahn, 2010; Mechael et al, 2010).

Starting from the identified gap between m-Health designers and the rural healthcare context, the motivation for this research is discussed in detail basing on: (1) what it means to develop a sustainable innovation in the field of m-Health and why it is important, and (2) to whom it is important such as, designers, economic development practitioners, investors and policy makers who have an eye for the needs of end-users in the research background.

In the Knowledge Gaps section, from a theoretical perspective, there is discussion of research areas that are not prominently discussed in the academic field of m-Health. Specifically there is focus on the design process and how to apply and use theories with regard to sustainable development and using business model literature to take the idiosyncrasies of developing economies into account. Based on the knowledge gaps as formulated, the research objective was made explicit and the core research questions to be answered were derived.

It is essential to mention that the methodology used in this thesis was selected based on the specific research requirements, that is, understanding rural users and their context, and business model tooling that enables evaluation of innovation's viability and feasibility in the context of a developing economy. Ethnography and Action Design Research allow the study of individuals and communities and their lives while allowing researchers to make appropriate changes as observations are made. The research approach section discussed these two methodologies in detail and their relevance to a design oriented approach.

1.2 Research Background

Defining Information Communication Technology for Development (ICT4D) begins with the definition of ICT as: the old media and new digital technologies that can store, manage, and allow communication and sharing of information facilitated by telecommunication networks (Chapman and Slaymaker, 2002; Labelle, 2005). When applied to development-oriented situations, they are referred to as ICT4D (Heeks, 2008; Tas, 2010). M-Health innovations are ICT4D applications that use technologies such as:

Bluetooth, GSM, Wi-Fi, WiMAX and other emerging mobile technologies. These applications are used to provide various healthcare services using devices such as: mobile phones, smart phones, Personal Digital Assistants (PDAs), laptops and tablets (Vital Wave Consulting, 2009; Hwabamungu and Williams, 2010). These use either SMS or specialized software for remote monitoring of chronic diseases, data collection and reporting, for education and awareness campaigns, communication and training for health workers and for diagnostic and treatment support for health workers (Mechael et al, 2010).

Furthermore, the motivation for designing these innovations for healthcare is derived from: (1) the 64% mobile phone users in developing economies (Patil, 2011), and (2), the poor state of health in communities and the healthcare system for developing countries, especially in sub-Saharan Africa. 24% of the world's total disease burden is in sub-Saharan Africa (International Finance Corporation, 2008). Most of this is HIV/AIDS, tuberculosis and malaria (60%) which are preventable. The World Health Organization (WHO) is encouraging and supporting African nations to develop Primary Health Care (PHC) approaches to strengthen their health systems and combat the above-mentioned challenges (Van Lerberghe, 2008). A Primary Health Care approach would include: (1) essential healthcare based on scientifically sound and socially acceptable methods and technology, (2) A structure that is universally accessible to all individuals, families and communities, with their full participation and at a cost the community, and a country can afford to maintain at every stage of development, (3) an integral part of the country's health system, and (4) the first level of contact between the community and the national health system is either in their households or at work, which contact is continued throughout the healthcare process. These goals are achieved through the District Health System which is a referral system that uses community based services as the first point for delivery of healthcare in the form of preventive and curative programs. Community health workers, commonly referred to as Village Health Teams (VHTs) in Uganda take the place of professionally trained health workers to implement preventive and curative programs. These refer patients to health centers at parish level referred to as Health Centres IIs and IIIs. At the county and district level, are Health Centre IVs or a hospital where the lower level health workers can refer patients for more specialized treatment (Hall and Taylor, 2003: pg. 18; Parker, Walsh and Coon, 1976). With support and funding from WHO, developing nations have made a Primary Health Care national policy, and implemented healthcare strategies that reflect PHC goals. However, with limited infrastructure, facilities, and only 3% of the world's health workers, sub-Sahara Africa's national health systems are inadequate for disease burdened populations (International Finance Corporation, 2008). Poor and inaccessible services when combined with poor social and economic determinants, such as low-income levels and poor infrastructure create a vulnerable situation for poor communities (Van Lerberghe, 2008). Moreover, the majority of these vulnerable, remotely situated groups of people are in rural areas (Chapman and Slaymaker, 2002; Shanmugavelan and Warnock, 2004; Patil, 2011).

In addition to the above, sustaining m-Health service innovations requires that they should have: (1) the ability to generate adequate revenue to cover their costs and expenditures over time, (2) can deliver value to the targeted users, and, in addition, the users' must be seen to accept, adopt and adapt it into their social setting, and (3) have institutional and political support as key players in the social and economic environment (Fillip and Foote, 2007; Ali and Bailur, 2007). Each of these domains must work together for the service to survive over time (Heeks, 2008). Heeks (2002) states that although it is difficult to pin point the exact number of ICT4D projects that have failed to attain sustainability because of lack of evaluation, literature and a focus on primarily case studies, what literature indicates is that the number is high.

ICT4D and m-Health in particular are vital tools in the fight against poverty. In addition, projects are funded by International Agencies (Heeks, 2002), governments formulate policy to create favorable conditions for ICT4D deployment (Labelle, 2005), and the creative efforts of designers are evident in the healthcare market (Mechael et al, 2010). To continuously experience sustainability failures is disheartening, not only for each of the above mentioned stakeholders, but also for the poor communities that expect to experience real value added to their healthcare needs.

1.3 m-Health and Context Knowledge Gaps

Literature points to two gaps in the field of m-Health; the first is lack of evaluation to determine what works and what does not work for m-Health applications (Tomlinson et al, 2013). It is for this reason that there has been a call for objective evaluation of m-Health initiatives (Mechael, 2009; Mechael et al, 2010; Tran et al, 2011). The second gap is the lack of research method application to the design, deployment and evaluation activities in the life cycle of ICT4D applications (Dörflinger and Gross, 2010). It is probably because of this reason why most literature on ICT4D focuses on “impact, benefits, limitations, risks, and goals” (Raiti, 2006) evident in (Chapman and Slaymaker, 2002; Herselman, 2003; Labelle, 2005). Heeks and Molla (2009) have developed a Compendium for Impact Assessment for ICT4D projects whereas Tongia and Subrahmanian, (2006) developed a design model that can be used to identify service and product through continuous interaction with all stakeholders while continuously refining knowledge of the problem and the innovation. There are some documented research studies that focus on impact assessment (Nsanzimana et al, 2012; Lester et al, 2009; Phillips et al, 2010; Costa et al, 2010; Free et al, 2010; Mahmud, Rodriguez and Nesbit, 2010; Lester et al, 2010; Pop-Eleches et al, 2011; da Costa et al, 2012; Zurova, 2011; Free et al, 2013). Three reported benefits; one found none, and two reported modest benefits (Tomlinson et al, 2013). Other studies have focused on assessment and evaluation of individual mobile service innovations (for instance, Seebregts et al, 2009; Banks and Hersman, 2009; Marrow et al, 2011; Asiimwe et al, 2011). One study (that is to say Hwabamungu and Williams, 2010) has attempted to examine the perception of potential users (patients and healthcare workers). The study was done in Pretoria, South Africa with HIV/AIDS patients and health workers. There has however been no attempt to study the relationship between a developing context and the sustainability of a mobile service innovation. It is not yet known what opportunities, impediments and constraints exist in a developing rural context that might influence value creation for a mobile service innovation.

Apart from the need for evaluation, there has been a different demand for ICT4D researchers to develop a deeper understanding of the contexts ICT4D and how they are implemented. Lucas (2008) raises the significant differences between ICT4D designers and development practitioners. The differences, he argues, are due to the unique perspectives the development practitioners have of the context in which ICT4D are implemented while designers demonstrate a limited understanding of this context. Schuppan (2009) makes reference to the need for a context-oriented approach, while Prakash and Rahul De’ (2007) refer to the need for a broader understanding of the development-context in the design process. This lack of understanding and knowledge of the context is visible in the sustainability challenges that Heeks (2002) categorizes as follows: (1) the intentions of the innovation may not match the intentions of the users (design- actuality gaps), (2) the innovation may fail to incorporate cultural and political influences in the organizational processes (hard – soft gaps), and (3) the innovation may be implemented in a country context that differs from the context in which it was originally designed (country context gaps). Each of these gaps point to the fact that ICT4D designers lack knowledge and

understanding of the contexts of application. There is therefore a real need to address the knowledge gap between ICT4D designers and the developing rural context to guide the design process of the innovations.

1.4 A Context-Aware Model for Designing m-Health Innovations

Dey (2001:pg. 2) defines context as:

“any information that can be used to characterise the situation of an entity. An entity is a person, place, or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves.”

The definition of a context aware model is adapted from Dey’s definition of a context-aware system which states that:

“A system is context-aware if it uses context to provide relevant information and/or services to the user, where relevancy depends on the user’s task.” (Dey, 2001:pg. 3)

Thus, we consider a model to be context-aware if it provides the user (ICT4D designer) with relevant information that will guide the design of viable m-Health innovations for a developing rural context. This information includes characteristics of all stakeholders that will use an m-Health service innovation and social, political and economic factors in a rural healthcare context that affect viability of a service innovation. To design such a model, we look at the fields of development and Business Models for guiding theory and method.

Development has been defined, but it is important to understand that there are a range of meanings ascribed to the term, some of which may overlap. The distinction is in the priority they give to a specific development goals (McGillivray et al, 2008). The reason for the wide range of meanings and perceptions is a result of evolution in understanding, global trends and events during the course of world history. I initially, defined poverty in strictly monetary terms, hence economic measurements for development were devised. Alongside this was the thought that development was modernization, urbanization and industrialization. Thus, measurement of development was either structural adjustment or the rate at which the urban and industrial sector developed and absorbed the rural sector. When the purely economic perspectives began to produce undesirable effects, for instance, unequal growth patterns, inequalities, failed states and many others, then perceptions of development began to take a closer look at contexts of poverty. Today, development includes human development that examines wellbeing of individuals and households in terms of a specific criteria of measurement referred to as the Human Development Index. We have development programs that may focus on unequal distribution of resources (these may be income based, gender based, and social inequalities and so forth.). We may also have programs that are focused on a specific sector or a contemporary issue, for instance, agriculture or environment. However, internationally and nationally, the guiding model is the Human Development Index that bases its measurement and understanding of poverty on three dimensions: health, knowledge or education and standard of living or economic (Willis, 2005). Ultimately, the final measurement is based on household consumption levels. However, it is realized that the approached so far identified only measure poverty, but not what causes. This will only provide one dimension in describing and understanding the poor context.

A new development paradigm referred to as Rural Development grew out of the extensive research in rural poverty and agriculture. This paradigm focused on the unique rural context and two development approaches have emerged: the livelihood approach and capabilities approaches were developed and have been used in the field of ICT4D (Heeks, 2010). The capabilities approach examines the capabilities or functioning of individuals, a community or country. By improving the functioning, one improves capabilities and therefore their well-being. These functioning include: (1) Life, (2) Bodily Health, (3) Bodily integrity, (4) Senses, imagination and thought, (5) Emotions, (6) Practical reason, (7) Affiliation, (8), Live with and concern for other species, (9) play, and (10) control over one's environment. This approach has been applied to the Human Development Index earlier discussed. To ICT4D, the capabilities approach has been used to assess the development contribution ICT has had on development (Kleine, 2008). However, considering that this approach only measures poverty, but fails to determine causes of poverty, we perceived this not appropriate for our need to describe and understand the poor context. We thus look at the livelihood approach.

The livelihood approach was developed from agricultural and village studies, contemporary issues on environmental sustainability that were tied to agriculture, and the new Bottom – Up approaches to understanding and defining poverty (Ellis and Biggs, 2001). During this period, there were prevailing arguments for more people-centered approaches in poverty definition and development programs. During these studies, it became evident that the poor did not define poverty solely in terms of income or consumption but also included insecurities referred to as causes of poverty (Rakodi, 1999). The livelihood approach is not only concerned with understanding the causes of poverty, but understanding them from the perspective of people experiencing poverty. It gives opportunity for this research to analyze the context of poverty from the perspective of the poor and thus define their needs as opportunities for value creation in m-Health innovations. In the next section, we discuss the livelihood framework as a method that applies the livelihood approach. We discuss how the livelihood framework describes and analyses a poor context so as to develop an understanding of poverty from the perspective of the poor.

1.4.1 The livelihood framework

The livelihood framework is a method of application for the livelihood approach and enables researchers to understand and represent individuals and communities perspective of their poverty and reality. Researchers do this by identifying vulnerabilities (insecurities, challenges, barriers and impediments) the poor experience (Farrington, 1999), what they possess and what they use to overcome these vulnerabilities (assets), social / cultural structures, policies and institutions that support or hinder their efforts and how they combine all of these resources to overcome their vulnerabilities (livelihood strategies) (Scoones, 1998; Ashely and Carney, 1999; Duncombe, 2006). The outcome of activities they undertake to overcome poverty determines the effectiveness of their efforts (Niehof, 2004). In addition, the livelihood framework provides a strategy to logically understand and explain the practical needs of a rural context, defined by a rural community. Furthermore, It also identifies preferred means (activities that combine resources and assets) to overcome their state of poverty.

Primarily, the livelihood framework has been used to understand poverty, livelihood strategies of the rural poor, and the impact on sustainable development. Most of the work has focused on agriculture, natural resources and the environment (Scoones, 1998; Bebbington, 1999; Ashley and Carney, 1999).

However, ICT4D researchers are beginning to use the framework to develop a broad understanding of information and communication needs of the rural poor (Chapman, Slaymaker and Young, 2003; Duncombe, 2006). Chapman, Slaymaker and Young (2003) use the framework in a desk study to develop an understanding of information systems existing within rural development and agriculture and how policy makers can build on the existing information systems in intervention strategies. Duncombe (2006) applies the livelihood framework in a post-implementation evaluation of an ICT4D innovation, assessing the development impact the artifact has on users. Both studies conclude that the framework does identify and broaden the knowledge on information and communication needs in a developing context.

In this research, the focus is on healthcare in a rural context. The research identified vulnerabilities (insecurities, challenges, barriers and impediments) the poor experience in healthcare. From these, the development goals and needs of a community are identified, and these used as the basis for service design and definition of the social value that the service innovation must attain. The research identified capabilities and assets available to a rural community and used to overcome healthcare vulnerabilities. This process identified end-users while describing their challenges and characteristics that might influence healthcare access and delivery, hence, influence viability of a service innovation. This process also contributed to the service design while identifying variables that we later on used to evaluate the economic and social viability of the service innovation. The research also identified livelihood structures / institutions, policies and programs in rural healthcare and how these influences health seekers and providers in delivery or access of healthcare. From livelihood structures and institutions, partners that support, maintain and operate a service innovation were identified and described. Descriptions of livelihood structures / institutions identified challenges and characteristics that may affect viability of the service innovation. Finally, livelihood strategies adopted by end-users identified yet more challenges and characteristics of end-user, which were also used to evaluate the viability of a service innovation. The result of this analysis identified variables from which, (1) requirements, assumptions and specifications of the artifact were identified, (2) while providing a window for predictability on the ability of the innovation's adoption in the context it has been introduced. However, the livelihood framework does not provide a mechanism to design and evaluate the service innovation against sustainability requirements. Basing on the above discussion, this research looks at business models and business model tooling.

1.4.2 A Business Model, Sustainability and Social Entrepreneurship

The definition of sustainability earlier pointed to the need for ICT4D to survive overtime. In other words, the innovation must be viable. Business Models (BMs) are able to demonstrate if a specific idea is viable or profitable. In the context of organizations, a Business Model (BM) represents the core logic and strategic choices in creating and capturing value within a value network that includes suppliers, partners, distribution channels and coalitions (Shafer, Smith and Linder, 2005). A Business Model in action, within an uncertain market, should act as an intelligent device that allows the organization to introduce new innovations that can be supported by the value network (Doganova and Eyquem-Renault, 2009).

Of significance is ICT4D literature which explores the subject of Business Models and their possible contribution to sustainability. There has been a call to develop Business Models alongside ICT4D

innovations (Heeks, 2008; Mechael et al, 2010). From the field of Information Systems, Business Model tooling has emerged focused on the design and evaluation on ICT based service innovations. Bouwman et al (2012) points out four dominant Business Model tooling from the field of IS: (1) CANVAS which designs, describes and analyses BMs, (2) Ballon's approach which classifies BMs basing on a set of key design parameters, (3) E3-Value methodology for modeling economic and financial aspects of BMs, and, (4) STOF which provides elaborate and detailed ways of dealing with design issues and success factors of Business Models. However, it is necessary to select a Business Model tooling that will support design and evaluation of an m-Health service innovation using the description of a rural context given by the livelihood framework analysis. CANVAS is detailed in design and modeling, but is limited to a single firm. Mobile service innovations are operated by multiple firms and partners, thus creating a complex value network. CANVAS is therefore perceived as inappropriate to design a BM for an m-Health service innovation. Ballon's approach is limited to analysis at a high level, but does not provide practical guidelines for designing a BM. Our intention was to design and evaluate a low level BM for a case rural context, though Ballon's approach was not appropriate. E3- Value's is limited to modeling economic and financial value. This leaves us with STOF. In the next section, we discuss STOF and why it was found appropriate for design and evaluation of our m-Health service innovation.

1.4.3 The STOF Framework

In the design of business models, it is noted that mobile service innovations are unique and do not necessarily belong to a single organization. There are multiple players and actors working in a complex network that must provide value to users and owners of the innovation. In this context , the business model becomes a blueprint that defines the service, intended value for a target group, identified sources of revenue, an architecture for service delivery, resources required, organizational and financial arrangements between the business players, their roles, cost and revenue divisions (Bouwman, Vos and Haaker 2008:pg 33). The STOF model is a framework that was developed to cater for specifically the ecosystem of mobile and wireless service innovations. Secondly, the STOF framework provides a method (The STOF method) with step by step detailed design and evaluation guidelines which supports the design objective of our research. The STOF model bases its framework on four domains: Service, Technology, Organizations and Finance and each domain demonstrates the contribution and expectations of the actors and stakeholders in the service innovation while drawing causal effect of these variables in the overall chain of value generation.

The STOF method builds the four domains using four stages: the first stage develops a rough service and business model design called the Quick Scan. The Quick Scan is implemented and evaluated against a set of Critical Success Factors (CSFs). The evaluation process helps to define Critical Design Issues (CDIs) of the service and business model and the final stage evaluates the Critical Success Factors and Critical Design Issues against the environment outside the ecosystem of the service innovation.

Of significance, was the fact that the research was able to use the development needs or goals (social value), end-users, partners and assets identified from the livelihood analysis as input variables to design the service innovation and its underlying business model (Quick Scan). The challenges and characteristics of all stakeholders and the context identified were used by STOF to evaluate viability of the service (Evaluate CSFs, Specification of CDIs and Evaluate). In other words, the livelihood framework explains and predicts rural areas, while the STOF framework demonstrates viability and feasibility of rural contexts. The end result of the livelihood and STOF framework activities is a context-

aware design model made up of variables that create value for mobile service innovations and variables that negatively affect the viability of the service in a developing rural healthcare context. The following figure, 1.1 demonstrates the structure of the context-aware model.

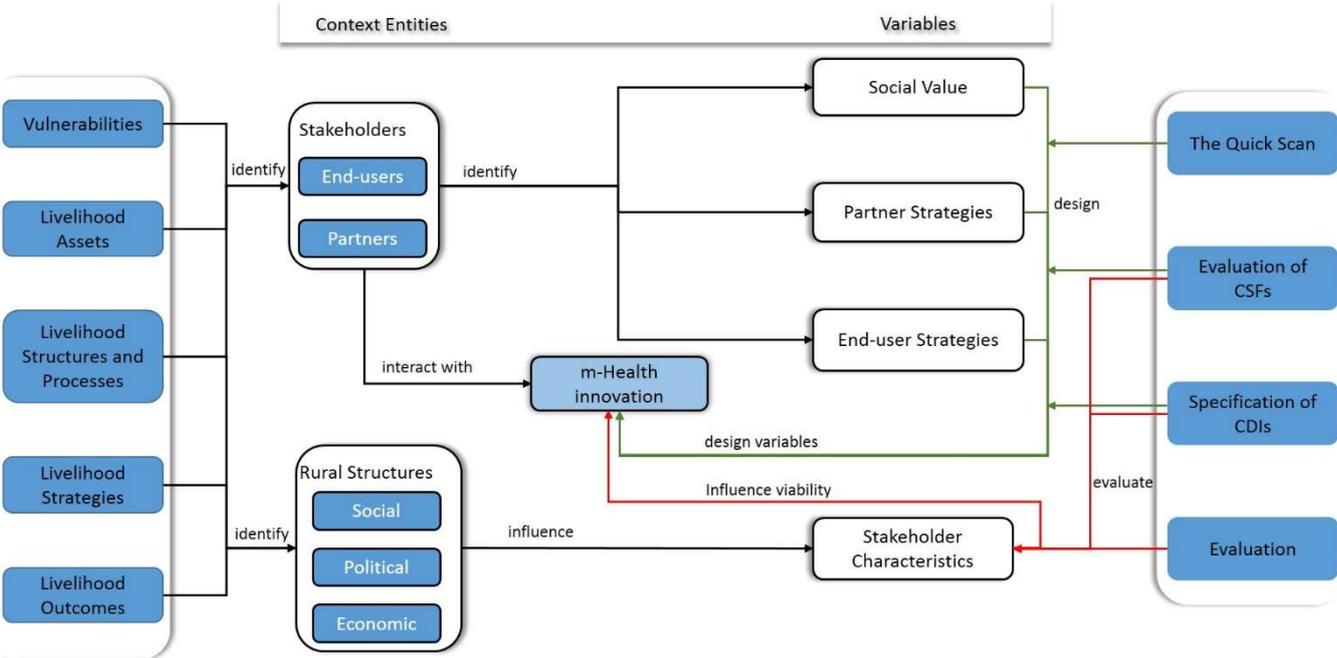


Figure 1.1: Structure of Context-Aware Model (Source; Research)

Significantly, the research takes note of the fact that the context from which Business Models and Business Model tooling emerge differs from the context ICT4D are applied. Traditional entrepreneurs and therefore traditional BMs focus on what people want and not what people need (Seelos and Mair, 2005). ICT4D and m-Health service innovations focus on human needs, for instance, access to healthcare. Social Entrepreneurs especially focus on social value (human needs) and demonstrate new Business Model strategies in creating or capturing this type of value. They basically discover, define or exploit opportunities in order to create or catalyze social change, either by creating new wealth or managing existing organizations (Zahra et al, 2009). Social Entrepreneurship (SE) Business Model literature although relatively new, highlights unique strategies not found in traditional Business Models (Yunus, Moingeon and Lehmann- Ortega, 2010). There are four domains (strategic choices, value networks, value creation and value capture) that are highlighted in all BMs (Shafer, Smith and Linder, 2005). SE recommends that for strategic choices, social entrepreneurs should define the social objective that is to be achieved, and based on this, select partners that will participate in the value chain. This recommendation was used in the design of the Organizational domain of the STOF model, where partners with the same social objective as the m-Health service innovation were selected to govern and support the service. Corporate social responsibility is also recommended as a strategic choice to enlist support of the service. It is noted that this recommendation was realized in enlisting local partners to support the service. In a value network, strategic partners are also selected based on their expertise and available resources. In SE, these partners may not be available in the developing context. SE recommends that, in this case, entrepreneurs must take this as an opportunity to expand the value network. In our case, this was experienced with governing partners who lacked technical and financial resources to support the service thereby creating an opportunity for the partners to develop

personnel and financial resources to support the value network. Hence, in creating and capturing value, SE recommends that the “consumers” or the target group should be involved in the value creation process. Here, there was application of the recommendation of the service domain where the target group was involved in the design process.

The theories used merged the fields of development and business models and were also considered as appropriate because, (1) they are a state of the art in their respective fields and, (2) they are representative of core concepts that our research problem highlights – understanding of a developing context and the need for rigorous design and evaluation to determine what works and what does not work. This leads to the next section which presents the research objective and research questions that were used to solve the research problem.

1.5 Research Objective and Research Questions

It has been demonstrated that there is a knowledge gap between designers and a rural context when designing ICT4D innovation. In turn, this causes sustainability challenges for not only m-Health service innovations but also ICT4D artifacts in general. The objective of this research was therefore to *design a context-aware model that supports design and evaluation of a viable m-Health service innovation for a developing rural context.*

The research therefore seeks to answer the overall question:

What social, political and economic characteristics in a developing rural healthcare context should designers, development practitioners and policy makers consider when designing a sustainable m-Health innovation for developing rural areas? To answer this question, the research splits into four specific questions that can be summed up to answer the overall questions.

1) *What makes up a developing rural healthcare context in which a mobile service innovation is applied?*

The motivation for focusing our research on rural healthcare has been discussed. The purpose of defining the context was to begin the process of describing a developing rural healthcare context. Furthermore, the domain description provides a generic description of rural poverty, rural healthcare, rural telecommunication and m-Health service innovations applied in developing contexts. This description serves two purposes. The first is that it was later used in the initial livelihood analysis and STOF design and evaluation process. The second is, with a generic description of the context, there is identification of generic variables which can be generalized to similar contexts.

2) *What Rural Development Theory and Business Model tooling are appropriate to support the design and evaluation of a mobile service innovation in a developing rural healthcare context?*

A theoretical framework is essential as a point of reference when describing and defining those unique variables that can later on be used to make up out context-aware model. Earlier, there was an assertion that the theoretical framework must be able to analyze a developing rural context and from that study identify opportunities, challenges and characteristics that will influence sustainability. From the field of Rural Development, there was highlighting of theories that emerged, from which there is justification of the appropriateness of using the livelihood approach to understand a developing rural healthcare context. From the field of business models, we highlight business model tooling. Basing on

the above findings, it can be argued that the case for the STOF framework can best provide criteria to evaluate sustainability of a mobile service innovation.

3) What methods can the research use to understand a developing rural healthcare context while evaluating the viability of a mobile service innovation in the context?

The methodology took into consideration the unique nature of a developing rural context while using a design-oriented approach. To understand poverty from the perspective of the poor, the research used Ethnography. Design and evaluation of the service used Action Design Research. It is argued in the methodology chapter that these two research methods compliment the theoretical framework which present two requirements: (1) explanation and predictability of a poor context and, (2) design and evaluation of service innovation based on the explanation and predictability provided by development theory. Ethnography presents a systematic and scientific approach to describing a poor context and Action Design Research guides the design and evaluation process. The STOF method offers a step-by-step guide to service and business model design operationalizes Action Design Research. Using these three methods, there was identification and evaluation of variables in the context that create or negatively affect social value.

4) What social, economic and political characteristics in a generic developing rural healthcare context might influence the viability of a mobile service innovation?

Chapter 2 defines the makeup of a developing rural healthcare context. Based on this definition, there was an analysis of the context by applying the theoretical framework. Further analysis of the context with Rural Development theory, designed and evaluated a generic mobile service innovation that was later on applied in this case study. The end result of the domain and theory application chapter was (1) a mobile service innovation, (2) an underlying business model and (3) identified variables unique to a developing rural context that might influence viability of a mobile service innovation.

5) What social, economic and political characteristics in a case developing rural healthcare context influence the viability of a mobile service innovation?

This question guided the evaluation of a mobile service innovation in a case study context and then determine if the generic variables identified from literature exist in the case study and the influence they have on the viability of a mobile service innovation. A set of variables were further developed while refining the underlying business model and mobile service innovation.

To answer the above questions the research used a design-oriented approach including design science and anthropology methodology (Action Design Research and Ethnography). In the next section the research discusses the research approach and methodology used to answer the research questions and achieve the research objective.

1.6 Research Approach

This research is design-oriented, using the design process of an m-Health service innovation and its underlying business model to identify stakeholders, social, economic and political factors that influence the viability of the service. The design approach which builds artefacts to solve a problem follows six stages: (1) the first hunch, (2) requirements and assumptions, (3) structural specifications, (4) prototype, (5) implementation and, (6) evaluation (Verschuren and Hartog, 2005). Throughout

these stages a service innovation is designed and evaluated to determine if it solves the problem it was designed for. Kuechler and Vaishnavi (2008) explain that design science uses kernel theory to explain and predict the phenomena or problem that is solved by the artefact, while design theory gives explicit direction on how to build the artefact, or, in our case, a service innovation. During the design process, that is, in the six stages of design, the kernel theory (the livelihood framework) informs design theory (the STOF model). Analysis of vulnerabilities, livelihood assets and structures identifies social value and stakeholders (end-users and partners). STOF uses this information to build the service innovation and its business model – the first four stages of design. STOF then uses the description of livelihood assets and structures and stakeholder to evaluate viability of the service innovation. This leads to the next section that describes the methods used to build and evaluate our service innovation, business model and context-aware model.

1.6.1 Research Methodology

Selection of methods for this research was based on requirements of: (1) the overall objective of the research, and (2), the two theoretical frameworks (Livelihood and STOF) used by the research. The overall objective, designing a context-aware model underpins two requirements: design and context. The presence of a design requirement suggests a design-oriented methodology. Design Science Research (DSR) builds and evaluates artifacts that address existing problems in a context and the artifact extend the boundaries of known artifacts (March and Storey, 2008). DSR methodology uses the six steps that have been highlighted earlier (first hunch, requirements and assumptions, structural specifications, prototype, implementation and evaluation). However, this approach is one dimensional, focusing on the technology, disregarding that artifact design includes technical and context factors (Gregor, Imran and Turner, 2014). Our service innovation, business model and ultimately the context-aware model are shaped by context. It was found necessary to use a design-oriented methodology that is two dimensional in focus: Action Design Research. Action Design Research (ADR) is a combination of Action Research and Design Research. Further, ADR recognizes that the design of an artifact is influenced by the context it is applied and ADR follows four stages in the design process:(1) problem formulation in which the initial design is conceptualized together with all stakeholders in the context, (2) building, intervention and evaluation which uses interactive processes of action and reflection as the service innovation is continuously evaluated, (3) reflection and learning is done parallel to the first two stages and moves the research from situation to a general class of problems, and (4) formalization of learning stage was used to formulate our context-aware model using the design and evaluation variables from reflection and learning stage (Sein et al, 2011).

There is also context which is central to the context-aware model and Livelihood approach. The model is based on identified variables in a specific context that are relevant to the viability of a service innovation and its business model. A case study approach offers the research a strategy that examines a phenomenon in its natural setting / context (Benbasat, Goldstein and Mead 1987). It is also notable that a case study approach is appropriate when a researcher, (1) needs to understand why and how a phenomenon behaves in a context, (2) cannot manipulate the behavior of entities in the context and, (3) needs to identify conditions in the context / setting that are relevant to phenomenon under study (Rowley, 2002). This approach allowed us to identify, and to understand those variables in a rural setting that were unknown to ICT4D design. However, these variables had to be identified together with participants from the context. The livelihood approach advocates for a bottom-up approach in defining a context of poverty by giving power to the poor to define what causes their poverty and what

they use to overcome that poverty. Ethnography in a case study strategy not only supports the identification of variables, but does so from the perspective of the stakeholders (the poor) in the context. Ethnography, a qualitative research methodology, attempts to understand a way of life from the perspective of the native (Eisenhart, 1988). This was especially important for the model that had to define what is of value to the stakeholders while describing conditions that surround them.

Benbasat, Goldstein and Mead (1987) recommend using a single case study if the phenomenon is relatively unknown to scientific investigation. It has already been established the case for the lack of empirical study on rural developing contexts and mobile service innovation focusing on sustainability. A single context case study was therefore necessary to focus the study on identified variables in a rural context that might influence sustainability of a mobile service innovation. However, a case study strategy also involves studying specified dynamics in single settings with multiple levels of analysis (Eisenhardt, 1989). The first level was a developing rural area and its respective health system. A health system includes: (1) a population that it serves, (2) health workers, information, medical products, financing and governance and (3) incorporated programs and processes (Gilson, 2012). Nindye Parish which was the first level of analysis is a rural area in Nkozi sub-county, Mpigi District a central region of Uganda, with an estimated 10.7% population living under the poverty line from a total population of 8,135,500 (UBOS, 2010). Nindye has one public health facility, Nindye Health Centre III that supervises a team of fifty (50) community health workers. Community members access healthcare either from the health Centre or from community health workers. For specialized treatment, patients are referred to Nkozi Hospital in Nkozi-sub-county. Nkozi Hospital in turn supervises Nindye Health Centre III and the two facilities, (Nindye Health Centre III and Nkozi Hospital) and the team of community health workers can be found in any PHC and District Health System structure. Nindye Health Centre III and Nkozi Hospital were also selected for their proximity to Uganda Martyrs University, also located in Nkozi sub-county. Through a NUFFIC funded project and as a requirement for applying the service innovation, Uganda Martyrs University provided the two facilities with access to the Internet via wireless access points to support the mobile service innovation.

The second level includes two SMS service innovations (mTrac and Nindye Health Centre III's FrontlineSMS application) which were used in the study. The first, mTrac, is a Ministry of Health owned solution focused on institutional (governing and donor agency) information needs (data collection and reporting), while the second, using FrontlineSMS developed by kiwanja.net (Banks and Hersman, 2009), focused on a local facility and community informational needs (data collection and reporting, remote healthcare delivery, health education and information inquiry). Using the two service innovations in our selected case context enabled the study to examine all targeted actors including the community, local facilities and related local, national and international institutions in the rural health system that were deemed influential to the value chain of a service innovation.

1.7 Conclusion

The research approach described above places two major activities in the research: design and evaluation. Owing to the fact that the research area is fairly new to the field of ICT4D, the first order of business is to present a generic description of developing a rural area with specific focus on health care. Chapter 2 responds to the first research question by presenting to the research the components of a developing rural healthcare context. The components of our context include a description of: (1) poverty and rural areas, (2) the status of health, (3) the rural healthcare system and m-Health

application that have been applied in the rural healthcare system, and (4) the telecommunication sector. The chapter also highlights characteristics from the context that might influence the viability of a service innovation.

Chapter 3 presents the theoretical framework which responds to the second question by highlighting theories from Rural Development and Business Model tooling and presents the case for the two theories that were used to support the research objective. The chapter based its selection of the livelihood and the STOF frameworks on the two research requirements: (1) explanation and prediction of a developing rural healthcare context and (2) design and evaluation of a mobile service innovation and its underlying business model. The chapter also introduced Social Entrepreneurship to Business Model design. Social Entrepreneurship adopted Business Model logic from a profit-oriented context to a development-oriented context. The chapter further highlights the specific contribution each theory will make to the intended mid-range theory that will emerge.

Chapter 4 responds to the third research question where methods were selected to compliment the theoretical framework. Ethnography compliments the livelihood framework and a bottom-up approach in a study of a given context. The intention was to ensure that the design process is influenced by context. Action Design Research bridges the gap between the context and the design process. The four stages of ADR not only apply context and design stages, but also guide a researcher on learning from the design activities which were formalized into the context-aware model.

Chapter 5 began the design process on paper by applying the theoretical framework to the domain description. Using domain data, reports and literature there was designing and evaluating of service innovation on paper and in the process developed the first version of the context-aware model. Chapter 6 refined the context-aware model with findings from the context. Using the variables discovered in chapter 5, this chapter refines these variables, the relationships between these variables, and the evaluation criteria and therefore refines the context-aware model.

The last, Chapter 7, concludes this thesis, summarizes, and discusses the research questions. Limitations were identified from the theoretical framework and methodology and recommendations were given for these limitations. Lastly, the research contribution to stakeholders is given.

2. Chapter 2. Research Domain

2.1 Introduction

This chapter discusses a developing rural context, with a view that it is from context that designers begin to understand the social, economic and political characteristics unique to a developing rural area, characteristics that are later on evaluated in the design process to determine their effect on the viability of a mobile service innovation. Knowledge of what makes up the rural context provides opportunity to begin the process of understanding what works and what does not work in a rural context with regard to mobile service innovation specifically in the context of healthcare.

The term “Context” is used to mean any information that is used to characterize the situation of an entity which could be a person, place, or object considered relevant in the interaction between a user and an artifact (Dey, 2001). Unique characteristics of rural areas that might influence the interaction between a rural mobile service innovation and rural user are what is sought in a developing rural healthcare context. In defining a rural context the research takes the perspective of poverty and rural areas as economy spaces. Poverty implies a deprivation. As pointed out in Chapter 1, perspectives of what is exactly deprived differs. However, a human development perspective can be adopted in description of poverty in approaching the subject of rural poverty, which shall later be used to analyze Chapter 5 using a livelihood approach.

This analysis begins by presenting the relationship between rural areas and poverty which will then serve as introduction to indicators of poverty currently experienced in rural areas. The discussion will employ (Wiggins and Proctor, 2001) explanation of the nature of rural areas and poverty, then relate the indicators of the poor. This relationship begins the process of describing the poor as healthcare seekers and mobile phone users. Special attention is given to health, and a discussion on vulnerabilities that exist in health and healthcare access. These point to m-Health opportunities in the context that generate social value. Then, m-Health ICT4D artefacts shall be presented as implemented in developing rural areas.

The last section in this chapter discusses the telecommunication sector in Uganda and developing countries. ICT4D are dependent on this sector and the services it offers. There will also be highlights of characteristics unique to Uganda’s telecommunication sector as well as those in developing countries. This is to be followed by a discussion on how these characteristics influence mobile phone end-users, especially rural end-users.

2.2 Poverty and Rural Areas

Halfacree (1993) states that in defining rural areas, location is significant. This is expounded on by Wiggins and Proctor (2001) who explain why rural areas are poorer than urban areas. They begin by pointing out three distinct features of rural areas:

- 1) Relative abundance of cheap land and other natural resources
- 2) Significant distances that lie between human settlements and between the rural areas and the cities

- 3) Average incomes are lower in rural areas than in urban areas.

Whereas it is true that natural resources play a major role in the economic activities of rural communities, agriculture remains a major source of income in developing rural areas (Dercon, 2009). However, it must be noted that the rural sector is becoming increasingly diverse with more rural households engaged in non-farm income generating activities (Rigg, 2006). These diverse activities include, (1) employment which may be agricultural and non-agricultural, (2) self-employment, and (3) remittances from relatives in the city. Increasingly natural resources, especially land and water, are increasingly degraded (IFAD, 2011) and coupled with poor market conditions, rural agriculture operates in a risky environment.

It is also noted that remote locations of settlements usually have poor access to services (economic, social and financial) in addition to poor infrastructure. IFAD (2011) reports on poor roads, water and energy infrastructure, especially in rural Africa. Wiggins and Proctor (2001) explain that towns and cities developed as merchant centres. As trade developed, so did centres of trade, and services to serve the increasing populations. Rural areas that depend on natural resources which are immobile do not experience the same level of activity as merchant trade centres and therefore do not attract service development. It therefore follows that with low production levels and limited access to service and infrastructure, rural households will have significantly lower incomes than urban households. IFAD's (2011) Rural Poverty report puts 70% of the world's poor in rural areas with South Asia having the highest percentage of rural poor (80%), while sub-Saharan Africa has the highest incidence of poverty (60% live on less than \$1.25 a day and over 90% live on less than \$2 a day). The report further describes areas of location, as usually with unfavorable natural resources, poor infrastructure, weak states and market institutions, and experiencing political isolation.

This description of the relationship between poverty and rural areas highlights the generic composition of poor rural areas: (1) land and water which determines income generating activities, (2) remote and sparse populations with limited access to services and infrastructure and (3) limited incomes and earnings. It is necessary to determine the effect these might have on end-users and a mobile service innovation. A mobile service innovation like any ICT4D artifact depends on infrastructure, for instance, electricity and a mobile phone network. Consequently, limited access to these services may affect sustainability. It is however necessary to examine the situation in Uganda where our case study is done.

2.2.1 Country Profile

Uganda, a developing country in sub-Sahara Africa, classified as low-income (International Telecommunication Union, 2009), is landlocked with Kenya in the east, South Sudan in the north, Democratic Republic of Congo in the west, Rwanda in the south west and Tanzania in the south (Uganda Bureau of Statistics, 2010). Similar to many developing countries, majority of the population is rural and so are the poor (IFAD, 2011). It is also in the rural areas that we find the largest percentage of Uganda's labor force and yet earn less than a half of the average income of the urban work force. A summary of the state of poverty is represented in the following Table 2.1.

Table 2.1: Overview of Uganda's economic status

| Generic Information | Data |
|---------------------------------------|--------------------------|
| Size | 241, 000 Km ² |
| Population | 30.7 million |
| Population Distribution | |
| Rural | 85% |
| Urban | 15% |
| Poverty Ratio | 31.1% |
| Poverty Distribution | |
| Rural | 27.2% |
| Urban | 9.1% |
| Labour Force Distribution | |
| Rural | 81.8% |
| Urban | 18.2% |
| Average Monthly Incomes (2380) | |
| Rural | \$93.53 |
| Urban | \$277.31 |

Source: Uganda Bureau of Statistics, 2010; Ministry of Health Uganda, 2010.

This profile as represented above, emphasizes the motivation for development and the need to succeed in ICT4D. More so, Uganda's profile is similar to many developing nations and the challenges they face with poverty. Of concern, is poverty which is caused by a lack of assets, poor education and capacities, limited economic opportunities and disadvantages from social and political inequalities. The primary causes of poverty are vulnerabilities or shocks, for instance, ill health, poor harvests, social expenses or conflict and disaster (IFAD, 2011). A household when faced with one or more of the shocks and does not possess or have access to resources or capabilities to withstand the shocks is likely to fall into or remain in a state of poverty. In the next section we present a profile of the causes of poverty: a lack of, (1) education (2) economic opportunities, and (3) access to public infrastructure and services. Within these, we highlight inequalities between both regions and gender in Uganda and the rest of the developing world. These causes of poverty highlight opportunities and characteristics in a poor rural context that influence a mobile service innovation. Thus after a presentation of various causes of poverty, there is a discussion on the effect poverty might have on a mobile service innovation.

2.2.2 Education and Literacy

It is notable that part of the Millennium Development Goals is provision of universal education, a vision that has prompted governments in developing countries to provide education services at little or no cost to promote enrolment (Gertler and Glewwe, 1990). In many developing countries, there is improvement in primary school enrolment with up to 74% in sub-Saharan Africa and more than 90% in all other developing countries. Secondary school enrolment rate is much lower, (just over 30%) in sub-Saharan Africa. Although there has been an increase in enrolment, the quality of education has remained poor. There is also inequality in access to education between rural and urban areas and between genders (IFAD, 2011; Murray, 2012). There is a strong co-relation between education and poverty. Studies indicate that households and individuals with limited levels of education earn lower wages than those with higher education. For instance, studies indicate that individuals with primary level education earn double the amount of wages as those without any education, whereas those with secondary education earn even more (Wedgwood, 2007; Rolleston, 2011). Access to education in

Uganda is similar to most developing countries as Table 2.2 indicates, that at least half of the rural population in Uganda does not have access to universal education though the government has made it free at primary level. For an impoverished society, private education is an option. Access to secondary school facilities is at a lower level even.

Table 2.2: Access to Education facilities

| Educational Facilities in Rural Uganda | Percentage of communities reporting existence of at least one of the facilities present |
|---|--|
| Government Primary Schools | 49.4 |
| Private Primary Schools | 32.1 |
| Government Secondary Schools | 5.7 |
| Private Secondary Schools | 14.0 |

Source: Uganda Bureau of Statistics, 2010: pg. 17

From the above Table 2.2, it is evident that access to education affects literacy levels. Below, is Table 2.3 which presents the levels of education found in rural Uganda. Inadequate education infrastructure means that literacy levels are also inadequate. In turn, illiteracy deprives one of his / her ability to realize their full potential, hinders effective decision-making and economic activities (Uganda Bureau of Statistics, 2010). Literacy levels achieved by most rural dwellers in Uganda may allow them to read and write in any language, but their education knowledge remains inadequate to enable them achieve greater advantage, considering the fact that most have received only primary school education.

Table 2.3: Literacy levels in rural Uganda

| Levels of Education Attained | Percentage of rural population to attain level of education |
|-------------------------------------|--|
| No formal schooling | 19.7 |
| Primary Level | 56 |
| Secondary Level | 21.1 |
| Above Secondary Level | 3.3 |

Source: Uganda Bureau of Statistics, 2010: pg. 17

In turn literacy and education levels affect ICT use. In telecentre evaluation studies, research indicate that, while telephone voice services are widely accepted, computer related services were only used by those with secondary school education and higher (Gómez, Hunt and Lamoureux 1999; Parkison, 2005; Kari, 2007). These studies reveal that secondary and higher education users had more confidence in attempting to use this new technology. In cognitive skills and knowledge acquired, reading and writing is done in local languages, thus content on the Internet was irrelevant to rural users. Kari's research went further to suggest that the traditional oral means of communication influence channels used to communicate and access information. Written means of communication are deemed fit for the elite, and that limited levels of education affected the individual's ability to comprehend and use a piece of information. In effect, Kari's argument rules out the use of most modern technologies like computers that depend on an individual's ability to search for, read, comprehend and use information independently (2007). This has been described as, functional illiteracy – the inability for people to use modern technology in a modern society (Herselman, 2003).

The significance of the literacy gap between men and women is indicative of ICT use along gender lines. Studies have shown overtime the exclusion of women from ICT access (Dlodlo, 2009; Gillwald, Milek

and Stork, 2010), and, although national statistics do not indicate income levels between individual men and women, there is a gap between monthly household incomes headed by women and those headed by men – \$101 for men and \$73 for women (Uganda Bureau of Statistics, 2010: pg. 94). It is not clear how a context with users that are predominately illiterate will respond to a mobile service innovation. It is true that voice communication among poor community members is widely accepted but it unclear how they respond to, for instance, the SMS platform.

2.2.4 Rural Infrastructure

Rural infrastructure includes roads, electricity, and communication as items important for economic development (World Bank, 2013; Cruz et al, 2015). The IFAD (2011) report explains that, to improve economic opportunity for rural areas, there must be an improvement in investment of infrastructure. World Bank estimates that Africa’s growth rate is reduced up to 2% every year because of poor infrastructure (2013). In Uganda, the most commonly available roads to rural communities are feeder roads, best used by pedestrians, bicycles and motorcycles. Public transportation facilities within the communities are the least available and are limited to highways. Hanjra, Ferende and Gutta (2009) argue that better access to road infrastructure enables better access to markets, educational and health service. Poor infrastructure not only limits access to healthcare, but hinders agricultural growth output since access to food markets are hindered and thus creates lost income opportunities (2009),hence, a direct impact on household poverty (Jacoby, 2000). Table 2.5 below presents the type of roads rural communities’ access in Uganda and demonstrates the poor state of public infrastructure which in turn contributes to poverty.

Table 2.5: Community access to transportation facilities

| Regions outside Kampala | Only dry season feeder roads | All season feeder roads | Trunk road (murram / dirt road) | Trunk road (Tarmac) | Bus stop | Taxi/Matatu stop | Railway stop |
|-------------------------|------------------------------|-------------------------|---------------------------------|---------------------|----------|------------------|--------------|
| Central | 61.1 | 94.2 | 41.1 | 33.6 | 21 | 47.2 | 3.6 |
| Eastern | 85.7 | 86.7 | 38.4 | 11.3 | 17.4 | 33.7 | 0.5 |
| Northern | 85.2 | 82.1 | 50.5 | 5.9 | 13.3 | 22 | 1.5 |
| Western | 93.9 | 65.2 | 34.9 | 10.8 | 16.8 | 33.7 | 0.3 |

Source: Uganda Bureau of Statistics, 2010: pg. 156

It is important to notice that of all facilities and services so far presented, voice telephony is the only service that has almost achieved 100% coverage within rural communities. Impact studies have not been done in Uganda, however, respondents in a study that sought to determine factors that can lead a household from poverty cited the significance of accessing reliable information in Indian villages. The study went further to conclude that it takes a combination of factors, any or all of the above to push and keep an individual or household into poverty, which may be endured by generations (Krishna, 2003). The following Table 2.6, presents public communication services available to rural Uganda. These include mobile and fixed telephone services.

Table 2.6: Community access to communication facilities

| Regions outside Kampala | Post office | Telephone services |
|-------------------------|-------------|--------------------|
| Central | 10.1 | 80.4 |
| Eastern | 2.2 | 77.1 |
| Northern | 3.4 | 19.7 |
| Western | 4.2 | 84.7 |

Source: Uganda Bureau of Statistics, 2010: pg. 157

Apart from the fact that poor infrastructure curtails economic growth in rural areas and therefore income levels, it also directly affects mobile service innovations and their sustainability. In some cases, lack of access to electricity raises telecommunication costs (Dada, 2006). In other cases, it is difficult to charge mobile phone devices (Blynn, 2009). A mobile service innovation that targets poor end-users might face challenges of high operational costs, as well as maintenance costs.

The discussion points to challenges that might arise from the context and is sensitive to appropriate technology selection in the design process. However, from the perspective of sustainability, all these characteristics discussed must be analyzed in the context of development and business models to understand their effect on viability of a mobile service innovation. In the next section, there is discussion of the status of health in developing rural areas. Vulnerabilities that cause ill health and are catalyst to poverty are identified.

2.4 Health

“A child born in Niger today is 40 times more likely to die before her fifth birthday than a child born in the United Kingdom. A 15-year-old boy in Swaziland has only an 18% chance of celebrating his 60th birthday; if he had been fortunate enough to have been born in Switzerland, he would have a 91% chance. A young woman in Uganda is 300 times more likely to die in childbirth than her sister in the United States” (Sekhri, 2009: pg. 5).

Health or ill health is one of the shocks this research has pointed out earlier that also drive households and individuals into poverty (IFAD, 2011). The relationship between health and poverty is multidimensional. Deprivation leads to ill health, and may be at household or user level. A poor household may not possess capabilities to attain health or healthcare. The healthcare system may as well fail to provide accessible or affordable healthcare to the population it serves (Peters et al, 2008). In the following sections we shall present the contexts of disease burden and healthcare systems in rural areas. Finally, from these contexts, the characteristics that may influence a mobile service innovation will be identified.

2.4.1 Disease Burden

Rural communities in Uganda have to deal with an overwhelming disease burden, which is measured in DALYs, which is, the number of years of healthy life lost by virtue of being in a state of poor health or disability. The total disease burden is therefore the expected sum of current and future DALYs resulting from all incident cases of disease in a specific time period, taking into account lifetime probabilities of moving to each disease state (Havelaar, Kemmenen and Kortbeek, 2007; WHO, 2011). It is noted that Africa’s disease burden is highest among developing and other regions as Table 2.7 below presents figures of disease burden according to regions.

Table 2.7: Disease Burden by Region

| Region | Disease Burden |
|-----------------------|----------------|
| Africa | 511 |
| Eastern Mediterranean | 273 |
| South-East Asia | 265 |
| Europe | 171 |
| Americas | 164 |
| Western Pacific | 152 |

Source: WHO, 2011

Further discussion on the disease burden is predominately comprised of communicable diseases that include malaria, HIV/AIDS, tuberculosis and diarrhoea, diseases found in Africa. Table 2.8 below presents the types of diseases common to Africa and their percentage in the disease burden.

Table 2.8: Leading causes of Africa's Disease Burden

| Disease | Percentage in the total DALYs |
|----------------------------------|-------------------------------|
| HIV/AIDS | 12.4 |
| Lower Respiratory Infections | 11.2 |
| Diarrhoea diseases | 8.6 |
| Malaria | 8.2 |
| Neonatal Infections and others | 3.6 |
| Birth asphyxia and birth trauma | 3.6 |
| Prematurity and low birth weight | 3 |
| Tuberculosis | 2.9 |
| Road Traffic Accidents | 1.9 |
| Protein – energy malnutrition | 1.9 |

Source: WHO, 2011

In addition to the above outlined causes of Africa's disease burden, developing communities are also affected by a category of diseases referred to as Neglected Tropical Diseases that include 13 parasitic and bacterial infections. These include: ascariasis, hookworm infection, trichuriasis, lymphatic filariasis, onchocerciasis, dracunculiasis, schistosomiasis, Chagas disease, human African trypanosomiasis, leishmaniasis, Buruli ulcer, leprosy and trachoma (Conteh, Engles, Molyneux, 2010; WHO, 2011).

Sekhri (2005) identifies five sources from which disease may emerge: (1) genetics, (2) environment, (3) social economic factors, (4) behavior and (5) health systems. The tropical climate that Uganda and most developing nations experience is a catalyst in increasing the poor's disease burden. Tropical climates experience "wet season" or rainy season and "dry season". The wet season is characterized by an increase in infection of diseases like malaria and diarrhoea. This is also the time households are expected to plough their gardens for the next planting season while food from the previous harvest has run out. This implies that households are at a high risk of infection whereas they are expected to carry out strenuous work with limited food supplies (Chambers, 1982). Health seekers also opt out of seeking healthcare due to long geographical distances between them and health facilities. Poor roads already discussed exert a strain to health seekers in terms of cost, effort and time, a situation that may

increase health risks especially as it results in diseases not being attended to (Peters et al, 2008). The disease burden is made up of preventable diseases. For instance, malaria prevention starts at household level and can be prevented by spraying insecticides and using insecticide treated nets (Sekhri, 2005). It is noted that health practices depend on awareness and increase in healthcare knowledge, which could eventually create behavioral change at household level and therefore reduce disease infections.

Of significance is the fact that most diseases are preventable, yet a number of households may not possess knowledge to prevent infections. Household members may also not possess adequate incomes to purchase resources that can prevent infections. Therefore, in addition to the initial three characteristics, (1) illiteracy and functional illiteracy, (2) low incomes and earnings and (3) poor infrastructure, inclusive is, the fourth characteristic, (4) limited knowledge on healthcare practices.

In the next section 2.2.3, there is discussion on the healthcare system found in developing rural areas. There is also an analysis and profile of the healthcare system, the strengths and weaknesses that help to identify characteristics that might influence a mobile service innovation.

2.2.3 Rural Economy

A rural economy includes farming and non-farming income generating activities (Atchoarena and Gasperini, 2003). This implies that land and water bodies, such as lakes and rivers as natural resources are often available in rural areas. It makes sense for rural communities to use these “spaces” for “economic” purposes because they are widely and freely available. Because community members are highly unskilled due to limited levels of education, they are only employed as farm laborers, either on their own farms or on the farms of others. Earnings are low and households diversify their income generating activities to reduce poverty related risks such health or financial constraints (Reardon, 1997; Wiggins and Proctor, 2001). In most countries, agriculture drives the non-farming activities.

In the case of Uganda, 81% of the rural population are engaged in paid employment. And 60.4% of these are employed in agricultural and fisheries industry. Table 2.4 below presents a profile of the working population in Uganda’s rural areas and the percentage of that population that diversifies their income generating activities. Earlier in this chapter, it was pointed out that average household incomes stood at \$93.53. Household consumption patterns indicate that the largest portion of the household income is spent on food. In relation to the profile given above on the work patterns of the rural poor, the term subsistence livelihoods begins to take shape here. 50.4% of those engaged in agricultural activities are actually subsistence farmers.

Table 2.4: Working population in rural areas

| Description | Percentage |
|--|------------|
| Working population (15 - 64) | 81 |
| In the agricultural and fisheries | 60.4 |
| Of which are subsistence farmers | 50.4 |
| Working population with multiple jobs | 31.3 |
| Skilled labour | 25 |

Source: Uganda Bureau of Statistics, 2010

Dercon (2009) supports the fact that poverty is more in rural areas when he states that, “ if you picked any poor person in the world today, that person is most likely living in rural areas and is a farmer.”

Limited income levels also determine the choice of channel to use to communicate and communication behavior. Studies in ICT use and access in developing countries and specifically in rural areas have found a pattern that suggests opting for services (telephony, radio and television) that are relatively cheaper from the array that have been made available to them (Gómez and Hunt, 1999; Parkison, 2005; Kari, 2007; Gillwald and Stork, 2008). Users have even adopted multiple communication strategies, selecting from different services to communicate. For instance, mobile phone users were found to use public payphone because the rates of charge are lower than mobile phones (Gillwald and Stork, 2008: pg. 5). Low incomes and earnings influence adoption of a service innovation. Cost implications of a mobile service innovation must be examined to determine their influence on the value the service offers. Consequently, the limited incomes also determines the type of mobile phone devices they possess, and access to will determine the platforms on which a mobile service innovation must use to enable accessibility for users.

2.5 Rural Healthcare System: Structure and Composition

A health system is a means to achieve improved health through organizing, financing and ensuring the quality of health services. It comprises three components: (1) the population the system serves, (2) the building blocks that include service delivery, health workforce, information, medical products, financing and leadership / governance and (3) incorporated programs and processes (curative and preventive services, disease control programs, service delivery channels and a mixture of service providers) (Gilson, 2012). Braa et al (2007) describe health sectors in developing countries as consisting of a number of institutions ranging from small facilities to large hospitals. They describe these institutions as managed by institutional bodies organized into geographic areas (district, province, nation), according to vertical programs (HIV, maternal health, vaccination) and services (primary health care, hospitals, laboratories and drug supply). They also state that healthcare programs are influenced at national level by international donor organizations and the World Health Organization (WHO).

Further, to understand the composition of health systems in developing countries, we begin with the Primary Health Care approach. Primary Health Care (PHC) was first undertaken by WHO and UNICEF in the 1970s, and was formally adopted by all WHO member countries in 1978. A PHC approach aims at providing universal basic services through preventive, curative and health promotion programs. These programs usually include, (1) education on prevention and control of prevailing health problems, (2) promotion of food security and proper nutrition, (3) safe water supply and basic sanitation, (4) maternal-child health including family planning, (5) immunization, (6) prevention and control of locally endemic diseases, (7) appropriate treatment of common diseases and injuries and (8) provision of essential drugs (Hall and Taylor, 2003). PHC is delivered through a District Health System that was developed after it was realized that PHC was mainly made up of primary and community level activities, but lacked an organizational structure. Thus, the District Health System provides primary level facilities and community health workers who deliver integrated preventive and curative services with active participation of the community in a defined population. The facilities and community health workers are under the supportive supervision of a district hospital and health management team. A District Health System includes a referral system where healthcare workers will refer patients to higher-ranking facilities for treatment. The referral system at the village level all the way to the district level (Segall, 2003). Figure 2.1 illustrates the structure of the District Health System.

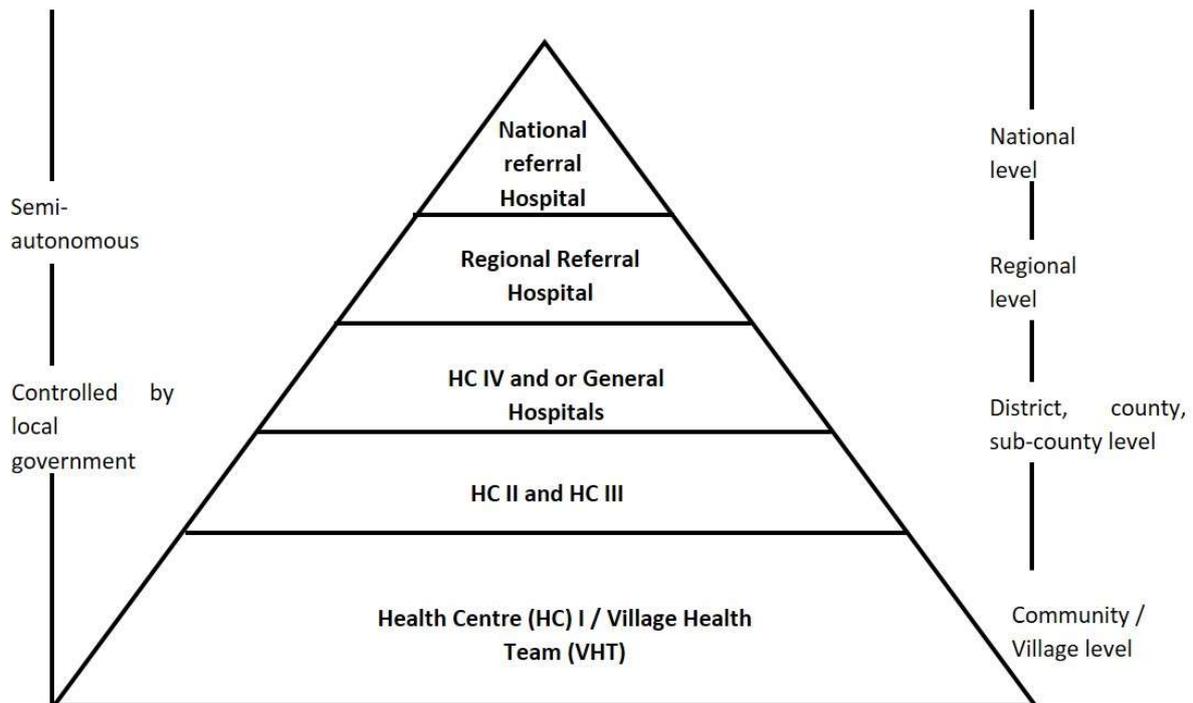


Figure 2.1: District Health System (Source; Research)

The above figure shows a structure designed to provide channels of outreach into remote communities of rural areas at household level. Health Centre I / Village Health Teams (VHTs) at the lowest level are ideally a team of health workers without physical facilities but have access to villages, communities and individual households. They act as a point of first contact as well as providing follow-up visits. Health Centre IIs provide mostly out-patient services and may have a registered nurse available. Health Centre IIIs and IVs provide basic preventive, health promotion and curative care and if equipped, Health Centre IVs will act as a referral Centre. The regional and national hospitals are references for specialized treatment, consultation and research (Ministry of Health, 2010). Limited resources, human and material, and limited infrastructure limit services available. In addition, VHTs have been established in 75% of the total country districts, but only 31% have fully trained VHTs in all villages (Ministry of Health, 2010: pg. 5).

Within a health system, we find a mixture of providers. The International Finance Corporation (2008) reports that due to limitations in public healthcare provisions, private healthcare providers move in to fill in the gaps in the healthcare systems. These include Private Not for Profit (PNFPs) and Private profit-oriented health facilities. PNFPs are NGO institutions that are either secular or religious founded. Although PNFPs, especially religious founded providers have existed in developing nations' health sectors, it was not until the 1980s sector reforms that there was a configuration in the relationship between public sector healthcare and non-state providers. Health services from faith groups started as part of missionary movements. In the 1960s, national coordination bodies – Religious Health Associations - were developed. In Uganda, these umbrella organizations include Uganda Catholic Medical Bureau (UCMB), Uganda Protestant Medical Bureau (UPMB), Uganda Orthodox Medical Bureau (UOMB) and Uganda Muslim Medical Bureau (UMMB). These organizations facilitate dialogue between PNFPs and government at policy level and in negotiation for funding (Green et al, 2002). Table 2.9 below includes a summary of the private practitioners in sub-Saharan health systems. There is also the presence of the informal sector including traditional practitioners, traditional healers, and traditional birth attendants (International Finance Corporation, 2008).

Table 2.9: Health facilities in sub-Saharan Health Systems

| | Primary financial goal | Financing/Capital | Charge for services/products |
|---|---|---|--|
| Private Health Practitioners (PHP) | Generating a return on investment | Market-rate | Market-rate |
| Social Entrepreneur | Entrepreneurial, income-focused strategies with a minimum expectation of financial return Reinvestment of profits in enterprise activities | Range of market-rate capital, below-market capital, or mix of donations and market-rate capital | Range of market-rate prices, subsidized rates, or mix of full payers and those who pay nothing |
| PNFP/Non-profit/ NGO/ Faith-based organization | Rely on donor support to carry out social missions | Donations and grants | Beneficiaries make minimal or no payments |

Source; International Finance Corporation, 2008: pg. 7

In an environment that includes the contracted private sector as partners with government in healthcare delivery, Uganda’s healthcare system is headed by the Ministry of Health (Ministry of Health), which takes on the responsibility of overall strategic planning, monitoring, evaluation and standardization (Ministry of Health, 2010: pg. 3). In response to WHO guidelines (WHO, 2010: pg. 44; Ministry of Health, 2010: pg. 2), government has devised a strategy referred to as the minimum service delivery package – Uganda National Minimum Health care Package (UNMHCP) which has been developed for both the public and private providers to ensure efficient and effective service delivery with limited resources (Ministry of Health, 2010).

Notably, financing in the health system comes from varying sources that include: (1) government spending (23%), (2) external sources (including loans and grants, 21%), (3) out-of-pocket (48%) and (4) other private spending (8%). Governments also vary on where they spend healthcare funds. Some spend on broad primary healthcare programs, for instance Zambia, while others disproportionately fund hospitals and institutions in urban areas at the expense of rural facilities for example, Rwanda, Kenya and Ghana (Sekhri, 2005). Although most of the sub-Sahara’s population is served by private practitioners (up to 60% in some countries (International Finance Corporation, 2008)), health seekers also spend in public health facilities, especially in under the table payments to staff and for resources, such as, syringes that should be available in facilities but are lacking due to poor supply and governance (Segall, 2003; Sekhri, 2005).

2.5.1 Quality of healthcare in Developing Countries

It has been advanced that healthcare services for poor rural communities in sub-Saharan countries remains largely inaccessible (Peters et al, 2008). In a multi-country study in Africa which included Uganda, more than two thirds of the study’s respondents rated the government health facilities as inadequate in the quality of service they deliver (World Health Organization, 2012). This is probably why (Trani et al, 2010) in their analysis of the poor’s choice of provider in rural Afghanistan noted a multi provider access strategy with a higher preference for private providers including private clinics, small pharmacy shops and traditional healers. Unfortunately, this puts a strain on the poor’s meager funds. Sekhri (2005) reports that some individuals and families are further driven into poverty because of high out of pocket expenditures on healthcare. On the other hand, some health seekers resort to

the informal sector (International Finance Corporation, 2008). Trani et al (2010) reveals that the informal providers usually offered what they perceived as cheaper services, although modern medication was the preferred alternative.

Further analysis reveals that the private sector in sub-Saharan Africa is however highly unregulated (Sekhri, 2005). Although PNFPs work closely with the public sector and within the PHC programs, most private providers are autonomous and the sector is fragmented. The result is sometimes delivery of poor and inconsistent services (International Finance Corporation, 2008). PNFPs, especially those that are religious founded have developed relationships with governments through their Religious Health Associations, particularly on policy and funding negotiations (Green et al, 2002).

Analysis of Literature on work-environment of rural healthcare facilities in Africa also indicates an overworked, under-resourced and understaffed context (Gladwin, Dixon and Wilson, 2003; Mecheal, 2009). Of concern, Africa has one of the lowest levels of resources and personnel in healthcare in comparison to other regions as well as health worker to population ratios. Table 2.10 below presents percentages of expenditures on health according to 2007 GDPs. As a result, the health workforce in the health system, especially those in the public sector is demotivated. It is also of concern to note that Unprofessional behaviour and absenteeism contributes to poor quality healthcare services, which in turn contributes to inaccessible services (Peters et al, 2008).

Table 2.10: Financial Resources and Personnel Distribution

| Region | Percentage of GDP Expenditure | Physician per 10,000 population | Nursing and midwifery personnel per 10,000 population | Hospital beds per 10,000 population |
|------------------------------|-------------------------------|---------------------------------|---|-------------------------------------|
| Africa Region | 6.2 | 2 | 11 | 9 |
| South East Asia Region | 3.6 | 5 | 11 | 11 |
| Eastern Mediterranean Region | 4.1 | 10 | 14 | 12 |
| Western Pacific Region | 6.5 | 14 | 21 | 38 |
| European Region | 8.8 | 33 | 68 | 63 |
| Region of the Americas | 13.6 | 23 | 55 | 24 |

Source: WHO, 2011

2.5.2 Poor Reporting Systems

WHO (2010) describes health information systems in developing countries as weak. These are reported to be highly fragmented and not fully utilized (WHO, 2011). Braa et al (2007) give a possible explanation for the fragmentation. Earlier, it was revealed that institutions in the health sector are managed by a number of geographically organized bodies and vertical programs, such as HIV/AIDS, maternal health and vaccinations, and services, such as PHC, hospitals, laboratories and drug supply. There are International donor agencies and WHO that support these programs and health information systems that report on these programs and services (Gladwin, Dixon and Wilson, 2003). Although the organizational structure earlier demonstrated in figure 2.1 and at policy level implies and requires local and integrated health information, this is not the case. Programs and services are independent, with each maintaining vertical and uncoordinated reporting systems. For instance, reporting on a program

on HIV/AIDS may occur alongside the PHC service while both may collect the same data. As a result of the fragmentation, there is duplicated data collected by different programs and in some cases there are gaps where important information is not collected.

2.6. Opportunities and Challenges in the Context

The descriptions profiling poverty and rural areas, education and literacy levels, the rural economy and rural infrastructure highlight challenges that need to be examined in relation to mobile service innovations. Also, education and literacy levels have challenged computer based ICT4D solutions as they pose challenges to mobile service innovations. While it is true that low incomes prevent access to basic services and may as well prevent end-users from accessing mobile service innovations. Poor public infrastructure, such as electricity may challenge the operations of a mobile service innovation. However, opportunities also arise from the wide spread penetration of mobile services into poor rural communities. This creates increased opportunity to access for rural end-users.

Other Profiles on the poor communities' state of health and the healthcare system raises both opportunities and challenges. There is high disease burden which indicates a development need. However, the profile reveals socio-economic characteristics that might be a catalyst in the high disease burden. Prominent is evidence of lack of knowledge on healthcare practices. Inefficiencies highlighted in the health system profile are potential development needs, specifically, the poor reporting systems. It is especially noted that existing m-Health innovations have attempted to address these opportunities. These include: (1) behavioral change applications especially on HIV/AIDS health education, (2) health promotion application on disease prevention, (3) drug adherence reminders such as, for TB patients, (4) disease surveillance applications, for instance, tracking malaria infections and treatment and, (5) drug supply and stock outs in health facilities (Patil, 2011; Asiimwe et al, 2011). It is evident that each application type targets a challenge and need in the health system. For instance, health promotion and health education targets preventive and health promotion objectives of the PHC structure. Drug adherence and disease surveillance applications target specific diseases that are rampant in the disease burden of developing countries and drug supply reporting systems keeps track of a scarce resource while improving on reporting and data collection.

However, challenges raised in the discussion can influence the sustainability of a mobile service innovation. Amongst these includes financing. This implies that health systems that are largely dependent on out of pocket payments from an impoverished population may not be able to financially sustain a mobile service innovation. Poor governance of public funds is also a threat since it does not guarantee availability of public funding for a mobile service innovation. Donor funding usually targets investment and pilot programs and does not cover recurring costs (Sekhri, 2005). Poor working conditions and understaffing threaten institutional support for the mobile service innovation. The question arises of who will operate the service innovation if staff who run the day-to-day health services are not available? Demotivated staff may also fail to support the service innovation, especially if they do not perceive that it adds value to their already poor working conditions. Yet, fragmented reporting may cause poor integration of systems. If m-Health service innovations are especially targeting improved data collection but there are no clear standards on what should be collected and by who, then the m-Health service innovation may simply be applied to a chaotic context, as (Lucas, 2008) argues.

2.6.1 m-Health Service Innovations in Poor Contexts

There are six application areas for m-Health service innovations in developing countries : (1) education and awareness which use SMS messages to educate people on health issues, for instance, HIV/AIDS prevention and treatment, (2) remote data collection especially on remote populations and communities that do not visit hospitals, (3) remote monitoring where patient conditions are monitored, maintain appointments and medication regimen adherence for example, for TB patients, (4) disease and epidemic outbreak and tracking innovations that follow pockets of outbreaks for instance, cholera before they become epidemics, (5) communication and training for health workers applications that focus on capacity building for resource shortages in developing countries health systems and improving communications between health facilities and (6) diagnostics and treatment support which focuses on providing advice to remote health workers from medical information databases or remote medical professional (Vital Wave Consulting, 2009). Table 2.11 presents some of the m-Health service innovations created, the areas they focus on, and some of the projects that are responsible for the development of some of these artifacts. Some innovations may use SMS, for instance, Text to Change uses an SMS quiz to test users on HIV/AIDS knowledge. Others may use voice, for instance, in Thailand, health workers call TB patients to remind them to take their medication. Some data collection innovations use specialized software that generate forms, for instance, the AED SATELLIFE project in Uganda. However, there exists service innovations that have used SMS platform, such as FrontlineSMS and RapidSMS to collect field data as well (Vital Wave Consulting, 2009; Mechael et al, 2010).

Application levels of these innovations include : (1) large geographic populations, for instance, disaster and emergency services, and health promotion and disease prevention, (2) communities which can include specialized groups like healthcare workers or targeted vulnerable or special interest groups in society, and (3) individuals including healthcare workers that are transmitting data from remote facilities, health providers to specific patients like HIV/AIDS and tuberculosis (Kahn, Yang and Kahn, 2010).

Table 2.11: Examples of m-Health Applications in developing countries

| Area of Application in healthcare | Details | Mobile service innovation and country of implementation |
|-----------------------------------|--|---|
| Remote monitoring | Artifacts focus on using text messaging and voice to remind patients on continuous treatment to take their medication periodically or about scheduled appointments. These are usually HIV/AIDS and Tuberculosis patients. However some are using voice, web browsers, and health hotlines Mobile phones are also used to track down counterfeit drugs | <ul style="list-style-type: none"> • TracNet in Rwanda used to follow-up patients and their treatment • m-Pedigree in Ghana used to identify and reduce counterfeit drugs (Mechael et al, 2010) |
| Remote Data collection | Artifacts are used by health workers in remote health facilities or areas to send reports and disease outbreaks in areas | <ul style="list-style-type: none"> • Asia Media (India). • EpiSurveyor (Kenya, Malawi, Tanzania, Zambia, India, Pakistan, Phillipines, Nicaragua, Brazil, Indonesia). |

| | | |
|--|--|---|
| | they operate. Artifacts use SMS, voice, and electronic forms | <ul style="list-style-type: none"> • Personal Data Collection Toolkit (PDCT) (South Africa) • RapidSMS (Uganda) • Frontline SMS (Uganda)(Curioso and Mechael, 2009) |
| Education and awareness | Artifacts use SMS to promote health behavior although Asia Media in India is attempting to use gaming. Areas of focus are usually HIV/AIDS and on-going healthcare exercises like the cleft palate surgery for children in South Africa. | <ul style="list-style-type: none"> • The Masiluleke project in South Africa • mDhil in India • Text-to-Change in Uganda. (Mechael et al, 2010) |
| Disease and epidemic outbreaks | Emergency and disasters are reported either using SMS, social networking or Voice. | <ul style="list-style-type: none"> • Ushahidi in Kenya first used in the post-election violence in 2008 as a platform for people to tell their stories, but can be used for epidemic mapping by health facilities. • Innovative support to Emergencies, Diseases and Disasters (in-STEDD) for group communication (Curioso and Mechael, 2009) |
| Communication and training for health workers | Communication among health facilities and to health workers that use a combination of mobile phones, landlines and tele-writers | <ul style="list-style-type: none"> • The National School for Nurses in Coban Guatemala (Vital Wave Consulting, 2009) |
| Diagnostics and Treatment support | Specialized software that allows a health worker to search a database or send symptoms to remote medical professionals for advice | <ul style="list-style-type: none"> • Diagnostic and analytical tool developed by researchers in University of Melbourne (Vital Wave Consulting, 2009) |

When the m-Health service innovations that have emerged from developing contexts are examined, several points stand out. The first is that, service innovations are designed to support objectives and challenges in healthcare systems of developing nations, for instance, education and awareness attempts to address the need for prevention, a primary objective of PHC. Remote monitoring data collection, communication and training and diagnostics and treatment all attempt to address challenges that arise from geographical distances between rural areas and service centres and limited resources and personnel in the healthcare system. The second point that, service innovations that target community end-users are limited to either SMS or voice platforms while those applications that target healthcare workers may use specialized software and devices. Thus, characteristics of applications highlights opportunities for value creation in rural healthcare. However, this will be determined from the theoretical analysis in chapter 5. In the next section, we describe our case. it is therefore evident that this research needs a context with similar characteristics as described above.

2.7 Case Study Area

The case study area, Nindye Parish, is located in the central region of Uganda and possesses all the major characteristics that have been identified in rural contexts. The population of Nindye is poor, with a corresponding poorly facilitated public healthcare infrastructure. Within the primary healthcare structure of a rural area, community members access healthcare up to four levels of the structure before they are referred to facilities outside of their locality. These levels include Health Centre I operated by Village Health Teams (VHTs), Health Centre II and III operated by medical personnel and Health Centre IV and a hospital for more specialized services (Segall, 2003).

Nindye has a total of fifty (50) VHTs with four or five attached to each of the 12 villages of Nindye. These are also the first point of contact between community members and the healthcare system. The parish does not have a health Centre II and therefore the next level of access for the parish communities is the Nindye Health Centre III. This Centre is supervised by Nkozi Hospital which also serves as a Health Centre IV and a private, not-for-profit (PNFP) healthcare facility that also provides subsidized healthcare services to Nindye community members and Nkozi Sub-County as a whole. Figure 2.2 is a map of Nkozi Sub-County and includes social infrastructures found in the area

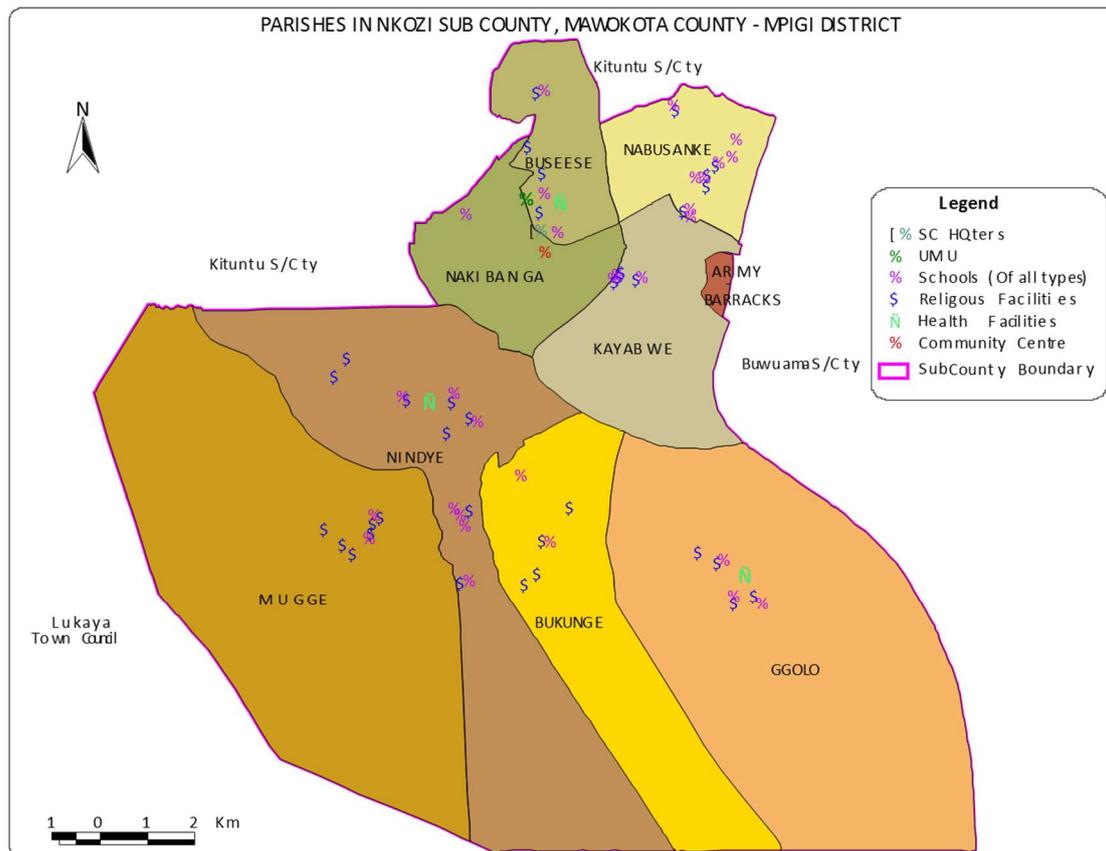


Figure 2.2: Nkozi Sub-County Map (Uganda Bureau of Statistics, 2012)

Nindye is located in the central region of Uganda, a predominantly rural area, though not the poorest in Uganda, indications of poverty are high. Only 9.1% of the region's population has received tertiary education, only 22.7% of the economically active portion of the population is engaged in paid

employment. Table 2.12 below provides a statistical profile of the region’s levels of poverty, disease prevalence and access to assets and infrastructure to enable mobile service use while Table 2.13 presents a profile of Nindye.

Table 2.12: Profile of Central Region (UBOS, 2010)

| General Information | Data |
|---|-----------|
| Population Size | 8,135,500 |
| Literate Population | 81% |
| Working Population | 22.7% |
| Population depending on subsistence farming | 61.6% |
| Disease Prevalence | 45% |
| Population Living below the poverty line | 10.7% |
| Households with access to Electricity | 19.9% |
| Households with a mobile phone | 56.1% |

A 2008 survey of Nindye parish on 301 households, by Wilsken Agencies, describes Nindye Parish as one of the eight parishes in Nkozi sub-county, made up of twelve villages. The parish has 6 primary schools and 2 secondary schools, one government health Centre III and five private clinics / drug shops. There is one government health Centre III (Nindye Health Centre III) that provides outpatient care, antenatal care, and immunization and community outreach services.

81% of the community members are engaged in farming activities and identify this as the main source of income. Although about 71% of the community members are literate, majority have only a primary level of education (86%). The age demographics indicate a pyramid structure in age distribution with the majority of the population (58%) are 19 and below, 26% are between the ages of 20 and 44, and 16% are 45 and above. 15% of households have a mobile phone. Table 2.13 presents a profile of Nindye Parish (UMU and Wilsken Agencies, 2009; Isgren, 2012).

Table 2.13: Nindye Parish Profile

| General Information | Data |
|---|------|
| Predominant Economic activity (agriculture) | 81% |
| Literate Population | 71% |
| Primary Education as the highest level of education | 86% |
| Percentage of households with a mobile phone | 15% |

The statistics above highlight that Nindye’s population is rural and poor. Nindye’s economy is predominately agricultural with a poor healthcare system. These characteristics are similar to those described in the poverty and rural areas in section (2.2). This is significant because we can relate our case study findings based on the similarity between the case and most developing rural contexts (Gibbert, Ruigrok and Wicki, 2008; Seawright and Gerring, 2008).

In the next section, there is a discussion about the telecommunication sector in rural areas. Although the sector is part of a developing rural area, it however operates in a different sector (private) from the health system (public). The research discusses the industry structure and infrastructure, technologies available and market demand.

2.8 The Telecommunication sector: Regulation and Liberalization of the market

For most developing countries, especially sub-Saharan Africa, telecommunication sectors are a result of a colonial and post-colonial state monopolies and a period of reformation during the 1980s – 1990s. State-owned monopolies were inefficient and failed to keep up with technology developments. It was believed that liberalizing the sector would introduce competition and investment (most of which is foreign) and therefore achieve universal coverage while improving service delivery (Shanmugavelan and Warnock, 2004). Liberalization was accompanied with independent regulation of the sectors. The regulator is supposed to: (1) contain abuse of market power, for instance, from high prices and poor service quality, (2) foster competition, for instance, by removing barriers to entry, controlling the number of entrants and access to scarce resources, (3) creating a favorable investment climate for both local and foreign investors and (4) narrow the development gaps. The last goal of a regulator is especially for rural and low-income urban areas supposed to ensure universal access to services in a profit-oriented driven sector (Smith and Wellenius, 1999). However, the process of implementing reforms was gradual. Governments have chosen varying paths and degrees of opening markets to private investors. Therefore, there have been varying degrees of growth (Fink, Mattoo and Rathindran, 2002).

It is noted that Uganda joined the telecommunication liberalization and regulation movement in 1994, with the admission of a second national operator Mobile Telephone Network (MTN) to compete with the incumbent Uganda Telecom Ltd (UTL) and one cellular provider (Celtel). The regulator initiated the Rural Community Development Program (RCDP) and negotiated an obligatory objective with the providers to install phone lines in rural areas. The performance of the sector has been regularly reviewed (Shirley et al, 2002; Tusubira et al, 2007; International Telecommunication Union, 2009), and results of these can be summarized as follows.

- 1) The pre-reform period recorded poor ICT distribution - mostly fixed phone lines, 1.6 lines for 1000 inhabitants with most of the lines in the city that has less than 10% of the total population (Shirley et al, 2002).
- 2) Uganda's slow infrastructure growth and poor distribution to all areas and sectors of the society was not being achieved after a period of 11 years of a regulated, partially liberal market (Shirley et al, 2002).
- 3) Core backbone infrastructure development could not be handled by the private sector alone but requires partnership with the public sector to ensure equitable and affordable access and distribution (Tusubira et al, 2007).
- 4) Relatively high mobile phone costs that exclude poor urban and rural users. Mobile phone costs are affected by import duty, VAT, and excise tax as well as high termination rate (cross network call charges). The charges discourage low-income earners that include most of the rural population (Tusubira et al, 2007; Gilwald and Stork, 2008; International Telecommunication Union, 2009).

Further, there are actions taken by the regulator and these include: -

- 1) Opening up competition in every aspect of the sector. This includes allowing providers with a Public Infrastructure that would boost the slow growth of infrastructure (Gillwald, 2005).

- 2) Public Private Sector partnership was agreed to enable the government in contributing to the development of a backbone infrastructure that would support affordable access and human development programs at local government level, schools and government healthcare facilities (Tusubira et al, 2007).
- 3) On-going debates in parliament to eliminate taxes on the phones (ITU, 2009), although these were the largest contributor to the sector’s total tax contributed to the revenue authority in 2013 (Uganda Communications Commission, 2013).

These actions by the government and regulator create the following market conditions for a rural consumer of telecommunication services: (1) a vertically integrated industry structure and infrastructure, and (2) a mobile service and technology dominated market.

2.8.1 Industry structure and Infrastructure

The regulator had initially left the development of the infrastructure to the private sector and issued the Public Infrastructure Provider license to 26 operators, however, 21 of these operators also hold a Public Service Provider that allows them to provide services (mostly ISP services) to the public (Uganda Communications Commission, 2010). This creates a vertically integrated operator industry structure that does not allow efficient competition. In comparison, in most of the European economies, an incumbent national operator owns the backbone infrastructure that covers the whole country and sells access to competing operators in a regulated environment, and these competitively provide services to the public. On the other hand, the vertical structure operators are running expensive satellite connections and as backbone operators, charge profit-oriented fees for access to their gateways. In turn, they charge high access costs to low-income earners for services to cover their costs (Williams, 2008; Mulira, Kyeyune and Ndiwalana, 2010).

| | | Capacity | | |
|----------|--------|-------------------------|---------------------------|-------------|
| | | <8Mbps | 8-450Mbps | >450Mbps |
| Distance | <100km | Satellite/ Microwave | Microwave | Fiber-optic |
| | >100km | Satellite | Microwave/ Fiber-optic | Fiber-optic |

Figure 2.3: Capacity of Infrastructure Technology Source: Williams, 2005: pg. 20

As the figure above shows, the fact that service providers predominantly rely on satellite and microwave means that the backbone is of low capacity bandwidth (Williams, 2005). Figure 2.3 above presents the average capacities of infrastructure technologies available to the telecommunication sector. Inclusive of the two national operators, government and the Uganda Electricity Transmission Company owned fibre optic, coverage is approximately 2500km. This is in the southern part of the country with a few areas north of the city. Most of this cable is concentrated in the city (central region) but is linked to the major centers, Entebbe in the central, Jinja in the east, and on-going construction of the Masaka and Mbarara links in the West (Mulira, Kyeyune and Ndiwalana, 2010). Figure 2.4 illustrates the infrastructure distribution in the country.

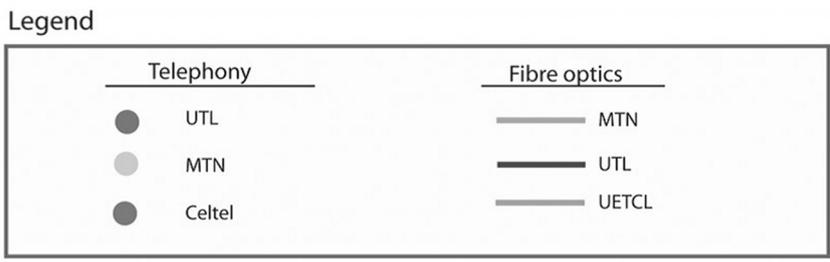


Figure 2.4: Infrastructure distribution in Uganda Source; Tsubira et al, 2007: pg. 28

It is seen that the microwave network is the most widely available, with a 65% geographical and 75% population coverage (Muliara, Kyeyune and Ndiwalana, 2010: pg. 11). This infrastructure and industry structure suggests that the poor may be excluded from access to services if network coverage is concentrated in urban areas and along highways while they are located in remote areas. Note, are high

service which costs also exclude low income earners and this might create a challenge for mobile service innovations.

2.8.2 Technologies available

According to the Uganda Bureau of Statistics, information indicates that by 2006, only 0.2% of rural households had fixed phone lines (2006: pg. 18). A demand-side household survey carried out in Uganda by Research ICT Africa in 2007 reveals that fixed line distribution were almost all urban (Gillwald and Stork, 2008: pg. 8). The limited or non-existent fixed phone lines in rural Uganda is a result of a post-colonial belief that phone lines were for the elite (Shanmugavelan and Warnock, 2004) and a flawed regulation process that did not realize the need for distribution of fixed phone lines in rural Uganda.

Thus, as a new technology, mobile phones simplified the providers' objective of meeting their required subscriber targets outlined above. The cost of infrastructure set up for mobile phone services is relatively low in comparison to fixed phone line infrastructure. Within six years of the liberalization period, mobile phone subscribers had multiplied by 131 times (Shanmugavelan and Warnock, 2004: pg. 1). Although most of the growth is urban, rural users have emerged in national surveys. According to Uganda Bureau of Statistics, in 2006, 9.6% of rural households had a mobile phone and 10.6% of the total rural population was in possession of a mobile phone (2006: pg. 18). By 2007, rural mobile subscriber figures accounted for 17.7% (Gillwald, and Stork, 2008: pg. 12). The availability of the cellular network country wide, easy adoption of the mobile phone by any user, literate or not, and promotional campaigns carried out by the telecom providers that have availed mobile phone handsets at "next to nothing" costs are some of the factors that have seen the mobile phone penetrate into rural populations (Tusubira et al, 2007).

Internet technologies in Uganda and developing world have gradually evolved. The earliest form of last mile access for Internet subscribers was dial-up where a user connected a PC using an existing landline. The user was charged a fixed monthly fee and telephony fees for time spent online. Digital Subscriber Lines were introduced as an improvement in service but still used fixed copper land lines. Leased lines are however the exclusive services of MTN and UTL, giving them unfair competition in the market. The General Packet Radio System and Wi-Fi have lowered costs and increased access to Internet services, especially for those without fixed land lines (Tusubira et al, 2007; Mulira, Kyeyune and Ndiwalana, 2010).

However, with regard to rural areas, the discussion so far indicates that existing infrastructure is extremely limited and in most cases non-existent in rural Uganda. Exact figures on rural Internet users are not available. In 2007, the subscriber base for every 100 inhabitants for the Internet service in Uganda was 0.01% (Gillwald and Stork, 2008: pg. 11). With most of the infrastructure concentrated in urban areas, it can be assumed that majority of these users are urban dwellers.

2.8.3 Market Demand

Despite the high expenditures experienced by mobile phone users, there is significant evidence of its desirability among users in Uganda. Gillwald and Stork estimate that there is a \$ 4, 510,000 untapped market in Uganda. Out of the 79% of Uganda's 16 year old and above population, 1,288,755 are willing and able to pay for mobile services at \$ 5 or less for a handset (current cost is \$14.98) (2008: pg. 16-17).

The fixed phone lines barely have any market demand from the general public with provider services packaged for urban business. Gillwald and Stork's report reveals that there was no willingness indicated by users to acquire a fixed phone line whose monthly charges were estimated at \$15.50. Out of the 70.2% of Ugandan households that do not have a fixed phone, 31.2% were not willing to acquire a fixed phone because they possessed a mobile phone (2008: pg. 10).

The Internet has been around the Ugandan market even longer than mobile telephony, but has experienced minimal growth. By 2006, there were 11,000 Internet subscribers (mostly urban users) in Uganda (Tusubira et al, 2007). Full liberalization has been an increase in number of subscribers (6.8 million) and increased International bandwidth (25,678.8 Mbps). There were also a recorded 98, 500 fixed Internet connections and 3,458,351 mobile wireless subscriptions (Uganda Communication Commission, June 2013). Number of users and number of subscriptions however are drastically unbalanced. This is because most users are using shared access points in work places, institutions and Internet cafes, all concentrated in urban areas.

Of concern are Africa's telecommunications markets, characterized by dominant players extracting monopoly rates, duopolists and oligopolists engaging in price matching rather than competition. Uganda's telecommunication sector has experienced numerous promotional campaigns from the different cellular providers that encourage increased on-network traffic in mobile phone networks. Tusubira et al report the lowering of prices (2007: pg. 25). However, Gillwald and Stork argue that this has been a case of price matching rather than competition. Subscribers to specific networks are treated to bonus packages that reduce communication costs within networks but not across networks. The result is that on-network calls increase and traffic between different networks has reduced according to (Uganda Communications Commission, (2009). Although the mobile phone has made significant improvement in voice communication, average monthly costs (mobile – \$5.75, fixed phone line – \$15.50) still remain extremely high for most users in Uganda. Consequently, this has resulted in the emergence of multiple SIM cardholders to take advantage of the on-network promotions (Gillwald and Stork, 2008).

There are providers who have increased fixed phone lines, more so, to the business sector in urban areas. This tilting of the competition scale towards urban and neglect of the rural, creates what Gillwald and Stork term as, sub-optimal performance of the telecommunication sector, which it is argued, is as a result of the failure of the regulator to establish a working market (2008: pg. 2). The failure to adequately address inclusion for rural areas has been pointed out in the regulation process. The private sector has been relied upon for the full development of the backbone infrastructure, which has resulted in increased exclusion of rural areas from Internet services. ICT4D that do depend on this telecommunication context therefore have to experience the opportunities and challenges that the sector poses. This is in addition to the challenges and opportunities that the rural users, may experience as users shaped by the context of poverty.

2.9 Synthesis Context Description

The description of our context reveals: (1) dimensions of poverty, (2) complexity of rural healthcare and (3) the profit-oriented telecommunication sector. These descriptions are broad and two dimensional, for instance, description on poverty does not only cover deprivation, but effects these deprivations might have on individuals and communities. The rural healthcare context does not only

cover structure, but includes challenges and impediments experienced. The profile on the telecommunication sector does not only cover technology and service availability but also gaps in service provision. Therefore, this paves way for a two dimensional variable descriptions – those that create value and strengthen the value chain and those that limit value creation and break the value chain.

Furthermore, the broad nature of the description highlights the need for theory to provide criteria for variable identification. The complexity of healthcare organizational structures present as many challenges as there are needs. The disconnection between the three components (the poor, healthcare system and telecommunication sector) is visible at this point in the discussion and poses a question: How can a common social value exist between these three components? Can a value chain be formulated from these three components? A theoretical framework will therefore guide us in discovering this possibility.

Noteworthy is the description of the context which is also the first attempt to introduce a development perspective into ICT4D design. Development starts from poverty. All three components of the context reflect characteristics of poverty or a developing context. For instance, the health sector challenges point to a developing sector and imperfect market conditions in the telecommunication sector highlight the existence undeveloped markets.

2.10 Conclusion

To conclude the context presents the “natural laws” in which an artifact works in order to survive. Noted, is the discussion this chapter presents which begins to expound on the initial definitions of these “laws” that ICT4D and m-Health designers will use in the design process. The chapter has not only outlined and described the rural context in Uganda, but has also related most of the characteristics to rural contexts in most developing countries. The realities, challenges and opportunities of the rural poor may not be the same, but they are all caused by poverty and the rural environment as a catalyst. It is the dimensions of poverty and the rural environment that ICT4D designers must be aware of in the design of artifact for rural users. Developing context challenges also affect the healthcare sector and these challenges may differ from context to context, but they are however disruptive, no matter what context it is. It is explicit imperfect market conditions exist in all developing countries.

The following chapter, presents the two theories that provide criteria for identification of context variables. These two theories will be used in chapter 5 to analyze our context description and come up with the first version of our context-aware model. There will be a continuation that is to follow the general trajectory of first looking to development before technology and design, by first development theory before discussing business model tooling.

3. Chapter 3: Theoretical Framework

3.1 Introduction

First of all, chapter 2 defines a rural healthcare context and initiates the process of identifying variables that might influence a mobile service innovation in rural areas and rural healthcare systems. However, this does not provide our research with empirical evidence to ascertain the influence of these generic characteristics on a service innovation. This chapter is therefore tasked with the question, *What Rural Development Theory and Business Model tooling are appropriate to support the design and evaluation of a mobile service innovation in a developing rural healthcare context?* This question presents to the research the task of developing a theoretical framework from the fields of Rural Development and Business Models that will guide the research in the primary task of design and evaluation. The two theories from Rural Development and Business Models provide the criteria for, (1), explanation / prediction of the rural context and (2), design and evaluation of a service innovation and its business model.

In matters pertaining to rural development focus is on improvement of conditions of living for communities in rural areas. The field of Rural Development has produced over the years theories and perspective to tackle poverty. These theories range from single-sector and multi-sector approaches such as social or economic inequalities such as, gender and environment, defined activities, such as, agriculture, wage, employment, and many more, to local realities that are complex and that can only be defined and articulated by the local communities. This field provides unique tools and perspective for understanding the rural context. The first section of this chapter examines the field of Rural Development, the tools and perspectives available in the field, the relationship between Rural Development and ICT4D design and finally the unique contribution the livelihood framework presents to understanding the rural context.

The second section analyses Business Model literature. It is notable though that sustainability has been highlights as a major challenge in chapter 1. Chapter 2 highlighted variables in the context that might influence the viability of a service innovation in a rural context. These have not been evaluated against Business Model criteria. Business Model literature provides tools and perspective to measure the viability of a rural context. However, Business Model tooling emerges from profit-oriented industries. To adopt the conceptual framework to a development-oriented context the research is guided by Social Entrepreneurship. Social Entrepreneurship is an emerging field from the fields of Development and Entrepreneurships. It highlights insights into Business Models in a developing context.

The third section of the chapter is to provide a synthesis of the two frameworks, livelihood and STOF. A combination of the two frameworks develops a criteria to guide the design and evaluation of our m-Health service. Lastly, a brief summary of the contribution, opportunities and challenges the two frameworks present to the field of ICT4D concludes the chapter.

3.2 Emerging Rural Development Theory

A definition of Rural Development is not available, but it is generally associated with farming and agriculture, emerging from decades of evolving international and national development thought and perspective (Van der Ploeg et al, 2000). One of the earliest debates and promoted strategies to

development and poverty after World War II was modernization and economic progress. It was believed that if poorer nations, most of which are in Africa, Asia, the Caribbean, the Pacific and Latin America were to be industrialized, urbanized and introduced to modern technology within all sectors of society then development would be achieved. Economists used Gross National Product per capita and Gross Domestic Product to measure development after structural changes were made to accommodate and facilitate the desired modernization and urbanization objectives. A country with a high Gross National Product is considered wealthy. These practices were a result of: (1) classical and neo-liberal development theories used in the pre and post war economies of developed nations and (2) the technology transfer approach which assumed that theories and practices that had worked for the developed countries, could work for developing nations as well. At this time, agriculture, which is largely a rural activity was viewed as backward and was to play only a passive role as a food supplier in the modernization process until urban areas took over (Ellis and Biggs, 2001).

The first attempt at moving away from the purely economic development perspective in measuring poverty was registered in the 1970s when the “Basics needs” approach was developed, and highlighted basic requirements for a household or individual to attain a minimum level of well-being. These basic needs include: (1), adequate shelter, (2) food, (3) clothing and (4) employment. Scaling and inequality measurements were also introduced to counteract the inadequacy of national Gross National Product and Gross Domestic Product measurements that do not highlight social and income inequalities that do not only exist between nations, but also between regions, urban rural, gender, households and individuals. Beyond income inequalities, social inequalities were also recognized, particularly between men and women, and ethnic groups (Willis, 2005). Strategies and policies of re-distribution along-side growth and development are used in this study.

Noted, is the United Nations Development Program, which in the 1980s developed the Human Development Index that incorporates non-economic indicators in measuring poverty whereby three dimensions are used, each with one or more index to measure development. The first is, long life and health measured by life expectancy at birth. The second is knowledge measured by adult literacy and Gross Enrolment Ratio. The third is, a decent standard of living measured by Gross Domestic Product per capita. In Amartya Sen’s Capabilities approach, the Human Development Index was given concrete theoretical foundation. In the Human Development Index and Capabilities Approach, the purpose of development is to improve human lives by expanding the range of things that a person can be and do, for instance, be healthy and well nourished, to be knowledgeable and to participate in community life. The process of development is therefore about removing the obstacles concerning what a person can do in life, for instance, illiteracy, ill health, lack of access to resources, or lack of civil and political freedom (Fukuda-Parr, 2003).

Up to 20th- 21st century, development has been largely macro-level. The “basic needs”, inequality and re-distribution perspectives introduced a micro-level perspective to poverty. With a more detailed and focused view of the poor, it was now possible to pinpoint poverty at individual, household, community and regional levels. Ellis and Biggs (2001) suggest that Rural Development perspectives began to take shape with two paradigm shifts, first, is the shift in role of agriculture in development. The agricultural sector (especially the small-scale farms) was initially viewed as a passive participant in the development plan as earlier pointed out. However, in mid 1960s, economist and development practitioners began to see agriculture as a key contributor to economic growth that provides labour, food, foreign exchange and a market for consumer goods from the industrial sector. As a strategy for

the basic needs and re-distribution approaches, agriculture began to be viewed as a means to spur growth and equity. Non-farming needs of the poor could be satisfied with increased production in small-scale farming. However, this perception did not take root until the late 1970s.

The shift was supported by village and community studies, for instance, the Rhodes-Livingstone Institute in Zambia and the Green Revolution study with several villages in India. These studies on farming systems, agro-ecosystems analysis and sustainability science began to discover the diverse and complex world of livelihoods in rural areas and subsequently created the second shift in the 1980s and 1990s a shift from the top-down approach (macro-level) to a bottom-up or grassroots approach. Central to this thought were the observations by Robert Chambers in 1983, in a book titled *Rural Development: Putting the Last First* (Scoones, 2009). The new perception was about empowering the rural dwellers by enabling them to decide their future through participatory processes. In the 1990's, rural development began to take shape in the development of the actor – oriented approach, participatory rural appraisal, environment and sustainability and now Poverty Reduction Strategy Papers (PRSP) dominate Rural Development. In the next section, there is a discussion of development Approaches that have contributed to Rural Development and an introduction and analysis of the Livelihood Approach used in examining rural healthcare.

3.2.1 Development Approaches

From a purely economic perspective, development has taken on a holistic and context aware approach. On the practical side, the rich historical growth and maturity of development paradigms has yielded an equally rich pool of development approaches that reflect a wholesome perspective and definition of development. These approaches also present practical guidelines in the form of frameworks and methods used for: (1) understanding, analysing and / or measuring poverty, (2) designing or developing plans for intervention and reduction of poverty, and (3) monitoring and evaluation of intervention and poverty reduction programs. A summary of development approaches, their description, methods and area of application is given in Table 3.1 (pg.44)

The poverty Reduction Strategy Papers (PRSP) are really macro and policy oriented, a product of World Bank and the International Monetary Fund. They describe a country's macro-economic structures, social policies and programs over a three (3) years or more period in order to promote broad-based growth. The PRSP uses three or four approaches to poverty reduction: The first is, creating opportunity through broad based growth. The second is empowerment through application of a range of policy settings from fiscal management to decentralized governance. The third is, to enhance security through investment in human capital. This can be done through investment in health or education. The fourth approach is, financial arrangements for the adversely affected by adjustment processes (Graig and Porter, 2003). PRSP's broad-based nationwide approach and predefined poverty alleviation requirements are not an appropriate structure for this research. With the intention to discover design variables within a poor context, it is necessary to use an approach that allows discovery rather than implementation, which the PRSP is more suited for, as discussion below explains.

This is the capabilities approach, which can be used at both macro and micro level. Unlike PRSP, which focuses on specific sectors and economic development, the focus of the capabilities approach is Human Development whereby human life is seen as a set of "doings and beings" which are called functionings. Functionings of an individual, community or country are measured by looking at their capabilities (Health, Knowledge and Participation). By improving the functioning of the poor, their

capabilities are improved. The Capabilities Framework is the method used to apply the capabilities approach and it includes: (1) Life, (2) Bodily Health, (3) Bodily integrity, (4) Senses, imagination and thought, (5) Emotions, (6) Practical reason, (7) Affiliation, (8) Live with and concern for other species, (9) play, and (10) control over one's environment. Its most well-known application has been with the Human Development Index (HDI) as discussed earlier (Robeyns, 2006). The focus is really measurement of an individual's poverty status with predefined "needs and challenges". The context is examined in relation to its ability to provide access to or hinder the individual from accessing / improve capabilities. It is flexible and can be used in different contexts for instance gender and inequality, as an alternative to cost benefit analysis, to evaluate or develop policies and as a basis for social political criticism (Robeyns, 2005). However, because it focuses on measurement, that does not enable understanding and description of the context which should lead to identification of design variables in the context. Like the PRSP, this approach may not be appropriate for the research.

There is also the actor-oriented approach, which focuses on participants (actors) in a poor or developing context. These actors may include the poor, key institutions and individuals who have differing views and understanding of the processes in which they are involved. The approach identifies key actors in a given context whereby map linkages are made that indicate information flows between them and looking at how these inhibit or support pro-poor innovations. First, this method starts with mapping the history of an innovation by listing key events in the evolution of an innovation and the roles of the actors. This is referred to as the Actor Timeline. The second stage are the actor linkage maps, which build on the actor timeline by going further, and analysing the linkages between actors. This stage identifies all the actors and shows the links between major actors in an innovation. This process creates a matrix that is represented by a listing of actors along vertical and horizontal axes in a spreadsheet. It is normally applied at a secondary level, analysing or evaluating a poverty reduction program (Biggs and Matsuert, 1999; Biggs and Matsuert, 2004). While this approach can also be used to provide an understanding of a situation of poverty (Turnbull, Hernández and Reyes, 2009), it is more suited for evaluation of a product after implementation. A product evaluation is finding out what the results of a program design and application are, what the value of the results are, and what are the long and short term effects of the program after it came into being (Verschuren and Hartog, 2005). Although this approach can describe a poverty situation, the resulting layout is a map with information flow between actors. It is not possible to clearly describe the actors themselves, their challenges, needs and the context surrounding them.

Another approach is the Participatory Rural Appraisal approach, which is in reality a family of approaches and methods, rather than a single concept or method. PRA transfers the activities that were previously done by the "outsiders" to the local people or the poor, who share, enhance and analyse their knowledge of life and conditions, to plan and to act. Methods in this approach reveal five major activities. The first is mapping and modelling where local people use the ground, floor or paper to map out natural and health resources, farmland and many more. The second is, transect walks or researcher walks with local people while observing, listening, discussing and mapping and diagramming resources and findings. The third is, a matrix scoring, for instance, trees or different soil conservation methods, seasonal calendars, major seasons and the changes that occur like labour, agriculture, amount of rain or soil moisture and others. The fourth is, recording trends and change analysis by listing major events that have happened in a village as is remembered by the local people. Finally, the fifth is to do with a well-being and wealth ranking and grouping, identify groups or ranking of households according to well-being analytical diagramming, especially by gender, social well-being,

occupation, age and many others. Application has been for the purpose of appraisal, analysis and research including: agroecosystems, irrigation, technology and innovation, health and nutrition, farm systems research and extension, pastoralism, marketing, disaster relief, organizational assessment and social, cultural and economic conditions. Much of the application has been done by NGOs (Chambers, 1994). It is noted that this approach was the first attempt by researchers and development practitioners in an attempt to understand poverty from the perspective of the poor. As such, the methods focus more on general descriptions than on specific poverty variables that might influence poverty in a context. There is not a clear method of analysis for the descriptions to determine causality. For instance, in the case of well-being and wealth ranking, while a researcher can identify and rank groups of wealth and well-being, it is not possible to determine causality. Hence, in this research, it is necessary to determine design variables in the context that affect viability of service innovation, though this approach may not support that particular need.

Finally, it is important to note that these approaches to development are hermeneutic, actor-centred and have moved from simply measuring the material possessions of individuals and households to determining causes of poverty in households and communities (Bebbington, 1999). Although the Capabilities approach can be applied at a micro-level, it comes with predefined needs and challenges and this does not provide opportunity to discover what is of value to the poor. The Actor-Oriented Approach is best as an evaluation tool after implementation, and the Participatory Rural Appraisal is ambiguous and may not provide concrete answers to the research. On the other hand, the Livelihood Approach allows us to examine a micro-level context, while defining needs and challenges according to the poor. Following is the next section that provides a discussion of the Livelihood approach, its method (the livelihood framework) and how it supports the objective of the current research.

Table 3.1: Development Approaches

| Development Approaches | Description | Framework and / or method (s) | Practical application |
|---|---|---|--|
| Capabilities Approach (Nussbaum, 1999; Fukuda-Parr, 2003) | Focus is on Human Development as opposed to Economic Development. | Capabilities Framework focusing on: 1) Life, 2) Bodily Health, 3) Bodily integrity, 4) Senses, imagination and thought, 5) Emotions, 6) Practical reason, 7) Affiliation, 8) Live with and concern for other species, 9) play, and 10) control over one's environment | - gender and inequality, - Evaluate policies, develop policies and a basis for social political criticism - Most well-known application has been with the Human Development Index (HDI) |
| Poverty Reduction Strategy Papers (PRSP) (Graig and Porter, 2003) | A product of the World Bank and the International Monetary Fund (IMF). Used to promote broad-based growth and develop primary policies for international development institutions. | - broad-based growth - Good governance. - investment in human capital e.g. health and education sector - social safety nets | A broad nation-wide application approach with predefined requirements |
| Actor-Oriented Approach (Ellis and Biggs, 2001; Martsaert, Ahmed, Islam and Hussein, 2005) | Maps linkages and information flows between them and looking at how these inhibit or support pro-poor innovations | - Actor Timeline that maps the history of innovation - Actor Linkage maps analyse the linkages between actors - Actor linkage matrices identifies all the actors and shows the links between major actors | - Normally applied at a secondary level, analysing or evaluating a poverty reduction program (Biggs and Martsaert, 1999; Biggs and Martsaert, 2004). - Can also be used to provide an understanding of a situation of poverty (Turnbull, Hernández and Reyes, 2009). |
| Participatory Rural Appraisal (PRA) (Chambers, 1994) | A family of approaches and methods using the Bottom-up. | Methods include: Mapping and modelling, Transect walks, matrix scoring, trends and change analysis, well-being, wealth ranking and grouping, analytical diagramming. | First attempt to completely transfer power of decision making to the poor. Application has been for appraisal, analysis and research. Much of the application has been done by NGOs (Chambers, 1994). |
| Livelihood Approach (Scoones, 1998) | A by-product of bottom-up, Participatory Rural Appraisal (PRA) approaches and the Environmental Sustainability. Attempts to understand poverty from the perspective of the poor by mapping out livelihood strategies. | The Livelihood framework with components: 1) vulnerabilities, 2) assets 3) Livelihood structures 3) livelihood processes 4) Livelihood strategies and 5) livelihood outcomes. | Areas of application and use include: 1) Identifying, designing and assessing new initiatives and projects (agricultural, natural resources, information and communication needs). 2) At policy level to understand how prevailing structures and processes affect livelihoods |

3.2.2 The Livelihood Approach

The Livelihood approach is sometimes referred to as Sustainable Livelihood approach (SL). It is a by-product of bottom-up, Participatory Rural Appraisal (PRA) approaches and the Environmental Sustainability concept (Brocklesby and Fisher, 2003). It was developed within research institutions (Institute of Development Studies), NGOs (CARE and Oxfam) and donors (DFID and United Nations Development Program) (Ashley and Carney, 1999), and attempts to understand poverty from the perspective of the poor by mapping out means by which people sustain a livelihood. In other words, the poor define what they consider to be their vulnerabilities (needs, challenges and impediments), and how they overcome these vulnerabilities using the assets available to them.

Furthermore, this approach differs from its origins (Participatory Rural Appraisal approach, farming systems, agro-ecosystems analysis, and sustainability science), by not focusing on rural areas and poverty as agricultural-centred, and takes an open-ended view that the poor will use a combination of assets and strategies to make a living (Ellis and Biggs, 2001). In application, the original focus was agriculture. However, the framework has since then been revised and has evolved in use extending to ICT and Information needs (Chapman, Slaymaker and Young, 2003; Duncombe, 2006). It includes five (5) areas of focus in determining rural area livelihoods and outcomes. These are: (1) Vulnerabilities (challenges, impediments and needs), (2) Capital Assets (physical, financial, human, social, natural), (3) Influencing Institutions, Policy and Social Relations, (4) Livelihood Strategies and (5) Livelihood Outcomes as represented in figure 3.1 below.

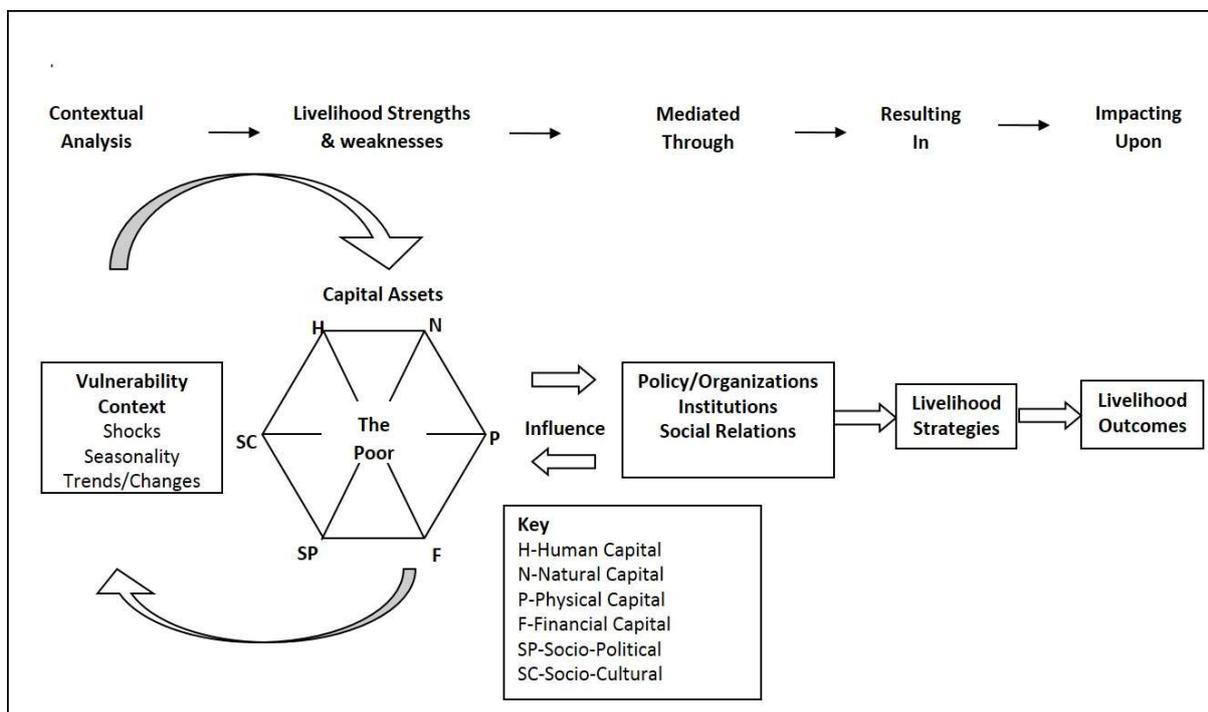


Figure 3.1: The Livelihood Framework (Duncombe, 2006)

Basing on the above diagrammatic representations, it is clear the first two sections of the framework (vulnerabilities and assets) enable contextual analysis. The community who define poverty by identifying risks and shocks that cause poverty defines the contextual analysis. They also identify assets, which may or may not be available to them. This analysis identifies livelihood strengths and

weaknesses. From the contextual analysis, the framework defines development goals or community needs and description of the poor (end-users) and their assets. The third section (organizations, institutions and policy) describes structures and processes that may support the efforts of the poor as they try to overcome vulnerabilities. Identifying the structures enables the research to identify development partners. Description of these partners also identifies strengths and weaknesses of the context. The last two sections, livelihood strategies and outcomes describe the actions taken by the poor and the outcome of those results while trying to overcome vulnerabilities. These two sections enable the analysis to evaluate the strengths and weaknesses of both the poor (end-users) and the institutional structures (partners).

The discussion further demonstrates the ability for the livelihood framework to present variable description in the rural context while demonstrating causal relationship between variables. The livelihood framework also enables this description to be determined by actors in the context. By introducing the bottom-up approach in the design process, the research responds to two requirements in the ICT4D design and sustainability field. The first is context-aware knowledge gap between designers and the developing context. Previously discussed in chapter one section 1.3, (Lucas, 2008; Schuppan, 2009; Prakash and Rahul De', 2007) argued that ICT4D designers lacked an understanding developing contexts and therefore implemented solutions that did not match the needs of end-users. The second reason was discussed by (Sutinen and Tedre, 2010) and is elaborated in the next section - the need to design technology that is owned rather accessed in ICT4D design.

3.2.3 A Bottom-Up Approach in ICT4D Design

Sutinen and Tedre (2010) categorize ICT4D research into four areas:

- a. Developers may pinpoint a specific social/cultural or economic issue and try to match it with an existing technology to improve the social/cultural or economic situation
- b. The developers will then evaluate to what extent the technology has solved an existing social/cultural or economic issue
- c. The developers may also carry out exploratory research where the problem area is not well known and the target is to delimit the boundaries of problems. This is usually ground work to enable the first two kind of research
- d. The need or problem is well known, but there isn't an existing technology to improve the situation. Here the task of the researcher is to construct an artifact.

However, Sutinen and Tedre argue that predominately, ICT4D follows the first two categories and rarely is an artifact created after exploratory research to determine the problem, delimit the boundaries of that problem and then design an artifact basing on the context the artifact is to be implemented, and also refer to this approach as, technology driven, and assume that "one size fits all" (pg. 224-225). To understand their argument we need to examine the history of ICT4D.

Heeks (2008) gives a historical perspective and description of ICT4D, as summarized in Table 3.2. It is important to note that the observation made by Sutinen and Tedre is evident as each ICT4D artifact seems to be a pre-existing technology that is implemented in a developing context and is personalized along the way so that it can fit into the context after conceptualizing the problem and context. The first computer installation was in India in the 1956 used to support administrative functions in

government institutions. Then, the private sector adopted these in the 1980s for purposes of economic growth.

The 1990s and 2000s was the time of the shift in development perceptions from single sector to multi-sector approach, from macro to micro development approaches. It was at this time that the perspective on poverty also changed from economic, to a more dynamic and holistic approach, including health education and gender equality. It was also a time when it was recognized that the poor lived in rural areas and in communities, hence, the strategy to deploy a community solution. ICT4D solutions were at this point led by International Development Agencies and NGOs and the tele center was the solution pushed as the ideal for community access to information and communication services. The tele center, a solution from Europe was applied to overcome social and economic poverty in poor communities.

It is noted that the 2000s was also characterized by the Internet boom. Therefore, after the tele center solution, there were personalized computer and Internet related solutions that were tailored to specific development goals. For instance, new hardware innovations with low-spec, low-cost, robust terminal device such as, one Laptop per Child (OLPC) were used to improve education. WiMAX and Wi-Fi technologies have been used by telecommunication providers to provide Internet and voice communication to poor communities. Old media ICT was refined to provide both voice and video. Community radio with local content and interaction with the community has replaced the generic radio structure which allows only information dissemination, but does not allow a local community to participate. Participatory video which allows creation of video content by the local community and presents at individual screenings for community groups, has also been one of the refined old media. In the mid-2000s, mobile technology was introduced and used to address the information and communication needs in the social and economic sectors. Notably, is the smart phone which is used mostly by urban users, with Internet and stand-alone applications, and the dumb phone with voice and SMS platforms is used by poor urban and rural populations. It is clear therefore that service innovations for poor communities have focused on healthcare, agriculture and banking.

Also, it is important to note that ICT4D implementations have been influenced by the popular development thought presented in the previous section. Computer implementations in the 1950s in public sector are reminiscent of the modernization and structural changes that were popular at the time in the development thinking. The switch to liberal market is reflected in the private sector adoption of IT, and the Millennium Development Goals drive technology implementations in 2000s.

Table 3.2: A Historical Profile of ICT4D

| Period | ICT4D artifact | Key Actor (s) |
|----------------------|--|---|
| 1950s-1990s | <ul style="list-style-type: none"> • First digital computer put to use in Kolkata in 1956 at the Indian Institute of Statistics for scientific calculations work. • Computer applications in the public sector mainly for internal administrative functions | Government |
| 1980s | Computer application in multinational and private firms for economic growth in the private sector | Private investors |
| Mid 1990s- Mid 2000s | <ul style="list-style-type: none"> • Driven by Internet growth and Millennium Development Goals that introduced poverty from a multi-sector perspective • Focus shifted to rural areas • The tele center was adopted from Europe and could be easily replicated across developing countries | International Development Organizations and Non-governmental Organizations (NGOs) |
| 2000s | <p>1) Refining and personalizing the Internet connected PC with:</p> <ul style="list-style-type: none"> • One Laptop per Child (OLPC) • Telecommunication using VSAT, Wi-Fi based systems and WiMAX to provide connectivity to poor communities. <p>2) Refining old media ICT with:</p> <ul style="list-style-type: none"> • Community Radio. The community radio not only transmits local and relevant content, but allows community input • Participatory video which allows creation of video content by the local community and presents at individual screenings for community groups | International Development Organizations and Non-governmental Organizations (NGOs) |
| Mid 2000s - To date | <p>The mobile phone:</p> <ul style="list-style-type: none"> • The smartphone for the urban and elite users • The dumb phone with voice and SMS platforms. Used in healthcare, agriculture and banking for poor communities | International Development Organizations and Non-governmental Organizations (NGOs) |

Just as development, thinking has changed to favour Rural Development, so has also ICT4D design and application. The focus on appropriate technology selection, for instance, mobile instead of computers, demonstrates a maturity in perspective. However, the technology transfer approach needs to be addressed. This approach, Sutinen and Matti Tedre (2010) argue emphasizes more on enabling access for targeted users, but not ownership of the technology, as also support evidence shown in Figure 3.2.

The lower axis represents the access approach that first generalizes an existing solution for users in a developing context then begin to personalize the artifact to adopt it to the context. This creates a danger of an artifact that might be stripped off just so that it can fit into the context. The alternative is ownership approach which focuses on first concretizing using inputs identified from the context. Clearly, this process enriches the artifact rather than strip it down.

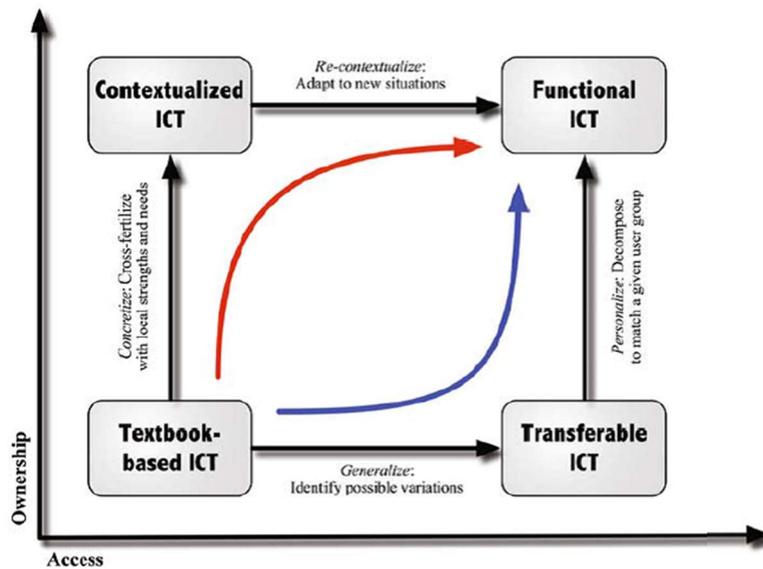


Figure 3.2: Alternative Approaches to ICT4D Design; Sutinen and Tedre, 2010, pg. 227

If analysis is to start from the context, the question is, how is it approached and begin to “contextualize”? The livelihood approach presents an opportunity for ICT4D designers to develop an understanding of the complex and diverse rural areas to design artefacts that can respond to the realities of these development contexts.

The study however needs to know what is viable and what is not, what supports creation of value and what breaks the value chain. For this reason, the research turns to Business Models that are discussed in the next section and how the elements and characteristics in the context can be exploited to create value, and which identify elements will break the value chain.

3.3 Business Models

“Sometimes, however, recognizing the opportunities for growth and new wealth creation seems easier than discovering how best to exploit them and determining whether existing resources and capabilities indeed facilitate such exploitation” (Seelos and Mair, 2007:pg. 1).

From the Livelihood framework, livelihood strategies were developed plus outcomes. From the set strategies and outcomes needs are defined, challenges, impediments, and opportunities. The set of needs, challenges, impediments and opportunities provide a base to derive requirements, assumptions and specifications, the building blocks for an artefact or service innovation. The process presents an artefact, but does not show how it could be operationalized. Who will be responsible for

the artefact? What will be needed to keep the artefact up and running for as long as the users have need of the artefact? These questions point to the resources and capabilities which (Seelos and Mair, 2007) argue may not be available in contexts of extreme poverty. The challenges are that identified “what to do” and “how to do it”. This process is demonstrated in figure 3.3 below.

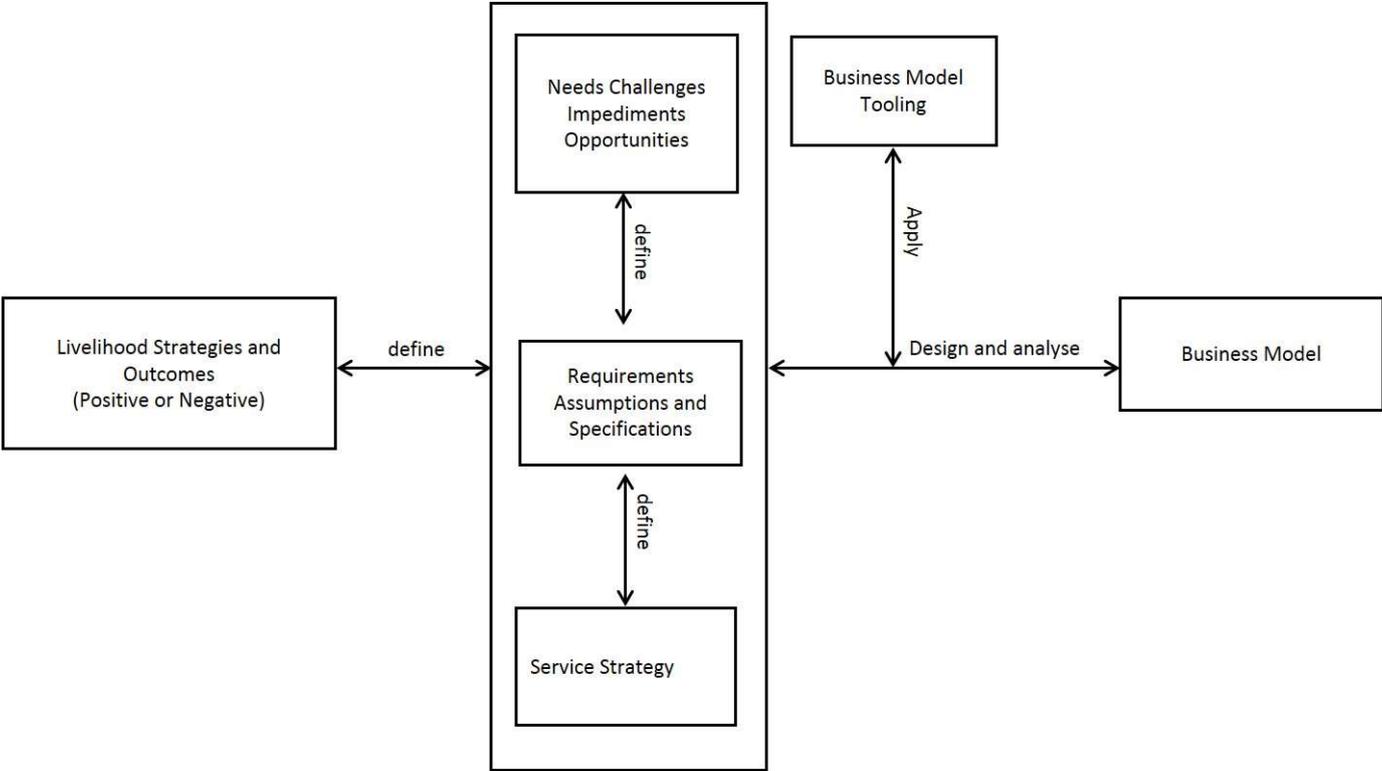


Figure 3.3: Business Model Design and Analysis in Rural Contexts (Source; Research)

The “how” question points to a strategy or the positioning of an artifact that generates value for the users and the operators. Strategy or Business Strategy is a pattern, plan, position or perspective that relates to choices about which product or service is offered (Shafer, Smith and Linder, 2005) and these choices are implemented by a Business Model (Osterwalder, Pigneur and Tucci, 2005; Solaimani and Bouwman, 2012). In Chapter 1, Business Models were defined as the core logic and strategic choices in creating and capturing value within a value network that includes suppliers, partners, distribution channels and coalitions (Shafer, Smith and Linder, 2005). Osterwalder, Pigneur and Tucci (2005) define Business Models as the translation of strategic issues, such as, strategic positioning and goals to a conceptual model that explicitly states how a business or in this case a service innovation and the partners involved function.

So far, this analysis presents Business Models as a concept, but does not direct the research to a practical guide on how the identified artefact can be operationalized given the existing resources and capabilities. Business Model tools and methods have been developed to ,(1) analyse viability and feasibility, financial impact, value exchange between stakeholders, (2) understand the business/strategy operations, (3) linking strategy to operational processes and (4) translate or map a Business Model to a business process model (Solaimani, 2014). Table 3.3 presents different Business

Model Tooling and methods. The table also presents a description and specific area of focus of different Business Model tooling.

CANVAS is a tool that is used to describe, analyse and design business models. It is based on nine (9) building blocks, four (4) of which focus on the customer end of business model logic (Client Segment, Client Relationships, Distribution Channels and Revenue Flow). The central building block (Value Proposition) describes the value offered to the customers based on the four customer blocks.

Balancing out the value proposition block are four (4) blocks that describe the partner and the resources available to them to be able to support the value offered to the customer end of the business model (Partner Network, Key Activities, Key Resources and Cost Structure) (Fritscher & Pigneur, 2010). CANVAS does present an opportunity for design and evaluation of a business model. However, it is more appropriate for single firm service innovations. There are also mobile service innovations that are primarily owned and operated by multiple partners (Bouwman, Vos and Haaker 2008). Ballon's approach deals with mobile service innovation business models. However, the focus is on categorizing business models into four levels (Value Network, Functional Model, Financial Model and Value Proposition) rather than design and evaluation (Bouwman et al, 2012).

The E3-Value Methodology was developed to evaluate networked value chains, by defining the economic value exchange between actors within the network (Gordijn & Akkermans, 2001). E3 is also able to develop implementation models when combined with ArchiMate, and enterprise architecture modelling language (Bouwman et al, 2012). A mobile service innovation's business model does include a networked value chain because it involves multiple partners. However, the specific service innovation we studied generates social value and not economic value. This tool is therefore inappropriate for the specific case study.

There is CSOFT, a business model tool with five components: Customer, which attempts to understand the customer segment and their needs, Service, which demonstrates the intended value, Organization, that includes the partners and resources available to them, finance, with payment schemes, costs and revenue sharing between partners and Technology, which depicts ICT that supports the service. CSOFT was created to transform Business Models into operational models (Heikkilä et al, 2010). Just like the E3 and Ballon's approach, CSOFT is an ICT based Business model tooling that captures the incense of ICT and mobile service innovations. However, the area of interest (application) it was developed for does not support the specific needs of this research (design and evaluation).

BEAM is a framework used to analyse business model ecosystems and modelling and includes a set of modelling components (an ecosystem modelling component, a simulation component and a service analysis component) and a set of analysis methods from value network modelling, game theory and multi-agent systems (Tian et al, 2008). The framework provides insight into value distribution among entities and evaluation of Business Model Performance (Solaimani, 2014). BEAM supports the design and evaluation objective of this research. However, in viewing the market actors and entities as modules, the framework works best in developed economies where actors and their roles are clearly defined. This is not the case with developing countries and their economies. It is not yet clear who the actors are their roles and how they influence one another. The research needed a tool that would allow identification and description first before analysis.

Secondly, Allee’s Value Network analysis is a model that examines the inter-organizational exchanges. These exchanges are categorized as, (1) goods, services and revenues, (2) knowledge and (3) intangible benefits. The model therefore examines participants who can be individuals or a group (organization or community) and their transactions, deliverables and exchanges they perform. Allee’s model focuses on a single organization and exchanges. This limits the objective of our research that focuses on, (1) multiple organizations that collaborate to operate a mobile service innovation and, (2) on the context and its influence on the value network (Allee, 2008).

In addition, to the STOF framework was developed for the mobile industry taking into account the multiple actors involved in the operation of mobile service innovation. The STOF framework consists of four interrelated domains (Service, Technology, Organizational and Financial domains). Each domain guides a service innovation designer to design and describe the elements related to the domain while showing the influence it might have on other elements within the domain and elements in other domains. This process allows for evaluation, because as strategic choices are made during the design process, it is possible to see their effect (Bouwman, De Vos and Haaker, 2008).

The service domain describes the service offering, its value proposition and the market segment the offering is targeting. The technology domain describes the technical functional requirements to realize the service offering. The organizational domain describes the multi-actor value network that is needed to create and provide the service offering. The financial domain describes the way the value network generates revenue, the risks they face, and how investments and costs are divided among the actors (Menko et al, 2013).

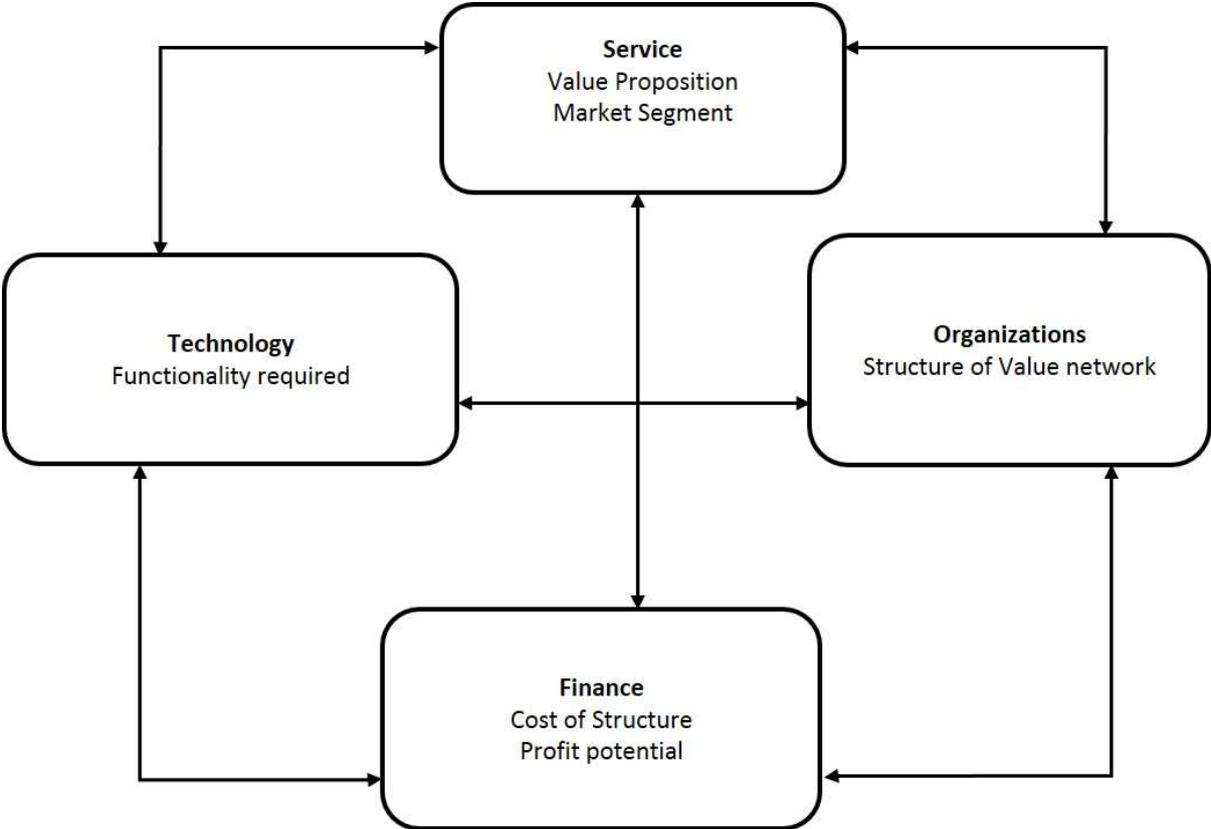


Figure 3.4: The STOF Framework (Bouwman, De Vos and Haaker, 2008)

The origins and focus of each of these toolings and methods vary. However, in selecting the appropriate tool for the implementation of a strategic - level Business Model for a rural context two general characteristics were considered: (1) the starting point for Business Model design and analysis should be the service since is the trajectory and the outcome of the livelihood framework analysis – service needs and (2) a mobile service innovation orientation. A Business Model method and tooling that takes into consideration the nature and characteristics of mobile service innovations / artefact facilitates a more appropriate analysis of the context. The STOF framework facilitates both requirements.

Table 3.3: Business Model Tooling and Methods

| BM Tool / Method | Description | Application Focus |
|--|---|---|
| CANVAS (Osterwalder & Pigneur, 2010) | Used as a tool for describing, analysing and designing business models. It is based on a nine (9) block conceptual model in which various design variables in the blocks are included. Its focus however is on a single firm / organization (Bouwman et al, 2012). | Generic / Single Firm Value Creation |
| Ballon's Approach (Ballon, 2007) | This is a Business Model Approach for mobile information communication technology (ICT) services and systems. It however, focuses on the classification of these Business Models. (Bouwman et al, 2012) | Mobile Service Innovation / Categorizations |
| E3-Value Methodology (Gordijn & Akkermans, 2001) | Defines how economic and financial value is created and exchanged between actors within a network. | Generic / Networked Value Chains |
| CSOFT (Heikkilä et al, 2010) | Business Model estimation (For instance, estimate level resources & capabilities). Provides a process to transform Business Model into an Operational model. | Generic / Operational Level |
| BEAM (Tian et al, 2008) | A generic framework for modelling and analysis involving a network of interconnected business entities. It includes the Business Ecosystem, simulation and service analysis. | Generic / Networked Value Chains |
| Value Network Analysis (VAN) (Allee, 2008) | Model, analyse, evaluate and improve the capabilities of a business by converting assets into other forms of value. This is done by linking specific interactions within the value creating network directly to financial and non-financial scorecards (Solaimani, 2014) | Generic / Tangible and intangible assets value creation |
| The STOF Framework (Bouwman, De Vos and Haaker, 2008) | A service-oriented Business Model Framework that can be used for the design and analysis of Business Models for Mobile and Wireless service Innovations. Describes the interdependencies between four (4) domains (Service, Organizations, Technology, and Finance). The framework also has a detailed and elaborate method that tackles design issues and successes (Bouwman et al, 2012). | Mobile service innovations / design, evaluation and analysis of networked value creation. |

It should be noted that the STOF framework, like all Business Model tooling, has been developed for profit-oriented service innovations. Social Entrepreneurship provides guidelines on how to design social value Business Models. This discussion leads to the next section that explores social Entrepreneurship and its suggestions for development-oriented service innovations.

3.3.1 Business Models and Social Entrepreneurship

ICT4D have so far not had much contact with Business Models. Their origins, presented in the first section of this chapter point to a blind faith that they would succeed on implementation, hence the call for Business Models design alongside ICT4D design and implementations (Heeks, 2008; Mechael et al, 2010). Business Models in developing contexts are based in Social Entrepreneurship. In developing nations and poor markets, the concept of Social Entrepreneurship has emerged for provision of basic human needs, which is the innovative use and combination of resources to pursue opportunities that catalyse social change and / or address social needs (Yunus, Moingeon and Lehmann- Ortega, 2010). Creating social value is the primary objective of the social venture (Mair and Schoen, 2007). These enterprises have developed business models by creating value, not from what people want, but what they need but cannot afford or access them in the traditional business entrepreneurship business models. For instance, Grameen Bank has targeted only the poorest, landless women in villages to offer loans and One World Health produces medication for the third world, by collaborating with biotechnology companies whose medication would otherwise remain on the shelf because it is not profitable in high-income companies (Seelos and Mair, 2005).

Social Entrepreneurship Business Models are unique in nature, just as the contexts of their applications are unique. Where Social Entrepreneurs seek the creation of social value, Traditional Entrepreneurs aim for economic value (Seelos and Mair, 2005). Using the discussions and analysis of two papers, (Yunus, Moingeon and Lehmann- Ortega, 2010) on Building Social Business Models: Lessons from the Grameen Experience and (Mair and Schoen, 2007) successful social entrepreneurial business models in the context of developing economies, as presented the unique structure of Business Models from the Social Entrepreneurship interaction with developing context. Yunus, Moingeon and Lehmann-Ortega (2010)'s paper trace the gradual growth and expertise of the Grameen social model and draw similarities and differences between Social Business Model and Traditional Business Model. Mair and Schoen (2007) using an exploratory study, examines how three Social Enterprises Grameen Bank founded by Muhammad Yunus, Sekem founded by Ibrahim Abouleish and Mondragón Corporacion Cooperativa founded by Jose Maria Arizmendiarieta achieved success despite limited or non-existent resources and capabilities in the market. Shafer, Smith and Linder (2005) identify four domains that all business models highlight: strategic choices, value networks, value creation and value capture. Social Entrepreneurship Business Models also have these four domains, but introduce unique elements into these domains. SE recommends that strategic choices for partner selection should be based the social objective. Partners should share the social objective and SE entrepreneurs should take advantage of corporate social responsibilities. All these recommendations help shape the organizational domain of the STOF model, in partner selection and division of roles in the value network. In a value network, SE recommends that where resources and expertise may not exist, entrepreneurs should use this opportunity to expand the value network. This recommendation is can be applied in the organizational domain with by improving the personnel and infrastructural resources of the structural partners. Creating and capturing value in an SE value network requires participation of the "customers" or target group in the value network as applied in the service domain during the service design. The service must be based on the needs of the target group. Table 3.4 presents these commonalities and unique characteristics along the four domains of a business model: strategic choices, value networks, value creation and value capture.

Table 3.4: Business Models in Social Entrepreneurship

| BM Domains | Commonalities with Traditional Entrepreneurship (TE) | Unique to Social Entrepreneurship (SE) | STOF application |
|--------------------------|--|--|---|
| Strategic Choices | <ul style="list-style-type: none"> - Involves challenging conventional wisdom and questioning the models that have previously led to success. - The role of the founder and his/her vision for the enterprise | <ul style="list-style-type: none"> - A clear social objective ensures a strategic selection of partners that share the same objective and avoid creating partnerships that might conflict with the primary objective of the enterprise - SE Business Models look to incorporate Social Responsibility and public institutions such as International Organizations, NGOs and development institutions as partners in the value network. - In some cases, the founders have created the value network. If a critical link is missing, the SE either filled this gap themselves or collaborated with a company that shared their social mission. | <ul style="list-style-type: none"> - Partner selection in the organizational domain must be based on the social objective of the service innovation - Local partners support the service innovation under social corporate responsibilities |
| Value Network | <p>Strategic partners with expertise and resources. The main advantage is to pool resources and knowledge</p> <ul style="list-style-type: none"> - Proactive creation of value networks. For instance, Sekem collaborated at a very early stage with distributors (Lebensbaum and Piramide) in Germany. | <p>Rather than view resource needs as a problem, SE views this as an opportunity to expand the value network. For instance:</p> <ul style="list-style-type: none"> - Sekem's founder Ibrahim Abouleish needed organically grown crops an essential input for organic, medicinal products. He bought farmland to grow the crops himself. - Muhammad Yunus founder of Grameen Bank, needed cash and personnel to start a microfinance bank. He developed the group lending method. Group members contribute cash to lend to member and the group members monitor the process. | <ul style="list-style-type: none"> - Structural partners develop personnel and infrastructural resources to support the service innovation |

| | | | |
|---|--|---|---|
| Creating Value / Capturing Value | <ul style="list-style-type: none"> - Undertake continuous experimentation, using small projects that can be scaled up. For instance, the Veolia Grameen business model, which first stage supplies water to approximately 25,000 people, and the second stage around 100,000 - Value networks that offer complementary goods on the supply side and establish positive network effects among consumers on the demand side. For instance, Grameen Bank realizing the potential of digital age founded Grameen Telecom and Grameen Phone. Using loans from the bank, women buy Village phones, which they use to provide phone services in their villages. | <ul style="list-style-type: none"> - Integrate “customers” or target group into the social value network. Target group can get involved in the value creation process. - Target group may gain employment, the founders in the process gain market knowledge and interact directly with their customers | Service design is based on the target group’s needs in the service domain |
|---|--|---|---|

Rural areas do not change the general composition of the Business Structure, but they change composition and activity. The cases presented in Table 3.4 demonstrate that the market develops alongside the innovation. Because ICT4D have not been engaged with Business Models or Business Model Tooling, it was not clear what composition they would have, let alone the ecosystem necessary to provide the resources and capabilities needed to facilitate sustainability. None of the Business Model Tooling, and therefore also STOF as presented in Table 3.3 was developed for Rural Contexts or Social Value Business Models. We therefore use the guidelines presented in Table 3.4 as guidelines in the design and evaluation process of the service innovation’s business model, with intention to ensure that our service innovation and business model generates social value.

3.4 Theoretical Framework

The two major processes of Design Science build and evaluate are guided by four basic principles, as identified in the writings of (March and Smith, 1995; Hevner et al, 2004; Peffers, Tuunanen, Rothenberger and Chatterjee, 2007) and are summarized as:

- 1) Rigorous design processes for an artefact for an observed problem: A viable artefact must be produced. This artefact can be in form of a construct (language in which problems or solutions are defined), model (represent a real world situation and aid problem and solution

understanding), method (define processes) and instantiation (implementations of constructs, models or methods).

- 2) Design Evaluation: There should be a demonstration of the quality and efficacy of the designed artefact through evaluation methods
- 3) Research contributions: There should be clear and verifiable contributions to either the design foundation or the design methods of the designed artefact.
- 4) Communication of Research: Present the research results to the appropriate audience.

The two frameworks (Livelihood and STOF) contribute to the four principles of design during the construction of a model for the design of viable and sustainable ICT4D mobile service innovations / artefacts for developing rural areas. The Livelihood Approach primarily used for its ability to explain and predict the rural context. Therefore in the attempt to apply theory that structured the problem and presented possible solutions (Sein et al, 2011) we used the Livelihood framework in the following ways:

- 1) Vulnerability and Assets: The concept of vulnerability represents much more than poverty which is a statistically measured concept. Vulnerability is dynamic and explains how people move in and out of poverty. Vulnerabilities are therefore the threats rural communities face daily or seasonally and the assets are the resilience to these threats (Moser, 1998). This view of the rural context provides the design process of a model for design of ICT4D artefacts with a rich and in-depth perspective from which the design process can frame problem identification and describe strategies. In other words, from vulnerabilities, we identify community needs and can formulate artifact strategies to overcome those needs. This in turn provides a sound base upon which the design process of an artifact can start.
- 2) Livelihood structures and processes: These include policy, institutions and structures that currently exist in the rural context and affect the livelihood outcomes of the poor (Chapman, Slaymaker and Young, 2003). Identifying these structures informs the research on partners that may support the service innovation, challenges and impediments they experience that may hinder this support
- 3) Livelihood strategies: In keeping with the changing view of the rural poor as single-sector dependent communities (subsistence farmers), the Livelihood Approach presents the concept of diversification in Livelihood strategies. Recognizing that the rural poor have more than one source of income, distribute their wealth in more than one asset, and use their assets in several activities and the multiple motives that prompt the poor to diversify their activities (Barret, Reardon and Webb, 2001). Strategies inform the design process on paths taken by the poor as they try to overcome identified vulnerabilities. From these strategies we can increase

knowledge on strategies for the artifact while identifying potential competition and challenges for the artifact.

- 4) **Livelihood Outcomes:** The outcomes are the end result to the strategies the poor carry out. The actual outcomes may be positive or negative. The outcomes of the poor's strategies inform the design process on what strategies need to be changed, and those that work and can be enhanced by the artifact. The outcomes also indicate the relevance and expected improvement from the artifact and present criteria for evaluation of the artifact in relation to development or social value creation (Verschuren and Hartog, 2005).

The STOF framework thus guides the design process. The four domains of the framework: service, technology, organizations and finance highlight the significance of the design choices and how they affect sustainability of the artifact (Bouwman, De Vos and Haaker, 2008). Together with the knowledge generated by the livelihood framework, the STOF framework enabled appropriate design choices. This was done in the following ways:

- 1) In order to rigorously design an ICT4D mobile service artifact, each domain of the STOF framework enabled us to define Critical Design Issues or variables that ensure the viability and sustainability of the artifact. With knowledge from the livelihood framework, we were able to determine those variables that are unique to a rural context.
- 2) Each domain presents to us Critical Success Factors, which are elements that present results of viability. In other words, Critical Success Factors presented to us criteria from which we were able to evaluate our artifact. Here we used the variables identified from the rural context using the livelihood framework analysis.

The combined contribution of the Livelihood and STOF framework produces a new perspective and structure for ICT4D mobile service artifacts which can guide designers, development practitioners and policy makers on the opportunities, design choices, viability and sustainability challenges present in developing in rural areas. Table 3.5 below demonstrates the contribution the two frameworks make to the construction of a model for the design of ICT4D mobile service artifacts.

Table 3.5: Theoretical Contribution

| Design Principle | Livelihood Framework | STOF Framework |
|----------------------------------|---|---|
| Rigorous design processes | Structures the problem / opportunities, challenges and characteristics in the rural context | Builds the Quick Scan by defining the service from the problem and opportunities identified |
| Design Evaluation | Defines desired end results to the problems / opportunities and challenges | Evaluate opportunities, challenges and characteristics unique to developing rural areas against Critical Success Factors and Critical Design Issues in the STOF framework |
| Research contributions | | Opportunities, challenges and characteristics unique to a developing rural areas |
| Communication of Research | | Context aware model with Opportunities, challenges and characteristics unique to a developing rural areas |

3.5 Synthesis: Sustainable Context-Aware Design Model

Rural development is shifting from the dictates of economic development and favours more grass root, bottom-up and local participation approaches (Cohen and Uphoff, 1980). Although ICT4D has been influenced by the development paradigms, rural development approach has not yet had any influence on the field, as demonstrated in Table 3.2. The field of Social Entrepreneurship however has taken strides to incorporate Rural Development approach in Business Model formulation. Mair and Schoen (2007) in discussing how Social Entrepreneurs interface with their customers or target groups, they are integrated into the value creation process as opposed to just being recipients. This approach actually differs from development agencies or institutions, which position their target groups at the end of the value chain. Mair and Schoen (2007) state that this approach has been a result of the founders' perspective on the individuals and communities they serve. Each individual is believed to be capable of and responsible for helping him / herself. This is possible once the right conditions are created and a sense of responsibility is enacted. It is explicit social Entrepreneurship organisations therefore facilitated the development of the individual and the target community.

The Livelihood Framework application presents the ICT4D field with the opportunity to develop grass root / bottom-up approach to design processes. This bottom-up approach presents an opportunity for ICT4D design processes to be driven-by-inputs from the context and not technology designs that are already in existence (Sutinen and Tedre, 2010).

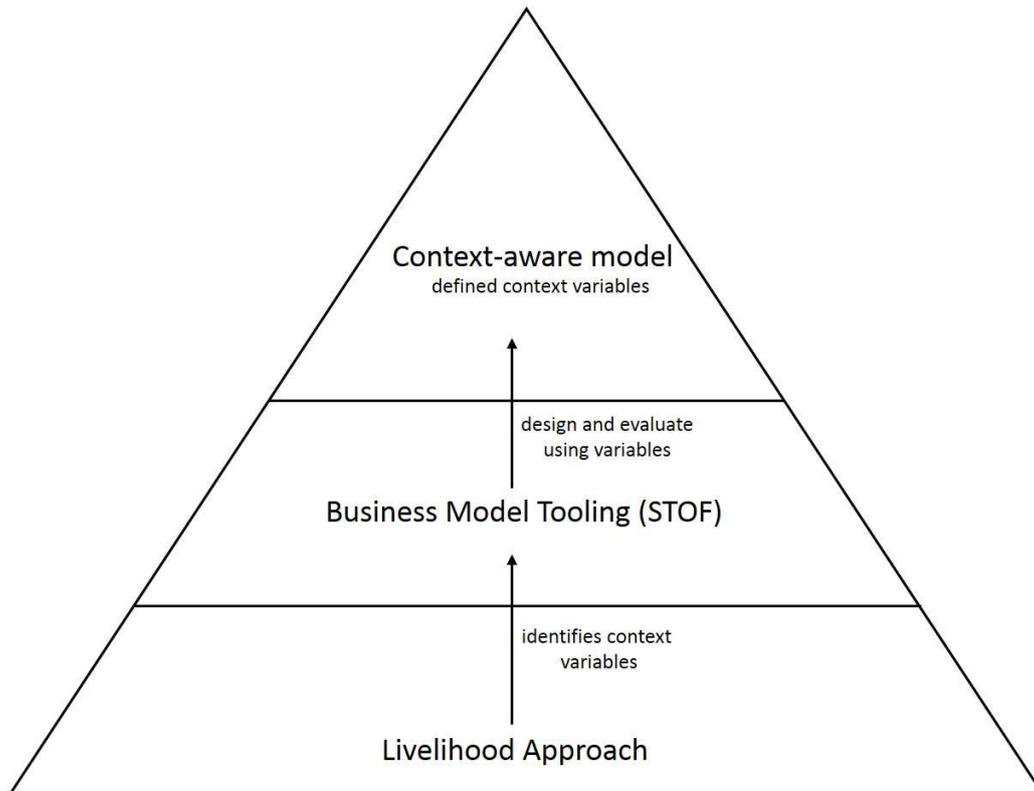


Figure 3.5: Bottom-Up Approach in ICT4D Design (Source; Research)

Social Entrepreneurship demonstrates that sustainability of social development – driven Business Models is possible. Business Modelling Tooling presents the research with an opportunity to examine this possibility in ICT4D innovations. Units of measurements may differ and resources and capabilities may not exist yet. This presents the research with two challenges that are also opportunities: (1) revision of Business Model Tooling (STOF) to accommodate Social Value Business Models and (2) Identification of social and economic business opportunities in ICT4D ecosystems. However, beyond this the immediate outcome is a context defining variables. With its detailed Critical Design Issues and Success Factors, the STOF framework presents the research with the opportunity to identify, relate and group context specific variables necessary for design of sustainable ICT4D artefacts, as demonstrated in Figure 3.5 above.

3.6 Conclusion

It should be notes that although ICT4D are multi-disciplinary (development, IS, Design Science) they are have been relatively isolated. They have however been implemented in development-oriented contexts, but have not adopted to the changing trends. Even other innovations (Social Entrepreneur innovations) have adopted Business Models, ICT4D have acted in blind faith. Hope is not lost however. New trends and developments in the field of development, advances in Business Model and Design Science ensure that there are tools and techniques to bring ICT4D forward.

However, it is important to note, because ICT4D are primarily isolated just as most of the rural contexts, they are implemented in, most of the tools and techniques we employ have been developed from dissimilar contexts. This is an opportunity not only for ICT4D, but also for the applied tools for instance STOF and the livelihood framework to identify areas that might need revision to accommodate the field of ICT4D and rural context.

Finally, it is also important to note that, unlike the previous top-down approach ICT4D took in design and implementation, introducing the livelihood approach informs, not the rural areas, but those at the top of the pyramid including development practitioners, policy makers and ICT4D designers. Where customers and end-users in market-driven economies articulate and are drivers of change, public and international institutions have been the drivers of change in development oriented economies. The approach taken ensures that the poor and context informs the drivers of ICT4D designs. The discussion in the following chapter presents the research approach used in this study.

4. Chapter 4: Research Approach

4.1 Introduction

This chapter answers the question; *what methods can the research use to understand a developing rural healthcare context while designing and evaluating the viability of a mobile service innovation in the context?* The previous chapter presents a theoretical framework the research used to guide the exploration of a rural context identify variables which were used to design and evaluate a viable mobile service innovation and its underlying business model. This chapter presents the methods the research used to explore the context, identify and describe these design and evaluation variables. Guided by the theoretical framework, methods selected for this task complement the two frameworks (Livelihood and STOF).

The first task of the research is design and evaluation. For this reason, it was decided to employ Action Design Research, a new method that is a combination of Action Research and Design Science. This method allowed the systematic design of our service innovation and made use of the knowledge from the context to shape the innovation, as discussed in the first section of this chapter. However, because the method is a combination of two methods, we present these two methods (Design Science and Action Research) and discuss the reasons for combining the two methods.

A second requirement of the research is understanding and defining poverty from the perspective of the poor (a Bottom-up approach). To achieve this, the research chose Ethnography, a method that seeks to understand the way of life from the perspective of the poor. In the second section, Ethnography is discussed as qualitative method with a focus on groups of people the meaning derived and understanding from a cultural and social perspective. This method complements the livelihood framework which seeks to understand the livelihood needs and strategies of the poor from the perspective of the poor.

The third section describes the STOF method, which operationalizes Action Design Research and the STOF framework. It consists of four steps that guide the design and evaluation process. In the third section, there is further discussion of these four steps and how they were identified, and defined design variables in the evaluation process. Data collected was used from reflections and lessons learnt in Action Design Research and Ethnography to design and evaluate the service to be used.

Just as demonstrated, how theory contributes to design science principles, in this chapter, fourth section, there is an exploration of the complementarity of the research methodology to the theoretical framework as discussed in the previous chapter. This section also demonstrates where theory was applied during method application.

Finally, the discussion focuses on the necessity and appropriateness of these three methods to the needs of the research. At the same time, it is significant to point out that there are limitations with the research methods.

4.2 Action Design Research

Action Design Research is a qualitative method, which recognizes that a designed artefact emerges from interaction with a context even when the initial design was guided by the researcher's goals.

However, to understand Action Design Research (ADR) one must first understand Design Science and Action Research, the two methods from which ADR was developed.

Design Science invents or builds new innovations and artifacts to solve problems or improve a given situation (Islam and Grönlund, 2012). Several fields that include Computer Science, Information Systems (IS) and Software Engineering have used Design Science in the design of artifacts to solve socio-technological challenges (Livari, 2007; March and Storey, 2008). March and Storey (2008) contextualize Design Science in the field of Information Systems (IS), and present two questions posed by managers: (1) Why IT investments do not lead to an increase in a firm's value, and (2) What IT artifact will yield value. The first question is answered by IS which examines the relationship between an organization, people and IT. IS uses Behavioural Science to develop an understanding (theories) that explain or predict IT implementations (Hevner et al, 2004). IS theories are then used to design working systems or IT artefacts. This is when Design Science comes in. Design Science does this through an iterative process that includes six stages:

- 1) The First Hunch; this is the initial idea about the artifact that is to be constructed and the product of this stage is a set of goals.
- 2) Requirements and Assumptions: From the goals defined from the first stage, requirements (functions that the artifact will perform, user interface and contextual requirements) are formulated. At this stage, assumptions of expected users and the context are made.
- 3) Structural Specifications or characteristics and aspects of the artifact can be formulated from the requirements and assumptions in the previous stage.
- 4) A Prototype is developed from the Specifications.
- 5) Implementation or putting into practice the prototype.
- 6) Evaluation of the artifact in relation to the artifact (Verschuren and Hartog, 2005).

Through the processes of building and evaluation, Design Science determines utility, and generates knowledge that informs theory. Hevner (2007) outlines three cycles in which the activities of design science exists. The Relevance Cycle, which includes activities that study context in which an artifact (innovation) will exist: and later on introduces the artifact into the context, the Rigor Cycle which generates new knowledge through application of theory and method, and the Design Cycle constructs and evaluates the artifact. Figure 4.1 demonstrate these three cycles.

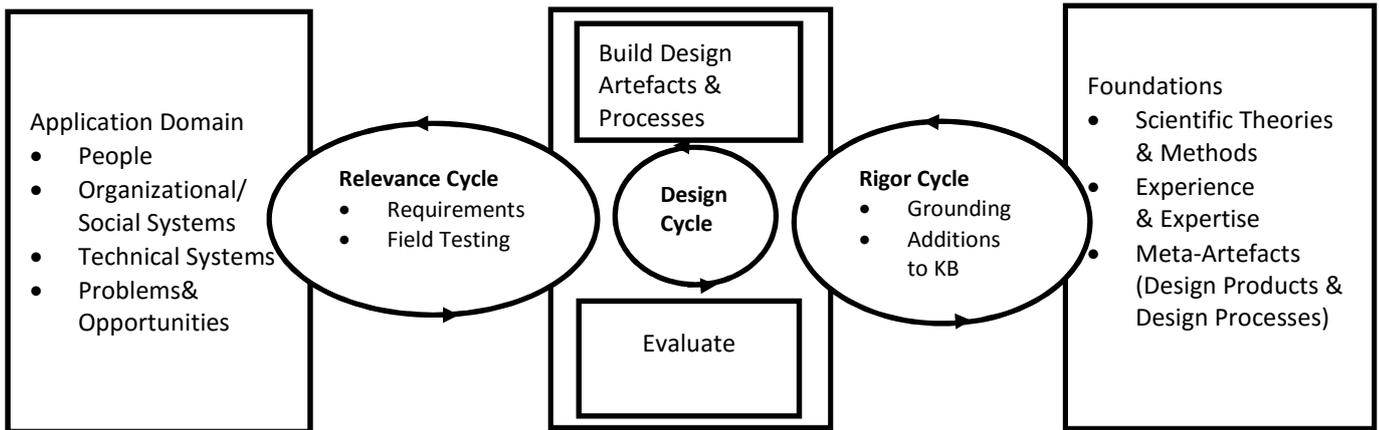


Figure 4.1: The three cycles in Design Science (Hevner, 2007).

On the Relevant side, Behavioural Science presents theory to explain and predict problem spaces in organizations – this Hevner et al (2004) refer to as truth. Design Science then constructs an artefact (material or immaterial) to improve the problem space using theory, methods and or framework on the Rigor side, and finally through these processes, Design Science creates new design knowledge (Sein et al, 2011). However, for the case of a developing context as the previous chapter points, development theory is necessary to explain and predict the problem space in the Relevant Cycle. The previous reveals that, the Design Cycle guides the activities of the STOF framework with a method and criteria that ensures rigor in the design and evaluation process. Application of the two theories introduced rigor into the research and therefore develops the context-aware model as new knowledge.

As artifacts are applied to problem spaces, ICT4D need Design Science methodology. However, this is not evident in ICT4D literature. Doerflinger and Gross (2010) explain that ICT4D lack research methods along the entire life cycle from design development, deployment and evaluation. In fact, Sutinen and Tedre (2010) state that the ICT4D field is mostly focused on evaluating feasibility of existing technologies from Western or the Far East Asia implemented in a developing context. Design Science therefore presents an opportunity to generate knowledge during the design process of an ICT4D artefact.

However, Design Science methodology in IS research falls short by failing to incorporate the Organizational context in building and evaluation of artefacts. This is because design creates a new reality, but does not explain an existing reality (Islam and Grönlund, 2012). Sein et al (2011) argue that there is a disconnection between research and practice in IS research, primarily because Design Science methodology (build and evaluate) is sequential, beginning with **identification of a problem**, **development of the artefact** and then **evaluate the artefact** to see if it meets the goals to eliminate or improve the problem. However, Design Science as Sein et al (2011) point out fails to take into consideration that the artefact is an “ensembled” technology structure that includes the designer’s building and the organizational stakeholder. Organizational intervention should be part of the building and evaluation process. If this perception is transferred to ICT4D artefacts, then the recommendation of Prakash and Rahul De’ (2007) that argues the influence of development context in the design of ICT4D artefacts can be related to the gap in IS artefact design.

According to (Avison, Lau, Myer and Nielsen, 1999; Cole, Puroo, Rossi and Sein, 2005; Sein et al, 2011) Action Research as a solution to the disconnect experienced in Design Research. Action Research is a qualitative research method that combines theory and practice by focusing interest on two goals, solving the immediate problem in a situation and contributing to social science through reflection on the effect of actions undertaken in solving the immediate problem. Because there is a dual challenge, (practice and theory), Action Research must be conducted in a mutually acceptable ethical framework. This caters for the interests of all stakeholders (practitioners and researchers) (Avison, Baskeville and Myers, 2001; Bydon-Miller, Greenwood and Maguine, 2003), balancing the need to effect change in a problematic situation or context (practitioners) and the need to add on to theory (researchers).

It is important to note that, Action Research was introduced in 1946 by Kurt Lewin to address social change through action. The change-oriented approach of Action Research uses the strategy of introducing change into a situation and observing the effect (Cole, Puroo, Rossi and Sein, 2005), a process that is iterative and requires researchers and practitioners to work together. It is therefore recommended for designers to use participatory action research where the researcher actively participates with the participants in a context. These participants (organizational stakeholders) contribute to the solutions design (Avison, Lau, Myer and Nielsen, 1999). (Sein et al, 2011) goes ahead to propose a new method – Action Design Research – that combines Action Research and Design Research, as a method that recognizes that the designed artefact emerges from interaction with a context even when the initial design was guided by the researcher’s intentions.

4.2.1 ADR Methods

Sein et al (2011) define four stages that Action Design Research follows in the design process: (1) problem formulation, (2) building, intervention and evaluation, (3) reflection and learning and (4) formalization of learning. In the problem formulation stage, we find the first three stages of Design Science (First Hunch, Requirements and Assumptions, and Specifications), but in this case, all stakeholders are involved. These may be practitioners, end-users and researchers. As the First Hunch is defined and conceptualized, the roles and responsibilities of the stakeholders are agreed upon. The agreed upon roles and responsibilities are the guiding ethical framework that ensure a balance in the mutual interests of practitioner or end-users on one side and researchers on the other. Conceptualization is also guided by existing theories. Here Sein et al (2011) recommend: (1) explanation and prediction theory to structure the problem or First Hunch and identify solution possibilities, and (2) design theories to guide the design. The building, intervention and evaluation stage is the second stage in ADR and the fourth and fifth stages of the design process (prototype, implementation). In this stage, the initial design is further shaped by the context where the problem was identified. Through iterative processes of action and reflection, the artefact is continuously evaluated and the final product is the designed artefact. Significant to this stage is clarity on the origins of the designed artefact. The origin influences the research design. (Sein et al, 2011) point to two sources: IT-Dominant or Organization-Dominant (which for the sake of this research shall be referred to as, Context-Dominant). IT-Dominant are usually technological innovations. Designers initiate an artefact, which is introduced to a limited part of the context. Through iterative processes of intervention and evaluation with participation from practitioners or end-users, the artefact together with the applied theories are evaluated and refined into a mature artefact which when implemented, has received a comprehensive evaluation into the wider context.

Organization or context-dominant origins of designs usually generate design knowledge whereby the researcher(s) begins by challenging participants within the context on the conceptualized First Hunch in order to create or improve it. The primary source of the artefact is the context. Interactions with the context reveal the situation and needs, which may lead to creation or an improvement process. This is done through processes of intervention and evaluation, and each interaction ends with the assessment of the artefact and design principles it represents. This locus of building, intervention and evaluation is more in line with our research interests. At the end of the build, intervene and evaluate stage, whether it is an IT-Dominant or Context-Dominant, a decision to either exit, spawn more cycles of build, intervene and evaluate, or adopt the new innovation is made.

Reflection and learning is done parallel to problem formulation and the build, intervene and evaluate stages. During this stage, the evaluation stage of design science is found. This stage leads the research from a specific situation to application of a general class of problems. Qualitative research usually focuses on a specific situation and some argue that it is not possible to apply findings to general situations (Myers, 1997). Hence, this stage serves to eliminate the fear of isolation in research. In addition, the stage ensures that the research is more than just solving a specific problem in a given context, but requires contribution to knowledge through reflection on the problem, theories used and the emerging artefact.

The final stage, formalization of learning, places the situation as specific study into a category of problems and innovations. In so doing, the researcher facilitates conceptualization of the situational problem by outlining and describing accomplishments and outcomes of the artefact, and the context, which at the end can be described as design principles. At a higher level of reflection, these accomplishments and outcomes can refine or define theory.

In these four stages, we apply the two methods are applied that together achieved the objective of studying the rural healthcare context, while designing and evaluating the service innovation and its business model, starting with Ethnography approach, which was used to study the context. Table 4.1 below presents a summary of ADR methods applied in the research.

Table 4.1: Action Design Research Methods

| Stage | ADR Activity and methods | Output |
|---------------------------------------|---|--|
| Problem Formulation | <p>Application of Theory to Domain</p> <ul style="list-style-type: none"> - A rural healthcare access problem is viewed as opportunity or First Hunch - Conceptualize the problem by applying the situation problem to a class of problems - Proposed m-Health artefact is informed by the Livelihood framework which explains and predicts the rural context, and the STOF framework which guides the design process of the artefact and its viability - Initial meetings and discussions with stakeholders including 1) health facility management teams, governing institutions and professional community health practitioners 2) Telecom providers | Initial idea of the m-Health artefact and a generic set of factors that might influence the viability and sustainability of the artefact |
| Building, Intervention and Evaluation | <p>Ethnography Methods</p> <ul style="list-style-type: none"> - Participation and observation of Implementation of m-Health artefact (mTrac) in Nindye health facility and community - Evaluation of reactions from the community - Refine the initial m-Health artefact, business model and the set of influencing rural social, economic and political structures | Specific set of requirements, assumptions and specifications of an m-Health artefact specific to the case study area, and a refined set of generic social, economic and political factors influencing viability and sustainability |
| Reflection and learning | <p>STOF Evaluation</p> <ul style="list-style-type: none"> - Conceptualization of the specific problem to a class of problems - Theoretical and knowledge contribution | Ideal m-Health artefact for the case study area and a specified set of social, economic and political factors influencing viability and sustainability |
| Formalization of learning | <ul style="list-style-type: none"> - Outline and described findings - Abstraction of findings - Articulate findings as design principles - Share and communicate findings | A set of design principles for m-Health artefacts in developing rural areas |

4.3 Ethnography

Under the umbrella of Qualitative Research, is Ethnography, a research approach whose roots can be traced to 1922 when Bronislaw Malinowski made the first documented attempt to study a culture foreign to him from the perspective of the people in the alternate society (Harvey and Myers, 1995). Ethnography studies people's behaviour in their natural settings, with a special focus on cultural

interpretation of behaviour. As a type of qualitative research, ethnography is interested in the identification of the presence or absence of something, description of the nature and features of things (Watson-Gegeo, 1988). Ethnography tries to understand another way of life from the perspective of the native, and in the end provides a descriptive and explanatory account of people's behaviour in a given context (Eisenhart, 1988). It is important to note that Ethnography studies a group and not individuals. Although individual participants are interviewed and a researcher builds relationships with individuals, it is the interactions and differences between the individuals that form cultural behaviour and the whole cultural experience (Watson-Gegeo, 1988).

In studying a context, qualitative approaches are especially appropriate because they consider context as a social construct and the reality of a specific group of people. On the other hand, quantitative approaches consider the variables in a context, categorizing some as interfering or noise that need to be controlled, and others as controlled variables that are especially experimented to determine cause and effect relationships (Harvey and Myers, 1995). In this case, the meaning and understanding of the context is lost.

The discussion on rural development theory and the livelihood framework subsequently highlights the need for a bottom up approach in development and development strategies. The same issue was raised for the design process of ICT4D. Ethnography therefore offers the opportunity for both development and design requirements that the research attempts to achieve. Qualitative research and specifically ethnography provides rich insight into context, the people and the underlying social processes that exist in a social setting. Ethnographers are required to spend long periods of time in the field and immerse themselves in the life of the people they are studying. Ethnographers therefore obtain an in-depth knowledge of people and the context in which they live and work (Myers, 1997).

4.3.1 Ethnography Methods

(Eisenhart, 1988) outlines four methods used in Ethnography:

- 1) Participatory Observation: The researcher becomes part of the group in the study by actively participates in activities of the group, but observes the scene as an outsider.
- 2) Interviews: The principle method that a researcher uses to gain knowledge of individual participants subjective views. Interviews are usually open-ended, but can take many forms including informal (more like a conversation between the researcher and participant and can be taped) and formal (with structured and open-ended questions).
- 3) Search for artefacts: This is a search for context, which can be written or graphical related to the topic under study.
- 4) Researcher introspection: Reflections of the researcher on research activities and context that explain account for inspirations, interpretations, feelings and effects that occur during the course of the study.

The strength of Ethnography is in studying a given context. Therefore, in the research we applied Ethnography methods in the first two stages of ADR.

4.3.2 Methods in the Problem formulation stage

Within the Problem formulation stage, the following methods are applied:

- 1) Village meetings for Nindye parish were organized. The participants were divided into three groups: men, women and Village Health Teams (VHTs). Each group was tasked with discussing among themselves healthcare challenges they experience, and recorded the discussion sessions of each group with their permission while they discussed healthcare challenges they experience in their villages. After the meetings, each group presented the results of their discussion, then, a second village meeting was set up to discuss challenges identified and formulate solutions to the challenges.
- 2) One of the results from this meeting was training and refresher training sessions for VHTs from Nindye parish. We attended and observed four VHT training sessions in which they discussed challenges they experience as they delivered healthcare to fellow community members
- 3) During the training sessions an opportunity was taken to interview one of the VHTs to gain more understanding on what the VHTs do and the challenges they had expressed in the various meetings and training sessions.
- 4) We participated in a council meeting for Nindye parish. This involved a variety of community members. We attended the council meeting as observers.
- 5) During the meeting, we interviewed Nindye community members to gain in-sight into the challenges they experience.
- 6) Most of the initial observations had been with Nindye parish, to validate and broaden our understanding of the health challenges. We however also interviewed health workers from Nkozi Hospital as well as health workers from Nindye health facilities to understand the challenges of the community, VHTs and health facilities.
- 7) With the same objective of attempting to validate and broaden our understanding of health care challenges we participated in an outreach exercise organised by Nkozi Hospital and the VHTs attached to the hospital.
- 8) We sought and obtained a report on views VHTs attached to Nkozi Hospital have on their work and mTrac one of the artefacts evaluated.
- 9) We interviewed a member of Nkozi area, to ascertain and validate the challenges voiced by community members in Nindye and community members in Nkozi Hospital

4.3.3 Methods Application in building, intervention and evaluation stage

The first stage was broad in observation, focusing more on general healthcare challenges than on the proposed artefact. As the research progressed to the building, intervention and evaluation stage, greater attention was paid to the reaction of the VHTs and health workers as users of the mTrac. During and after the application of mTrac the researcher applied the following ethnography methods:

- 1) Participatory observation of mTrac training sessions at Nindye health facility. The sessions involved two parts: the first was a refresher course on the work of a VHT, mTrac and the functional processes and finally the registration process. We recorded and participated in the registration process.

- 2) From the observation of mTrac training sessions, an attempt was undertaken to address the mobile literacy gap that exists in the case study area. We organized and observed mobile literacy classes for VHTs attached to Nindye Health facility. In addition as part of a request made during the group discussions, and installed computers at two health facilities and thereafter organized and observed computer literacy classes with health workers at one of the health facilities (Nindye Health Centre III).
- 3) We interviewed VHTs attached to Nindye Health facility after their training sessions to ascertain and validate the challenges observed with Nindye VHTs.

These methods are summarized in Table 4.1 and 4.2

Table 4.2: Ethnography methods applied to the four stages research

| Stage | ADR Activity and methods | Ethnography Methods | Output |
|---------------------------------------|---|---|--|
| Problem Formulation | <p>Application of Theory to Domain</p> <ul style="list-style-type: none"> - A rural healthcare access problem is viewed as opportunity or First Hunch - Conceptualize the problem by applying the situation problem to a class of problems - Proposed m-Health artefact is informed by the Livelihood framework which explains and predicts the rural context, and the STOF framework which guides the design process of the artefact and its viability - Initial meetings and discussions with stakeholders including 1) health facility management teams, governing institutions and professional community health practitioners 2) Telecom providers | <ul style="list-style-type: none"> - Community group discussions - Observation of VHT healthcare training sessions - Interviewed a VHT during healthcare training session - Observation of parish council meeting - Interviewed community members at the council meeting - Interviewed healthcare workers at health facilities - Participation in community healthcare outreach exercise - Supervisor report on meeting with VHT - Interview Nkozi area community member | Initial idea of the m-Health artefact and a generic set of factors that might influence the viability and sustainability of the artefact |
| Building, Intervention and Evaluation | <p>Ethnography Methods</p> <ul style="list-style-type: none"> - Participation and observation of Implementation of m-Health artefact (mTrac) in Nindye health facility and community - Evaluation of reactions from the community - Refine the initial m-Health artefact, business model and the set of influencing rural social, economic and political structures | <ul style="list-style-type: none"> - Participatory Observation of mTrac training sessions - Participatory Observation of mobile and computer literacy classes - Interviewed after mTrac training sessions | Specific set of requirements, assumptions and specifications of an m-Health artefact specific to the case study area, and a refined set of generic social, economic and political factors influencing viability and sustainability |
| Reflection and learning | <p>STOF evaluation</p> <ul style="list-style-type: none"> - Conceptualization of the specific problem to a class of problems | | Ideal m-Health artefact for the case study area and a specified set of social, economic and |

| | | | |
|---------------------------|---|--|---|
| | <ul style="list-style-type: none"> - Theoretical and knowledge contribution | | political factors influencing viability and sustainability |
| Formalization of learning | <ul style="list-style-type: none"> - Outline and described findings - Abstraction of findings - Articulate findings as design principles - Share and communicate findings | | A set of design principles for m-Health artefacts in developing rural areas |

Ethnography methods provided the research with a description of a rural healthcare context from which we identified needs / opportunities, challenges and impediments. Needs gave us the initial idea for the m-Health service while challenges and impediments pointed to factors that might influence viability. These elements were then used to design and evaluate the artefact. The design and evaluation process used ADR methods and the STOF method. In the next section, there is a discussion of the STOF method.

4.4 The STOF Method

In Chapters 1 and 3 STOF framework was presented and described as four domains with related design variables. These variables are design choices that create balance in the domains, which results in the viability of a service innovation. However, the framework itself describes but does not design. The STOF method was developed specifically to support the design process of business model and its service innovation. It presents a step-by-step approach in four stages that (Bouwman, De Vos and Haaker, 2008) outline as follows:

4.4.1 The Quick Scan

The first stage referred to as The Quick Scan develops a first draft of a business model for a mobile service innovation artifact. Using a set of recommended basic questions, the Quick Scan defines four domains (service, technology, organizations, and finance) that highlight the requirements, assumptions and specifications of a mobile service innovation. In this case, this will be for an m-Health artifact. This stage relates to the Problem formulation stage within Action Design Research. The first draft of the business model is evaluated on paper, referred to as a plan evaluation. Verschuren and Hartog (2005) define evaluation as, “the process of comparing separate parts with selected criteria and then draw a conclusion on whether the part or parts are satisfactory or not.”

Input for the first draft is derived from analysis of the domain using the livelihood framework. This analysis identifies the First Hunch, Requirements, Assumptions and Specifications from vulnerabilities and assets common to the poor in developing rural areas. This stage generalizes the problem and therefore gave validity to research findings later refined with ethnography findings in the case study. Evaluating the four domains developed from this initial stage was guided by the STOF method that recommends balancing the domains by examining how each affects the other. For instance, questioning how the value proposed by the service can be delivered by the suggested technology, organization and finance domains.

Specific to this research, is identification of underlying social, political and economic factors that influence the artefact and the four domains. These factors were later on used to build the context-aware design model that is the final product of the design process. The Quick Scan process and the expected outcomes are represented in the Figure 4.2 below.

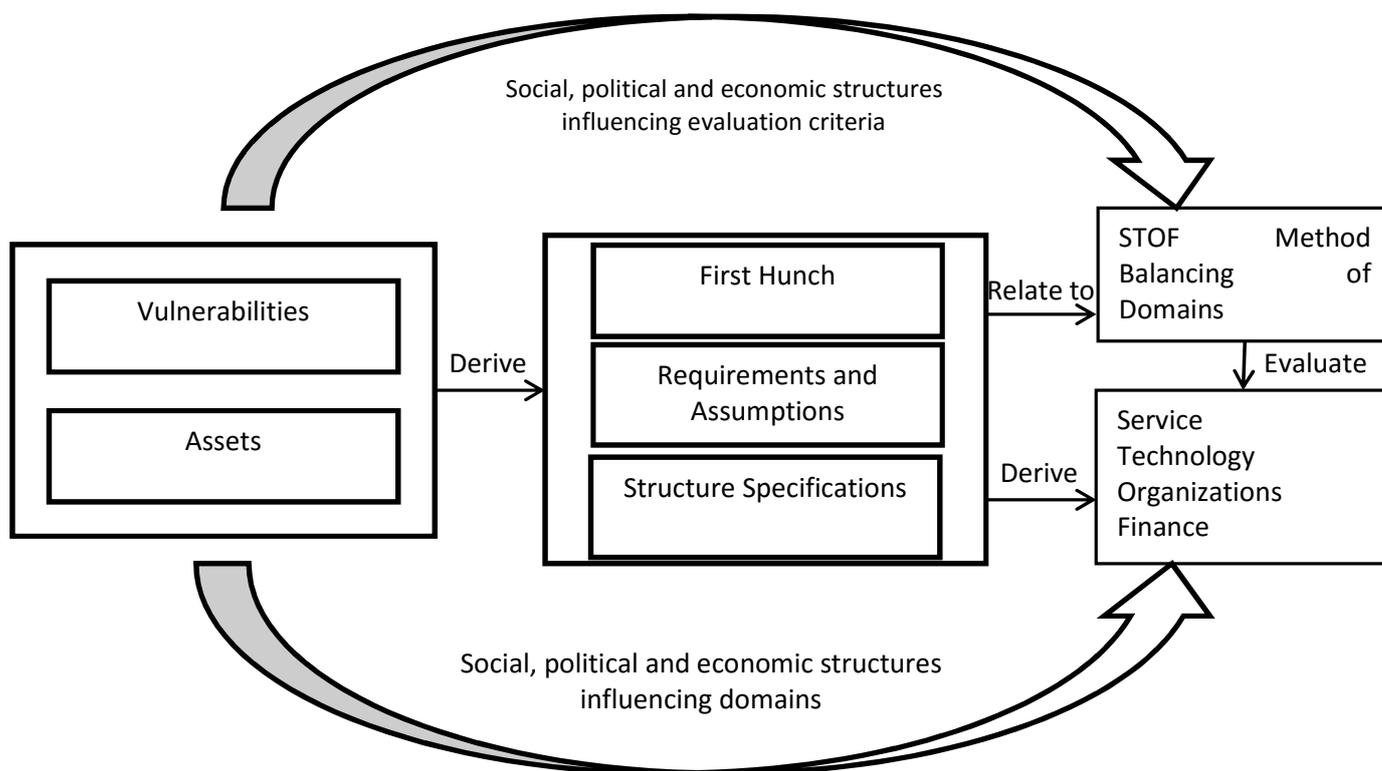


Figure 4.2: The Quick Scan Process (Source; Research)

Methods Applied in problem formulation stage

The Research applied the problem formulation stage through:

- 1) There was identification of a specific healthcare access and delivery problem in the rural case study area - distance between health facilities and community households hinder healthcare access. This problem was traced to other developing rural areas through existing literature, which also revealed other healthcare challenges experienced by poor communities, health facilities and governing institutions in a rural healthcare context.
- 2) Application of the livelihood framework. To explain and predict the healthcare challenges of community households, health facilities and governing institutions we used the livelihood framework. The researcher used the four sections of the framework to identify not only the initial challenge, distance health facilities, but also other healthcare delivery and access challenges that all stakeholders experience.
- 3) Application of the STOF method: the researcher applied the STOF framework to use the challenges and stakeholder identified in with the livelihood framework to guide the design process for the artefact and the business model. Using the Quick we developed, service innovation (artefact), organization (partners organizations that will operate and run the service), technology (technology architecture of the service) and the finance (revenue generation).

- 4) Involving all stakeholders. The initial idea was presented to stakeholders including management teams from the two health facilities in the case study area, a member of the governing board of directors for one of the health facility, a key personnel officer at a governing institution for one of the health facilities, and key personnel with telecom providers in the Ugandan Telecommunication sector, and also solicited the advice of professional community health workers and health promoters that have worked with developing rural communities other than the case study.

The result of this stage is a rough idea of the m-Health artefact specific to the case study area as well highlights of social, economic and political factors that might influence the viability of the artefact.

4.4.2 Evaluation with the CSFs & Specification of CDIs

In the second stage of the STOF method, is found the building, intervention and evaluation stage of the ADR. At this point, the artifact is evaluated (referred to as process evaluation) according to how satisfactory the proposed value of the artifact is for specific actors in the context of application. The STOF method suggests using Critical Success Factors (CSF), which enable a designer to measure to what extent each domain and the business model as a whole is able to deliver value to the target users. The social, economic and political factors are related to those suggested by the STOF method. The end result should be a set of CSF that are common to the STOF method and those that are unique , which together make up CSFs that ICT4D designers can base on as a measure on the viability and sustainability of rural ICT4D artefacts.

The third stage, specification of CDIs is in reality done alongside the evaluation of CSFs in stage 2. Bouwman, De Vos and Haaker (2008) point out that evaluation of the CSFs, a designer through causal relations with CSFs, is able to specify the Critical Design Issues (CDI) which influence the viability and sustainability of the business model. This approach and method also correlates to the Reflection and Learning stage in ADR that is done alongside the building, intervention and evaluation stage. CSFs and CDIs are related. CDIs also belong to specific domains. Bouwman, De Vos and Haaker (2008) therefore recommend two approaches in the specification of CDIs. In the first approach, CDIs are refined according to the domain they belong. For instance, while evaluating CSFs in stage 2, the designer refines the CDIs related to CSFs within the domain they belong. The designers carry out this process until all the domains are done. The second approach refines sets of CDIs for each CSF. For instance, as a CSF is evaluated in stage two, in stage three, the CDIs that influence the CSF are refined. Whichever approach is selected, the domains must be balanced as recommended in stage one.

Methods Application in building, intervention and evaluation and Reflection and learning stages

First, is the building, intervention and evaluation stage, which employs participatory observation, survey questionnaires and interviews to gauge the reaction of the context to the artefact. Implicit observation was first noted in the meetings and discussions with stakeholders mentioned in the problem formulation stage. Explicitly, this method was employed during the implementation of the first case study mHealth artefact and mTrac. The reactions to the proposed value and functional features guided the research in refining the second case study artefact, Frontline SMS. After implementation, the following methods were applied:

- 1) Survey questionnaires. This was designed together with the questionnaires basing on the STOF framework's service domain, specifically to evaluate mTrac's value proposition to the end-users. The survey tried to gauge the perception of the end-user to the value proposed by the service innovation. The questionnaire, using knowledge attained from ethnography and ADR

methods particularly also tried to determine the effect context social, economic and political factors might have on value proposition of the service innovation. The questionnaire targeted VHTs that were using mTrac. This questionnaire was administered to Nindye VHTs and, the same questionnaire administered to Nkozi Hospital VHTs to validate our findings from Nindye’s VHTs.

- 2) Health workers were interviewed, specifically those that participated and used mTrac from Nindye and Nkozi health facilities.
- 3) Following reflection and learning from mTrac, as we progressed to the development of the second mHealth artefact, Frontline SMS, and conducted computer literacy classes where tests were administered. The computer literacy classes were given to Nindye health workers and this yielded a report and test results. Mobile literacy classes were given to Nindye VHTs and community members. Test results included before and after test. That is, a test before the literacy class and a test after the literacy class.

These activities and evaluation processes refined the social, political and economic structures as well as variables identified in the structure, and were able to identify the effect they have on the viability of a service innovation. This process is represented in Figure 4.3 below.

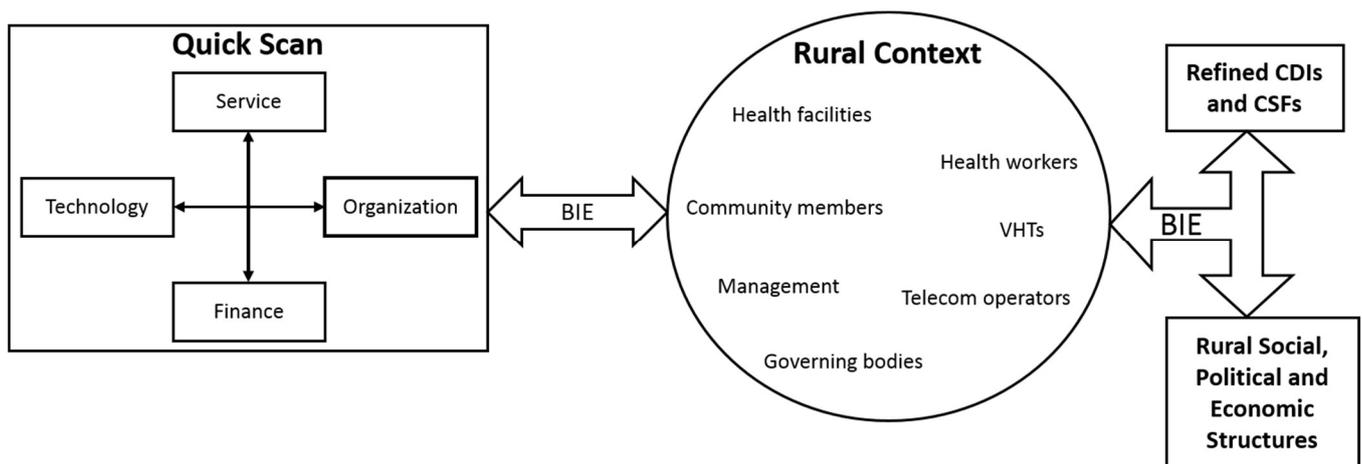


Figure 4.3: Evaluation of CSFs (Source; Research)

4.4.4 Evaluation

This is the final phase of evaluation in the STOF method which considers the external environment and its influence on the robustness of the business model. These external factors directly or indirectly affect the CDI, which in turn affect the CSFs. The point of the evaluation is not simply to identify the factors, but also to gauge the business model’s ability to adapt and evolve overtime so as to accommodate the influences of the external factors.

Methods in the Evaluation Stage

Some of the influences are picked up along the way from stage 2, but specifically in this stage, key personnel were targeted in some of the partnering organizations, together with key respondents that have a professional view of the rural context and key actors (especially end-users). Both sets of respondents were able to give insight into the domains and pinpoint influences external and internal factors might have on the business model. The respondents targeted are listed below.

1. Community Development Practitioner working with University Partnership for Outreach Research Development (UPFORD), an outreach program within Uganda Martyrs University that is located in Nkozi Sub-County and has been working with Nindye community to improve livelihoods. The respondent is familiar with the case study area and was instrumental in providing intimate knowledge and understanding of the community.
2. Community health practitioner involved in the facilitation and training of Nindye VHTs. The respondent is not only an academic profession in the area of community healthcare but has organized and facilitated a number of activities in the training and research with Nindye VHTs and health worker.
3. Interviews with partners of mTrac (UNICEF and Malaria Consortium): UNICEF Health Systems Strengthening Specialist: The respondent is one of the lead designers and developers of mTrac and working for UNICEF, one of the donors behind the innovation. The respondent therefore has insight into the internal and external influences in the service and business model design.
4. Malaria Consortium Technical Officer: The Non-Governmental Organization is the main coordinator of the specific activities that the VHTs and healthcare workers were expected to report on in mTrac. The respondent therefore provided insight into the strategies and influences on the sustainability of the innovation to enable continued service delivery on reporting.

CSFs and CDIs (the design variables) at the end of the research process point at specific context variables that become strategic choices for value creation. In addition, the underlying social, political and economic structures that influence the business model not only enriches the model, but demonstrate to practitioners and policy makers on areas of opportunity, challenges and impediments that need attention in poverty alleviation programs. Table 4.3 presents a summary of the methods used with the STOF method application.

Formalization of learning stage

The final stage, formalization of learning, places the situation study into a category of problems and innovations. In so doing, the researcher facilitates conceptualization of the situational problem, and does so by outlining and describing accomplishments and outcomes of the artefact and the context, which can be described as design principles. At a higher level of reflection, these accomplishments and outcomes can refine or define theory.

Table 4.3: Ethnography and ADR methods applied to the four stages research

| Stage | ADR Activity and methods | Ethnography methods | STOF methods | Output |
|---------------------------------------|--|--|--|---|
| Problem Formulation | <p>Application of Theory to Domain</p> <ul style="list-style-type: none"> - A rural healthcare access problem is viewed as opportunity or First Hunch - Conceptualize the problem by applying the situation problem to a class of problems - Proposed mHealth artefact is informed by the Livelihood framework which explains and predicts the rural context, and the STOF framework which guides the design process of the artefact and its viability - Initial meetings and discussions with stakeholders including 1) health facility management teams, governing institutions and professional community health practitioners 2) Telecom providers | <ul style="list-style-type: none"> - Community group discussions - Observation of VHT healthcare training sessions - Interviewed a VHT during healthcare training session - Observation of parish council meeting - Interviewed community members at the council meeting - Interviewed healthcare workers at health facilities | <p>The Quick Scan develops a rough business model using a set of recommended questions to design and balance the four domains (service, organizations, technology and finance)</p> | <p>Initial idea of the mHealth artefact, a rough business model, and a generic set of factors that might influence the viability and sustainability</p> |
| Building, Intervention and Evaluation | <p>Ethnography methods</p> <ul style="list-style-type: none"> - Participation and observation of Implementation of m-Health artefact (mTrac) in Nindye health facility and community - Evaluation of reactions from the community | <ul style="list-style-type: none"> - Observation of mTrac training sessions - Participation in community healthcare outreach exercise - Supervisor report on | <ul style="list-style-type: none"> - Survey Questionnaires - Computer and mobile literacy tests - Interviews with health workers that use mTrac from Nindye | <p>Nindye Frontline SMS application and business model, with a generic set of CSFs, CDIs and external social, economic and political</p> |

| | | | | |
|---------------------------|---|--|--|---|
| | <ul style="list-style-type: none"> - Refine the initial m-Health artefact, business model and the set of influencing rural social, economic and political structures | <ul style="list-style-type: none"> - meeting with VHT - Interviewed after mTrac training sessions - Observation of mobile and computer literacy classes | <ul style="list-style-type: none"> - and Nkozi health facilities - Evaluation of CSFs. Using the recommended CSFs in the STOF method, relate the social, economic and political factors identified from the case study area - Relate and define Critical Design Issues (CDIs) | <ul style="list-style-type: none"> - factors influencing viability and sustainability. |
| Reflection and learning | <p>STOF evaluation</p> <ul style="list-style-type: none"> - Conceptualization of the specific problem to a class of problems - Theoretical and knowledge contribution | | <p>Specification of CDIs. Using STOF's recommended CDIs, relate, identify and refine the CDIs</p> | <p>Nindy Frontline SMS application and business model, with a generic set of CSFs, CDIs and external social, economic and political factors influencing viability and sustainability.</p> |
| Formalization of learning | <ul style="list-style-type: none"> - Outline and described findings - Abstraction of findings - Articulate findings as design principles - Share and communicate findings | | <p>Robustness Check evaluates the business model against the external influences (the social, economic and political).</p> <ul style="list-style-type: none"> - Interviews with community and healthcare professionals - Interviews with key personnel with the partner organizations with mTrac | <p>Design model and principles for mHealth artefacts in developing rural areas</p> |

| | | | | |
|--|--|--|--|--|
| | | | The result is a set of design principles and model | |
|--|--|--|--|--|

Methods Applied in the formalization of learning

Developing design principles and model from the findings is guided by the two theories applied. The livelihood framework guides the research in establishing generic social, economic and political factors that influence healthcare access and delivery in a developing rural area, while the STOF model identifies business model composition requirements unique to a developing rural area.

4.5 Theory Application

In the previous chapter, two theories that the research used were presented. The purpose of the two theories was to provide criteria against which variables and use those variables could be identified, and used to design and evaluate the service innovation and its underlying business model. The livelihood approach provides the criteria for identification of needs (social value), stakeholders (end-users and stakeholder) and rural structures (social, political and economic factors).The research applied this theory in the first two stages: in the problem formulation stage to help conceptualize the problem (Hevner et al, 2004). Chapter 2 provides a broad description of a rural healthcare context. The livelihood framework in the problem formulation stage begins the process of conceptualizing design and evaluation criteria from this description. In the second stage – Build, Intervene and Evaluate: there was application of the initial design and refined the criteria identified in the first stage. Then, the structure of the livelihood framework was used to organize field data collection and analysis.

The second “theory”, STOF is applied in the first three stages of ADR, a framework that depended on identified criteria as input in the problem formulation stage. In turn, STOF through design and evaluation using criteria from the livelihood framework define context variables that are used to formulate the first version of our context-aware model. In the second and third stages, STOF defines these variables using field data. The formulation stage presents broad definitions of these variables. However, we used the building, intervention and evaluation for Reflection and Learning and refined these variables into concrete variables that define the context and entities in the context. Application of these two theories implicitly formalize our context-aware model to be generalized to m-Health applications for poor rural contexts. Table 4.4 below is a summary of the areas where theory was applied in this research.

Table 4.4: Theory application to ADR

| ADR Stage | Theory Applied | Output |
|-------------------------------|----------------------|---|
| Problem Formulation | Livelihood framework | Criteria for Design and Evaluation of service and business model |
| | STOF framework | Context Variables |
| Build, Intervene and Evaluate | Livelihood framework | Refine criteria for design and evaluation of service and business model |
| | STOF framework | Refine context variables |
| Reflection and learning | | |
| Formalization of learning | | Context-aware model |

4.6 Synthesis: Research Methodology

The discussion has outlined the research methodology used in this, research. Research methodology defines the way to systematically solve a research problem (Kothari, 2004). The question is if this methodology supports our overall research objective, which is to design a context-aware model to support the design and evaluation of an m-Health service innovation in rural areas. The first methodology selected ADR supports (1), the design objective of the research and (2), the bottom-up approach requirements of our theoretical framework. In addition, the design objective is supported by the four stages of ADR, (1) problem formulation, (2) build, intervene and evaluate, (3) reflection and learning and (4) formalization of learning. The bottom-up approach is supported by the participation of all stakeholders (designers and actors in the context) in the design of context-aware model.

However, ADR was developed for organizational contexts. The participation of all organizational stakeholders is easier to achieve in the design process than in a poor community. This is primarily because of the structures that define poor contexts: poverty and culture. These give “meaning” to the participation of the rural stakeholders. This is why the research turned to Ethnography. Ethnography gave ADR a meaningful description of the poor’s participation in the design of the artefact. However, it must be noted from the domain description, there are stakeholders in the rural healthcare context that are not necessarily part of the poor community and therefore were not active participants in the context although they are influential actors in the context. Ethnography has two major limitations: the first being that, it takes too long because it requires an in-depth study and the second is that, it does not have breadth (Myers, 1997). The time it took to study a rural community and its healthcare system did not allow for adequate study of those actors that were not physically present in the rural context. These include public (governing institutions such as Ministry of Health and international agencies such WHO) and private institutions (telecom providers). The research had to limit itself to the effects these stakeholders have in rural healthcare context.

The STOF method operationalized the methodology. The systematic guidelines it provides put into practice each of the activities and methods outlined in the methodology. However, the limitations of Ethnography left gaps in the evaluation processes. Further, the STOF framework includes an Organizational domain where the institutions that were not visible in the rural context are evaluated. However, because they were not adequately studied, evaluation of these as partners in the value chain was not sufficient.

4.6 Conclusion

To conclude, it is vital to state that the methodology selected complements the theoretical framework. It is also noted that Ethnography is appropriate for the livelihood approach to enable the research to describe the needs, challenges and impediments of the poor from the perspective of the poor. Action Design Research is appropriate in introducing the design bottom-up approach advocated for by Sutinen and Tedre (2010). The STOF method applies the Business Model tooling and will enable evaluation of the service innovation and the underlying Business Model.

However, it is noted that while the Ethnography was appropriate for the rural community and its healthcare context, it was not appropriate for public and private institutions that are stakeholders in the shaping of an m-Health service innovation. The in-depth nature of Ethnography did not allow for adoption of a third methodology to study these partners and were therefore not adequately evaluated in the business model.

The following chapter, begins the design and evaluation process by applying the theoretical framework to the domain, and design and evaluate our m-Health service innovation and its underlying Business Model. From this process, there is identification of elements and characteristics in the context that influence viability of the service.

5. Chapter 5: Domain and Theory Application

5.1 Introduction

The objective of this chapter is to identify design and evaluation criteria from the rural healthcare context description in chapter 2. These criteria are categorized as opportunities, challenges and characteristics unique to the social, political and economic make up of developing rural contexts that influence the design and sustainability of development-oriented mobile service innovations. Identification shall be done by application of theories discussed from Rural Development and Business Models to the domain as described in chapter 2, and will alternate between livelihood analysis and business model design and evaluation. Social Entrepreneurship (SE) literature discussed in chapter 3 highlights characteristics unique to development-oriented or social value business models in the domains of ,(1) strategic choice, (2) value network and (3) creation and capturing of value. Suggestions made by SE are applied to design choices when appropriate, and in that way contribute to the understanding and use of Critical Design Issues (CDIs) and Critical Success Factors (CSFs) relevant to development-oriented mobile service innovations.

This chapter is divided into three sections: (1) Vulnerabilities and Assets, (2) Livelihood Structures and Processes and (3) Livelihood Strategies and Outcomes. From vulnerabilities and assets, are identified healthcare needs, that serve the starting point for the service design. Livelihood Structures and Processes are used to identify and select partners to support the service innovation value network. In this section, there is discussion of organizational arrangements capable of supporting a development-oriented service innovation. Livelihood strategies and outcomes draw attention to the positive or negative outcomes livelihood strategies employed by rural communities and facilities.

In chapter 2, a high disease burden is identified as the predominant description for health, and highlighted vulnerabilities (health risks) common to developing rural areas, and outlined assets common to developing rural areas. Then, these two (high disease burden and health risks) are used as input in our framework to analyse Vulnerabilities and Asset(s). Analysis is done by using relevant literature that traces relationships between these vulnerabilities and asset(s). It is also important to note that the unit of observation in a livelihood analysis is a household. A household is a co-residence, task-oriented unit that may include close family, as well as wider kin networks or unrelated co-residents like lodgers (Beall and Kanji, 1999). In this initial analysis, it is assumed that individual members of the household have equal access to assets. However, social and cultural norms affect access to wealth, assets and to decision making (Masanjala, 2007). This aspect was highlighted in the second analysis using data from the case study.

Chapter 2 also highlights structures within a rural health sector including Ministry of Health, donor agencies and NGOs that govern or support healthcare delivery and access. Processes (Primary Health Care and District Health System) that influence operations and activities of healthcare delivery and access. This chapter further explores how these structures and processes using literature influence how assets are used in order to overcome vulnerabilities. Literature was further used to identify strategies and outcomes employed by poor communities as they use assets available to them to access healthcare structures and processes.

5.2 Vulnerabilities and Assets

In the assessment of healthcare access and delivery, it was deemed vital to start with vulnerabilities, defined as the risk of staying poor in the future (Zhang and Wan, 2008). Where poverty is ex-post, vulnerability is ex-ante. Vulnerabilities are risks and unpredictable events that create the possibility of a household or individual falling into or staying in poverty (Dercon, 2005). Examples of such risks include natural disasters, drought, conflict and insecurity, high incidence of health problems, currency crises, commodity price shocks and the contagious effects of worldwide recession (Dercon, 2005). In rural healthcare, the risk is related to sickness or disease. Rural areas in chapter 2 were described with a high disease burden (sum of current and future expected number of healthy life lost by virtue of being in a state of poor health or disability, Chapter 2:2.4.1). In the same section, it was also revealed that the majority of prevailing diseases (malaria and Neglected Tropical Diseases) are a result of the tropical climate where the majority of poor nations can be found. Other sources of health risks include, (1) a poor healthcare infrastructure, which results into, (2) poor quality of service, (3) limited knowledge on healthcare practices and (4) a lack of safe water in rural areas.

Assets are material and social resources that individuals and households use to overcome the vulnerabilities they face (Scoones, 1998). These include natural, physical, social, financial and human assets (Bebbington, 1999; Duncombe, 2006). Natural assets are those resources that naturally occur in the environment. They include land, water, climate, minerals, and forests. Physical assets are produced assets, for instance, technological infrastructure, such as roads, telecommunication infrastructure, tools used for water and energy supply and shelter. Social assets are “features of social organization” such as rules, norms, trust and reciprocity that is embedded in the social structure and supports the actions of individuals and households as they pursue livelihoods. Financial assets are the monetary resources that a household has at its disposal including: savings, remittances, credit, gifts and microfinance. Human assets are the skills, knowledge and the ability to work of household members (Rokadi, 1999; Duncombe, 2006).

5.2.1 Health Risks

The risk of disease in a poor context can result into illness, injury or death, culminating into a direct threat to human capital, the single most important asset poor households possess. The high disease burden does not only include killer diseases such as malaria and HIV/AIDS, but also includes Neglected Tropical Diseases that lead to a lifetime of suffering and disability (Conteh, Engles, Molyneux, 2010). As noted in chapter 2, the labour force in rural areas consists of largely unskilled farm labourers, implying dependence on physical strength in income generating activities. However, poor health is a risk to this physical strength and subsequently to employment and work. A possibility of ill health means either a loss in number of days at work or reduced productivity while at work. In Indonesia for example, men with anaemia were found to be 20% less productive than men without anaemia (Bloom and Canning, 2003).

Among children is found a high disease burden, especially in the case of malaria, which raises the risk of loss of number of days in school, reduced cognitive development and learning abilities, for instance, in cases of severe malaria infections. In Kenya, primary school children reported missing up to 11% of their school days and secondary school students missing up to 4.3% of their school days. Cerebral malaria, a severe case of malaria affects 575,000 children in Africa each year, killing 10-40%. 5-10% that do survive suffer from behavioural disorders, impairment and lose the ability to carry out executive functions, such as, initiating planning and executing tasks (Sachs and Malaney, 2002). In fact,

diarrhoea, respiratory infections, malaria, measles, and perinatal conditions are responsible for 21% of child deaths in developing countries (Bloom and Canning, 2003). The most significant result of the healthcare challenges and resulting strategies should be the reduction of the high mortality rate. It is significant to note that Africa has the highest mortality rate in all the five regions of the world as demonstrated in Table 5.1.

Table 5.1: Regional and Uganda's Adult, under 5 and infant mortality rates

| Region / Uganda | Adult Mortality rate per 1000 population | Under 5 mortality rate per 1000 live births | Infant mortality rate per 1000 live births |
|------------------------------|---|--|---|
| Uganda | 436 | 128 | 79 |
| Africa Region | 392 | 127 | 80 |
| South East Asia Region | 218 | 59 | 46 |
| Eastern Mediterranean Region | 203 | 72 | 54 |
| Western Pacific Region | 113 | 13 | 18 |
| European Region | 149 | 18 | 15 |
| Region of the Americas | 126 | 21 | 12 |

Source: WHO, 2011

Basing on the data as supplied above, the effect on human capital directly affects a household's financial capital in the short term and in the end. In case of household members or individuals engaged in income generating activities, the threat of illness reduces either the number of working days or their level of productivity, and in either case, this affects income levels. Children affected by physical and mental disabilities, and (as a result) limited education levels are more likely to remain in poverty their entire lives. However, the direct effect of a high disease burden to financial capital is through the costs individuals or households incur in accessing healthcare. These costs include prevention, diagnosis, treatment and care (Sachs and Malaney, 2002), costs which are many times unexpected and lead into borrowing just to cover up the cost (Krishna, 2003: pg. 128). However, literature reveals that natural capital in the form of land is sometimes used to cover the cost of treatment. TB patients reported selling land or livestock to cover costs of treatment.

With regard to natural capital, the fact is already highlighted, that prevailing diseases are especially catalysed by the tropical climate present in most poor countries (Chambers, 1982). Another natural resource that is a threat to health is water. Only 50% of Africa's rural population has access to clean water (WHO, 2011). Combined with a lack of basic sanitation, for instance, lack of latrines, poor communities are in danger of infection from water borne diseases (Moe and Rheingans, 2006).

An examination of the physical capital available to health seekers as discussed in chapter 2 provides evidence that there is a limited number of health facilities. Although public health facilities are also supported by faith-based health facilities referred to as Private-Not-For-Profit facilities (PNFPs), these charge subsidized fees, which most people perceive as expensive. The result is that health seekers resort to private health providers that might be closer to them and charge a lower fee than PNFPs. Usually the cheaper sources are sought from unqualified healthcare providers. Krishan's (2003) research and the WHO's (2012)'s survey in Africa reveals that some of rural poor in times of illness follow a multiple –provider strategy, a pattern of behaviour that involves, first seeking the cheaper providers that include traditional healers, pharmacy shops and retailers with partial medical training,

and then if the sickness persists, they may resort to borrowing to access private clinics and hospitals (2003: pg. 127; Trani et al, 2010: pg. 1752). These unqualified private providers are unregulated and potentially cause harm to health seeker as also supported by findings provided by the International Finance Corporation (2008), which poor and rural communities rely on unregulated drug peddlers and in a study with drug shopkeepers revealed that only 3.7% of children treated received adequate malaria treatment. In addition, the private sector is a source of brain drain, where the overworked and underpaid healthcare workers from the public sector relocate their skills to increase their earnings.

Cultural and indigenous beliefs and practices also impact health-seeking behaviour. In the same 2012 WHO survey, health seekers pointed out that there are certain ailments, for instance, depression, arthritis and malaria that are not taken to the health facilities but to traditional and spiritual healers (WHO, 2012). A survey carried out in Nigeria with 1,594 people reveals that 58% of the poorest in the survey mainly access healthcare from traditional healers and drug shops (International Finance Corporation, 2008).

Public health facilities are also resource challenged, as the discussion has already highlighted a work-environment with overworked, under-resourced and understaffed personnel (Gladwin, Dixon and Wilson, 2003; Mecheal, 2009). Segall (2003) reveals that, in the 1980s and 1990s health workers experienced a drastic fall in the real value for their salaries with the result that health workers could only cater for a small fraction of their household needs. There is widespread demoralization, demotivation and cynicism including undesirable practises, such as, charging patients ‘under-the-table’ fees, stealing drugs and equipment, ‘moonlighting’ during working hours to practise privately. As a result, health workers have developed negative attitudes towards patients and a decline in professional ethics. Women have been known to opt for traditional birth attendants because they are more receptive to them during delivery (Uganda Bureau of Statistics, 2010; WHO, 2012). Significantly, Africa has one of the lowest levels of resources and personnel in comparison to other regions. Table 5.2 also presents percentages of expenditures on health according to 2007 GDPs

Table 5.2: Financial Resources and Personnel Distribution

| Region | Percentage of GDP Expenditure | Physician per 10,000 population | Nursing and midwifery personnel per 10,000 population | Hospital beds per 10,000 population |
|------------------------------|--------------------------------------|--|--|--|
| Africa Region | 6.2 | 2 | 11 | 9 |
| South East Asia Region | 3.6 | 5 | 11 | 11 |
| Eastern Mediterranean Region | 4.1 | 10 | 14 | 12 |
| Western Pacific Region | 6.5 | 14 | 21 | 38 |
| European Region | 8.8 | 33 | 68 | 63 |
| Region of the Americas | 13.6 | 23 | 55 | 24 |

Source: WHO, 2011

Furthermore, resources such as drugs and facilitation are not available in public health facilities. In the World Health Statistics report of (2010), availability of essential drugs in public health facilities of poor nations was 44%, while private facilities were up to 66%. The report states that hostile circumstances force health seekers to purchase drugs privately (WHO, 2010). The persistent lack of drugs and the

poor attitude of the overworked personnel is one of the reasons why health seekers are discouraged from visiting public health facilities. Figure 5.1 below is a representation of reasons why health seekers do not seek health care from public health facilities.

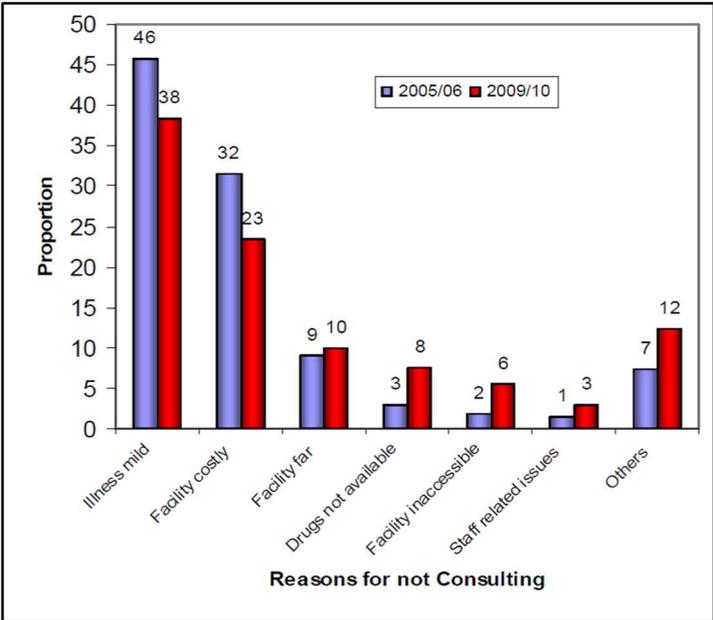


Figure 5.1: Reasons for not consulting public health facilities (Uganda Bureau of Statistics, 2010)

Ignorance, lack of awareness on health, coupled with lack of access to healthcare is also evident among health seekers. The 2012 survey reveals that most health seekers believed public sector facilities were only for child immunization, antenatal care and delivery (WHO, 2012) while a 1998 study with expectant mothers in Kigorobyia sub-county, Hoima district in Uganda reveals that lack of awareness and poor perception influence health-seeking behaviour. Most of the women participants were not aware of the purpose of antenatal visits. 83% of the participants were not aware of the effects of chloroquine, though most had undertaken self-medication while pregnant. Chloroquine is a malaria treatment and a prevention drug that can cause miscarriage. Lastly, the people perceived that the formal health facilities were expensive, as the study reveals that 55% of the women had delivered from villages with their first pregnancies despite attending antenatal care (Ndyomugenyi, Neema and Magnussen, 1998).

From the discussion above, it is evident that the overall vulnerability related to health risks and to a high disease burden most significantly affects human capital, which in turn affects household financial assets. Natural assets like contaminated drinking water are a major health risk, and physical assets like inefficient public healthcare facilities and unqualified private healthcare providers contribute to creating vulnerabilities in the form of health risks. Furthermore, human capital is disempowered and disadvantaged by an apparent lack of knowledge and awareness on basic healthcare and health services available. This web of risks and challenges is represented in Figure 5.2 below.

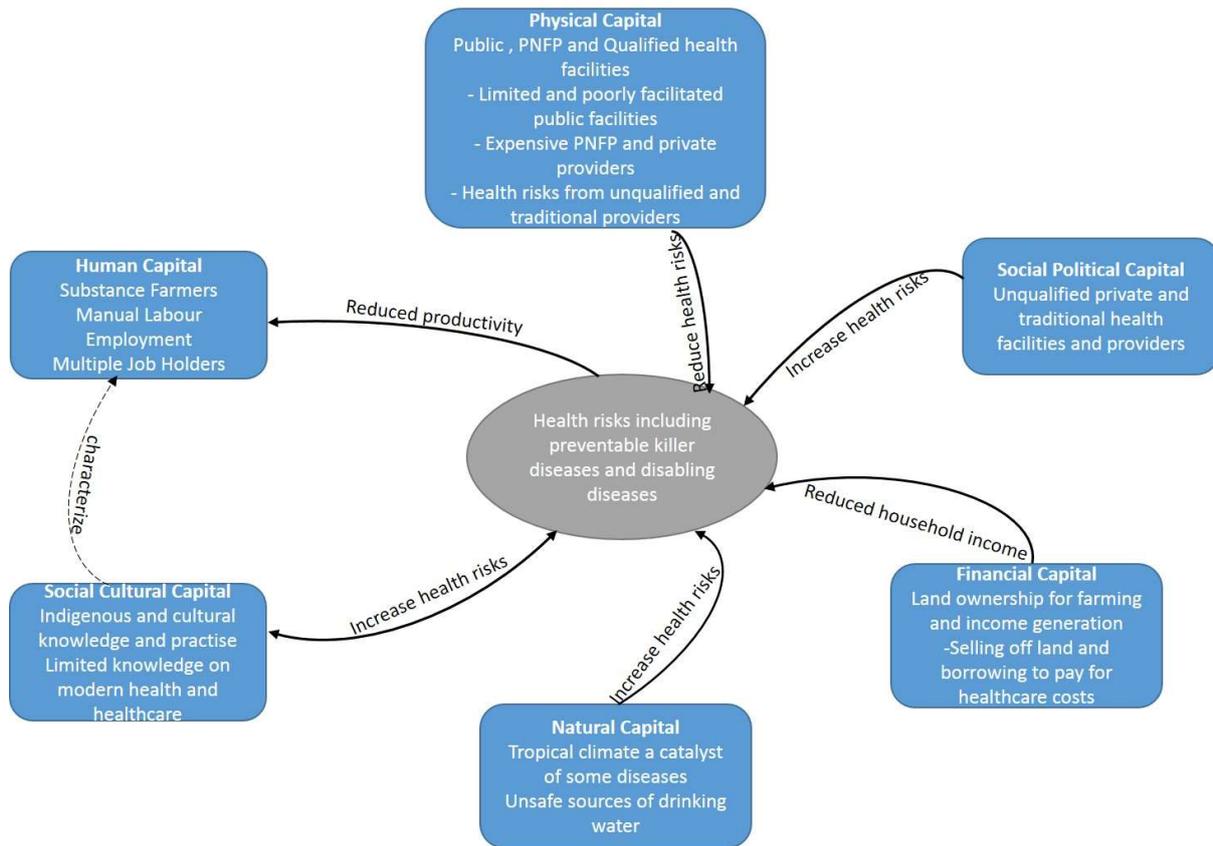


Figure 5.2: Rural Assets and Vulnerabilities (Source; Research)

Focusing our attention on the assets and their relationship with the vulnerability context, there is ability to identify needs and the groups of people or institutions in rural healthcare that experience those needs. Further, positive and negative effects are identified, and each asset has on the vulnerability context. Using this as a guideline, requirement can be developed for service innovation that supports assets that positively affect the development goal – reduction of health risks and reduces the effect of assets that negatively affect the development goal. This is what Social Entrepreneurship (SE) refers to as a clearly defined social objective, that is, values which go beyond economic value per se. In the process of service design, both the Value Proposition as well as Critical Design Issues (CDIs) for the service innovation can be defined. Asset characteristics are also highlighted in Figure 5.2 describing the context in which a service innovation will operate. Evaluation of a service innovation based on these characteristics can determine sustainability and define Critical Success Factors (CSFs).

5.3 Service Design

The Service Design used the above analysis, basing on the Traditional and Social Business Model guidelines presented in chapter 3, Table 3.4. Attention is given, first to causal relationships between assets and the vulnerability context presented in Figure 5.2 above. The development goal or social value is supposed to reduce health risks in the prevailing disease burden with each asset above demonstrating a positive or negative effect on the context. A service innovation that strengthens efforts to reduce health risks and weakens conditions that lead to health risks should in essence provide value to a target group that desires reduced health risks.

5.3.1 Target Group, End Users, Customers and Value Elements

The first CDIs to develop in the service design target, End-Users and Customers. Targeting involves selecting a group of people in a market that will use or consume the service, that is, the customers. The process of targeting involves identifying needs of the proposed customers, which later shall be translated, to Value Elements (Reuver and Haaker, 2009). In the previous discussion, the following generic development needs were identified: (1) Health risks that affect the human capital of a poor community, (2) poorly facilitated public, PNFP and qualified health facilities responsible for providing healthcare and reducing health risks among poor communities. These two generic needs point to the target groups, poor communities and the facilities that serve the poor communities with their healthcare needs: public and PNFP facilities. Private qualified health facilities were excluded from the target group because, although qualified private providers are essential to rural healthcare, they are however autonomous and operate in isolation. This prevents geographical scaling of the service to be developed. Public and PNFP facilities on the other hand are part of a national healthcare system and the innovative service can be introduced at a single facility and then be replicated to other facilities within the same structure.

Next to the two generic needs, that is, reduced health risks and improved professionalism, identified specific needs experienced by both poor communities and health care providers that can be translated into value elements. These include: (1) long distances between community members and scarce public or PNFP health facilities, (2) poor drug supply and absenteeism of health workers which leads to, (3) expensive alternative services from private providers, (4) Limited financial resources to cover the costs of healthcare and (5) reliance on indigenous and cultural knowledge for healthcare. An innovative service that can lead to delivery of some services remotely and ease the burden of traveling to access healthcare would have clear benefit. Providing access to information on drugs and staff can reduce trips to expensive private or visits to unqualified healthcare providers. Using mobile phones to deliver health education can support increased knowledge and awareness on health, healthcare and healthcare related services for a community. These values are summarized in table 5.3 below.

Table 5.3: Value elements in a Rural Healthcare Mobile Service Innovation

| Healthcare Needs | Social Value | Value Elements and Service Strategy |
|---|---|--|
| Long Distances between poor communities and public or PNFP facilities | Access and deliver healthcare in remote areas | Remote delivery of healthcare services |
| Limited drug supply and absenteeism of health workers | Access to healthcare information | Information inquiries |
| Reliance on indigenous and cultural knowledge | Deliver health education on health risks and disease prevention | Health education services |

5.3.2 Defining the Target Group, Pricing and Accessibility for customers

It is important to define the target group for various reasons. This includes making clear what value is offered and to whom, that is to say, the expected users of the service (Bouwman, De Vos and Haaker, 2008). In Business Models focussed on commercial exploitation, the consumer of a service pays for

the service (Bouwman, De Vos and Haaker, 2008). It is from the service pricing that revenues are generated and profit is realized. However, the “customers” we have identified have been described as low income earning poor community members and poorly facilitated and funded health facilities. Service needs and value elements are based on public values and users’ needs for medical services. The “customer” therefore in Social Entrepreneurship (SE) business model design is defined according to the social value and not economic value that is created. It therefore follows that if the SE business model does not seek economic but social value, then revenue generation is not requirement per se. To attain social value, it is necessary that the SE business model generates social change and is funded not on contributions from the “customers”. However, in order to be sustainable the business model needs a long-term revenue model, an issue to be discussed in organizational arrangements.

The community is defined as manual labourers who are predominately subsistence farmers, sometimes with multiple jobs, whose biggest financial asset is land, which the poor sometimes sell off to cover medical costs. Furthermore, it is assumed that consumers of the service will own a basic phone, for example Nokia 1280 with Voice and SMS at most. This means that our service must limit itself to these two platforms. Using these two platforms also affects pricing. Standard voice and SMS charges are a starting point for determining service charges, which can be incurred either by the community end-user or by one or more of the development partners that shall be discussed later. If service costs are the responsibility of individual community end-users, this may influence adoption negatively. Due to the limited incomes of the target group, service costs may discourage service use. On the other hand, if it is the responsibility of development partners, there is a question of sustained institutional and political support, as shall be discussed later under organizational arrangement. Chapter 2 also points out that only 56% of Uganda’s rural households have access to a mobile phone (UBOS, 2010). There is a possibility that some community members might not have access to the service if, (1) they do not possess a mobile phone and (2) do not have money to purchase credit for mobile services. There is a possibility of using commercial phones or sharing phones between households and friends in the case of inquiry. This might however limit the reach of services, especially for those without phones.

The description and definition of poor communities: ‘as customers and end-users of the service’ raises a few questions in relation to adoption and sustainability. Is it possible to attain the social value that is intended to deliver, given the description of our target group? For instance, does a community member have access to a mobile phone to access the service? Can a community member afford the standard service costs to use the service if free services are not available?

On the other hand, health facilities have been described as poorly facilitated with health workers that are overworked and underpaid. Both public and PNFP facilities rely on donor funding, governing bodies to mobilize and facilitate services and in the case of PNFP facilities, a minimal fee is charged to patients. Operators of the service facilities are facing equipment costs and recurring service costs if free services are not available. These need support from their governing bodies to fulfil their role as consumers of the service. However, the fact that these facilities are poorly facilitated points to limited funding from governing bodies responsible for their facilitation. Segall (2003) observes that political economy has starved the health sector of resources, moreover, the poor working and living conditions of health workers in developing nations is the source of demotivation and demoralization with the result of poor quality services. All of these have brought about failure of health structures at the level of Primary

Health Care (PHC) and District Health System issues that will be discussed in detail in the Livelihood Structures and Processes.

It is important to ascertain the perception of health workers towards remote healthcare delivery. Norris, Stockdale and Sharma (2009) point out the common traditional attitude of healthcare practitioners towards healthcare delivery. Usually they favour face-to-face delivery of healthcare to remote mediated healthcare services, the attitude that may affect acceptability on the part of health care providers and facilities.

In this case, is found a poorly facilitated health sector, which struggles to deliver day-to-day services. It therefore poses the challenge, if the facilities are able to absorb a service innovation such as this. This is in terms of, (1) financial support and (2) available personnel to operate and maintain the service. Is the health facility able operate the service, given the conditions of work? What will be the sources of revenue if we prioritize social value over economic value? Table 5.4 is a summary of the target group descriptions and the roles assigned to each segment of the target group.

Table 5.4: Defining the Target Group

| Target Group | Asset | Asset Description | Accessibility for Customers | Role Assigned | Responsibility in value network | Pricing |
|---|------------------|--|---|--------------------------|--|---------------------------------------|
| Community Members | Human Capital | Manual labourers, subsistence farmers, low incomes | Limited number of phones and finances to purchase phone credit may limit access | Customer and End - Users | Access service from remote location | Standard service charges |
| Health workers in Public and PNFP facilities | Physical Capital | Poorly facilitated facilities demotivates health workers that are overworked, underpaid. | Limited personnel, heavy workload and demotivation may limit operation and therefore access | Customers and End-users | Operate service innovation at local facility level | Equipment and recurring service costs |

In the process of defining our target group, we also define the Technology Critical Design Issue (CDI), Accessibility for Customers and the Finance CDI Pricing.

5.3.3 Compelling Value Proposition

From business, model CDIs, that is to say, Targeting, Value Elements, and the Critical Success Factors, that is to say, Clearly Defined Target Group one is able to determine if so far there is a Compelling Value Proposition. Value Proposition are the benefits a provider delivers to customers or end-users of a service (Bouwman, De Vos and Haaker, 2008). While we have a clear social value and marching value elements, characteristics of the target group pose threats to the intended value and therefore the value proposition, as has been highlighted while defining our target group, that include: (1) limited

finances that may limit community end-users access to mobile phones and mobile phone services, (2) limited donor and government funding for facilities may not sustain the service at facility level, (3) Limited personnel available to operate the service at facility level and (4) limited commitment from demotivated and demoralized health workers in using the service. Figure 5.3 is a summary of the CDIs and CSFs so far defined and evaluated. Then, attention is turned to the technical architecture.

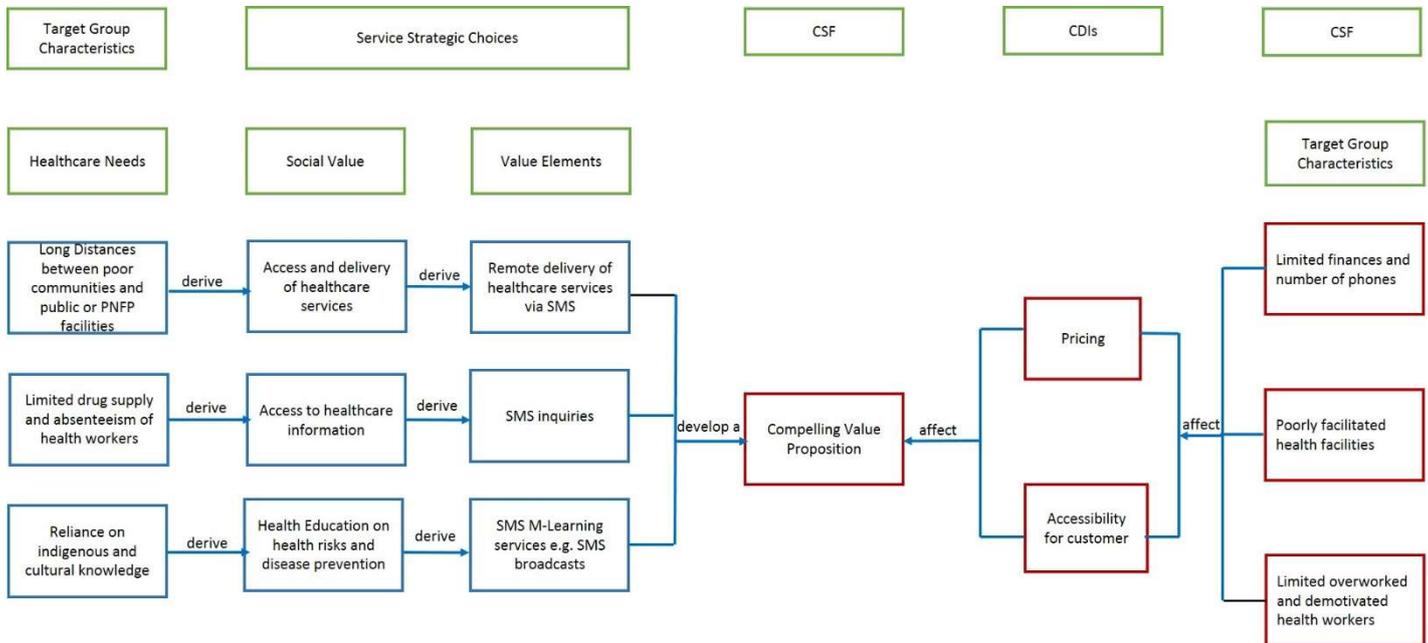


Figure 5.3: Elements and characteristics that influence the service value proposition (Source; Research)

5.4 Technological Architecture

The architecture of the service is developed based on: (1) technologies and services available in the telecommunication sector, (2) m-Health applications readily available in the market and (3) the requirements of the value elements identified in the service design. Each of the value elements: (1) remote service delivery, (2) inquiries and (3) health inquiries imply that there is an operator and a recipient of the service. The operator would be a health facility and the recipient is the community end-user. The operator therefore needs an application that will send and receive messages and manage groups of community end users or recipients of services. Two applications highlighted in chapter 2 section 2.5.4, FrontlineSMS and RapidSMS include features that a health facility can use to manage receipt and sending of messages to individuals or groups of users. Both are open source with FrontlineSMS operating as a standalone application while RapidSMS is web-based. Messages can be sent from and to a computer enabled by a standard GPRS modem. The modem contains a SIM card enabled to receive and send messages at standard SMS costs (Adewumi and Daramola, 2010). Telecom providers provide GPRS modems with a SIM card. It is the responsibility of the modem owners to load the SIM card with credit so that messages could be sent through the application to individual mobile phones. Figure 5.4 below demonstrates the technology architecture of the service. Next, is a discussion on critical technical design issues (CDIs).

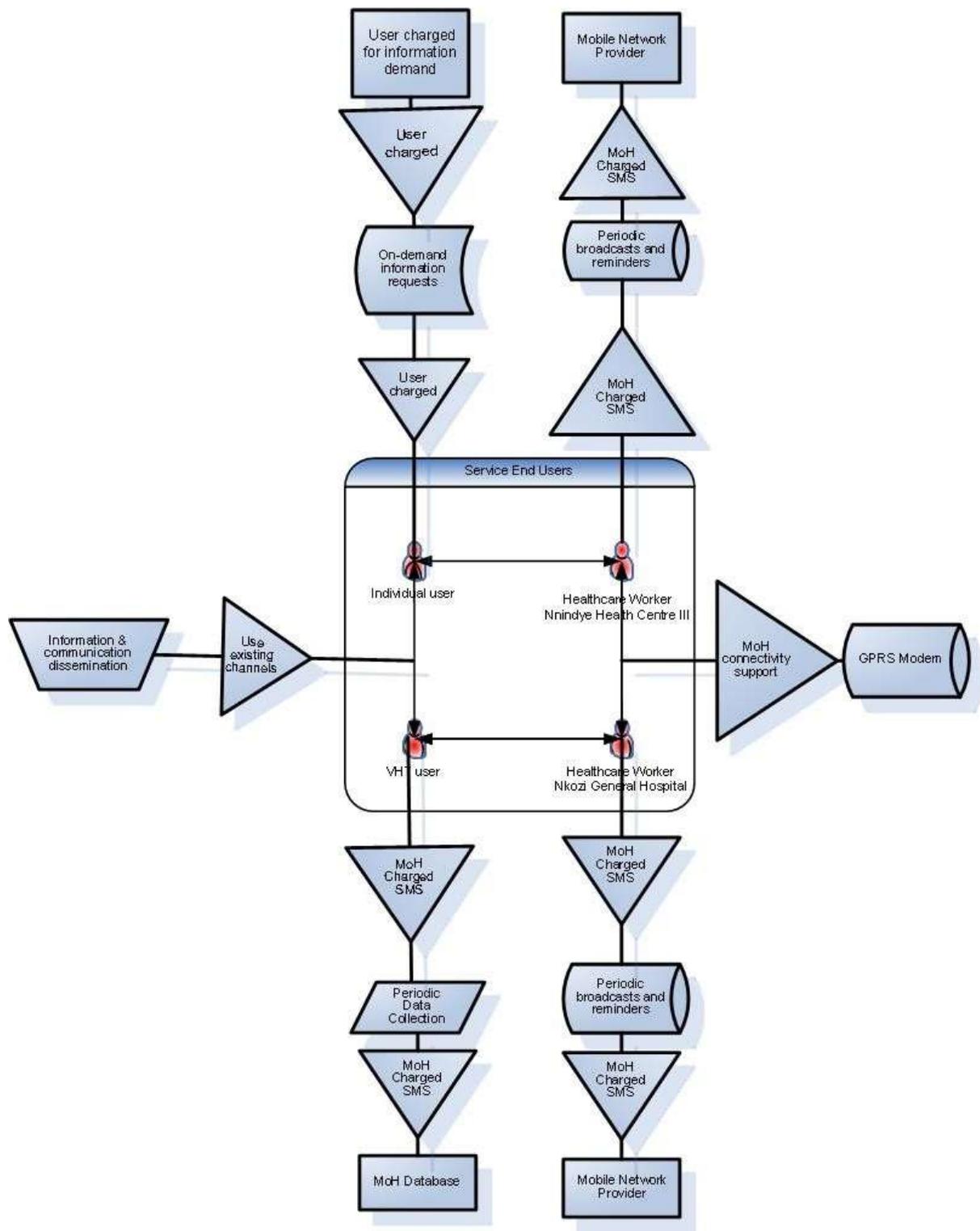


Figure 5.4: Technical Architecture of Service Design (Source; Research)

5.4.1 Security, Accessibility for Customers, Quality of Service, System Integration and Management of User Profiles

First, the CDI Accessibility for customers is influenced by the platform, devices and architecture selected for the service (Bouwman, De Vos and Haaker, 2008). The researcher opted to use SMS-based applications FrontlineSMS or RapidSMS. In chapter 2, it was argued that because community members

are low income earners, it is therefore safe to assume that most mobile phone owners may only have access to basic phones with voice and SMS platforms. While applications with specialized software, for instance, the SATELLIFE project have been developed, the devices required for such applications may not be affordable to low income earners. These applications have been applied at health facility level and operated by health workers. However, Lucas (2008) reports that maintenance charges were most likely too high for governing institutions and their budgets. So they were eventually abandoned.

Secondly, the security CDI includes deciding who gains access to the service and how the security of communication and information on end-users is arranged (Bouwman, De Vos and Haaker, 2008). From the two defined end-users, the community members and health workers, we have two ends of the system. The community end-user security concerns would extend to those of a mobile phone user. A health worker would experience security concerns that extend to a computer connected using Wi-Fi technologies. Noris, Stockdale and Sharma (2009) point out that some of the concerns in m-Health application include privacy and security of personal information, and argue that there are ethical issues that surround the electronic storage and transmission of sensitive information. Moreover, there are concerns regarding wireless security protocols. Bouwman, De Vos and Haaker (2008) state that security builds trust in the service innovation. Lack of security might influence the evaluation of the service negatively and therefore the CSFs Acceptable Quality of Service and Compelling Value Proposition

The quality of service CDI examines performance of the technical architecture in delivering the technical functionalities of the service innovation (Bouwman, De Vos and Haaker, 2008). Our architecture depends on mobile networks. Noris, Stockdale and Sharma (2011) point out that m-Health innovations are hindered by unreliable and poor coverage of mobile networks. Chapter 2 points out the poor network infrastructure on which mobile networks depend. The fact that coverage is concentrated in urban or highly populated areas and ignores remote and sparsely populated areas means that network coverage for most rural areas is poor. This affects quality of services and therefore value of the service. So these characteristics might affect the CSF Acceptable Quality of Service.

In addition, management of user profiles involves personalization of the service (Bouwman, De Vos and Haaker, 2008). The value elements relate to the different user groups the service might need to manage. Remote service delivery, for instance, handles individual patients as well as groups, for example, HIV/AIDs and TB patients. Health education targets groups of people, for instance, women or pregnant women. User profiles in mobile service innovations for healthcare are tailored according to the specific healthcare needs of the individual or groups of people. In handling the identity of groups like HIV/AIDs patients, the concern of electronic storage and transmission of personal information earlier raised in the security CDI is also relevant in this CDI. Unlike profit-oriented service innovations where the concern is obtrusive marketing strategies, here it is a question of privacy of those receiving treatment and the possibility of unauthorized access to these user groups. This access is at both the community end-users side and the health facility. An SMS message stored on a mobile phone device can be read by anyone especially in cases where phones are shared among community members. Unauthorized access at the health facility can lead to revealing the identity of sensitive user groups for instance HIV patients. Therefore, this CDI influences the security CDI and consequently acceptable Quality of Service while it diminishes the Value Proposition for some users.

System integration refers to the ability for the new service to be integrated into the existing technical infrastructure (Bouwman, De Vos and Haaker, 2008) of the health system and local health facilities. Chapter 2 points to a poor health information system that includes fragmented reporting and data collection based on different programs and services. Furthermore, electronic systems are either just as fragmented or non-existent in developing nations. ICT infrastructure and services especially in Africa’s health sector is described as weak with limited pilot eHealth projects that are small scale (WHO, 2011). As Lucas (2008) points out the service innovation is applied in a chaotic health information system context. This also affects the CSFs Acceptable Quality of Service and Value proposition of the service. These effects including those discussed above are summarized in figure 5 below.

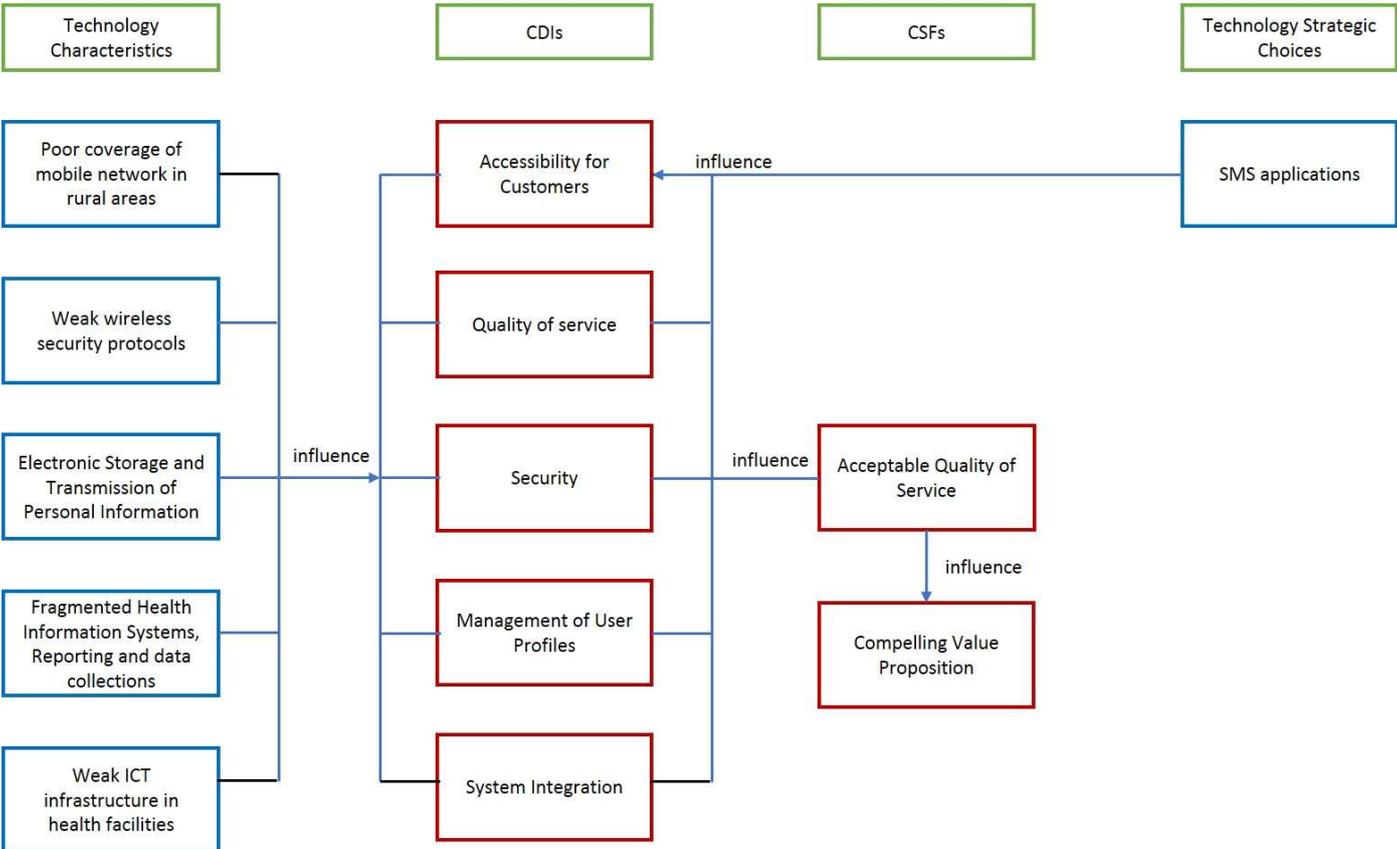


Figure 5.5: Characteristics that influence Technical Architecture of the service innovation (Source; Research)

The next section of analysis looks at livelihood structures and processes that influence healthcare in rural areas. These are the structures responsible for the existence of health facilities, both public and private in rural areas, and are responsible for how they operate or deliver healthcare to a poor community. Basing on the above analysis, not only structures and processes are identified, but also how they influence the current status of healthcare, and from these processes, CDIs and CSFs developed from the previous section shall be defined.

5.5 Livelihood Structures and Processes

Duncombe (2006) describes livelihood structures as, “the public, private and non-governmental organizations that set and deliver policy, while the processes are the political, economic, social, legal

and cultural mechanisms that govern how structures interact with groups and individuals.” From the discussion, we have had so far and from chapter 2, the livelihood structures present in a rural context can be identified. Three structures are responsible for setting and delivery of healthcare policy: (1) International donor agencies and the World Health Organization (WHO), (2) Ministry of Health (MoH), and (3) NGOs and Religious Organizations. WHO is the global coordinator and director of health matters within the United Nations that has driven most healthcare programs including Primary Health Care and influenced the adoption of Health Information Systems. Donor agencies fund healthcare programs, for instance, Primary Health Care or implementation of specific Health Information Systems (Braa et al, 2007). Primary Health Care (PHC) was first undertaken by WHO and UNICEF in the 1970s, and was formally adopted by all WHO member countries in 1978. A Primary Health Care approach governs healthcare programs and healthcare processes in public healthcare facilities, and aims at providing universal basic services through preventive, curative and health promotion programs, which usually include seven goals: The first is, education on prevention and control of prevailing health problems. The second is, promotion of food security and proper nutrition. Third is safe water supply and basic sanitation. Fourth is maternal-child health including family planning. Immunization is sixth and seventh is prevention and control of locally endemic diseases. Appropriate treatment of common diseases and injuries and provision of essential drugs are the last goals (Hall and Taylor, 2003). In the case of Uganda, these focus areas are found in the Uganda National Minimum Health care Package (UNMHCP) (Ministry of Health, 2010).

Findings reveal that Primary Health Care is delivered through a District Health System, which was developed after it was realized that PHC was mainly made up of primary and community level activities, but lacked an organizational structure. Thus, the District Health System provides primary level facilities and community health workers (referred to as Village Health Teams in Uganda’s context- VHTs) who deliver integrated preventive and curative services with active participation of the community in a defined population. Facilities and VHTs are under the supportive supervision of a district hospital and health management team. There is also a District Health System, which includes a referral system where healthcare workers refer patients to higher-ranking facilities for treatment. The referral system starts from the village level all the way to the district level (Segall, 2003). Ministry of Health is the overall supervisor and facilitator of the structure and system responsible for protection and promotion of public health (Ministry of Health, 2010).

PNFPs working in the PHC structure are also supervised within this structure. However, because their religious institutions often govern them, supervision and facilitation is extended to the affiliated governing body of their NGO or religious institution. The latter are referred to as Religious Health Associations. These form the third structures. Health services from faith groups started as part of missionary movements. In the 1960s, national coordination bodies – Religious Health Associations - were developed. In Uganda, these are the umbrella organizations including Uganda Catholic Medical Bureau (UCMB), Uganda Protestant Medical Bureau (UPMB), Uganda Orthodox Medical Bureau (UOMB) and Uganda Muslim Medical Bureau (UMMB). These organizations facilitate dialogue between PNFPs and government at policy level and in negotiation for funding (Green et al, 2002). PNFPs thus depend on subsidies from government, donor funding and minimal charges for their clients to sustain services (International Finance Corporation, 2008).

Also, are World Bank Health sector reforms that opened up the health sector market for private providers (Green et, al, 2002). Driven by market demand and traditional practises, private health

practitioners with market-oriented services exist alongside public and PNFP providers (International Finance Corporation, 2008) as pointed out in chapter 2. These include clinics, pharmacies, traditional healers and traditional birth attendants. About 90% of public healthcare personnel work in the private sector, this means there is a presence of qualified personnel in some private clinics, and pharmacy shops although they are unregulated. However, traditional providers do not have any affiliation to any institute and are unregulated (Ministry of Health 2010). The market-oriented approach adopted by private healthcare providers is evident from their focus on curative, rather than prevention or health promotion in their healthcare practise. This has a direct appeal on a market that is looking for an immediate cure for their ailments. Traditional healers and birth attendants are part of the community. Prevailing traditional and cultural practises among the poor also presents these providers as appealing to some healthcare seekers. In summary, Figure 5.6 presents the structures and processes discussed above.

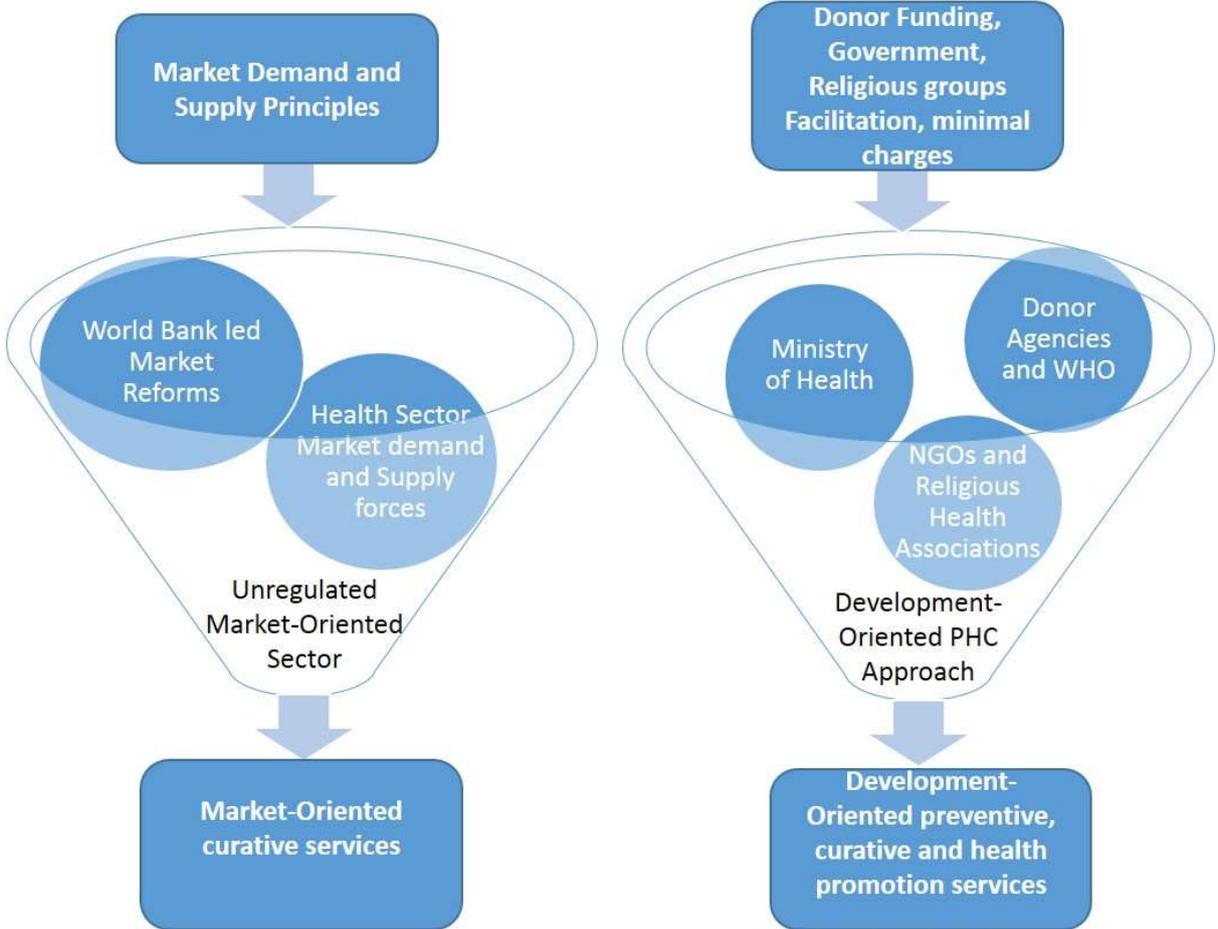


Figure 5.6: Rural Healthcare Structures and Processes (Source; Research)

5.6 Organizational Arrangements

The structure and process section presents to the design process, two parallel sectors, public and private. Within the public sector is found the international donor agency and coordinator (WHO) and the governing institution (Ministry of Health). NGOs and Religious Associations are duo operators, partnering with Ministry of Health and operating within the PHC structure while adopting private sector strategies to sustain services and personnel. Although the private sector is market driven, the market is still poorly developed. These parallel sectors provide the design process with a choice of

structures from which one can select partners that might support and facilitate the service within facilities and the health sector at large. It is necessary to make strategic choices in partner selection. In traditional business models, an organization or a network of organizations are involved in creating and capturing value from technological innovations (Reuver and Haaker, 2009). Value is generated and captured through chained linkages of activities of the physical world to create a value chain an organization(s). With the particular case of mobile service innovation, it is found that a number of organizations come into partnership to create value for a service innovation, that in turn creates what is referred to as a value network where each actor or partner is positioned in the value chain with a specific role or responsibility (Peppard and Reylander, 2006).

In the next section, there is further discussion on the design process focusing on organizational arrangements that might own and support a rural service innovation, by identifying the organizational CDIs: (1), partner selection which will guide us on which partners to include in the value network depending on the resources and capabilities needed for the service innovation, (2) network openness which is the degree to which other actors can join the value network to offer services to the customers, (3) network governance which is the identification of the dominant actor(s) and (4) network complexity that examines the number of actors the focal actor must manage within the value network. Based on these CDIs, CSFs shall be evaluated, (1) a sustainable network strategy which examines access to resources and capabilities, (2) acceptable profitability which are positive results matching returns and risks, and (3) acceptable risks which examines uncertainty in the market (Bouwman, De Vos and Haaker, 2008).

5.6.1 Partner Selection, Network Openness, Network Governance and Network Complexity

Partner selection in business models is driven by access to resources and capabilities that the service innovation will need (Bouwman, De Vos and Haaker, 2008). Social Entrepreneurship demands that partner selection must be based on a shared social objective or social value. Since the social value is derived from a development and public service perspective, then partners must be selected from the development-oriented or public sector structures that include, Ministry of Health (MoH), Donor agencies and WHO, NGOs and Religious Health Associations.

However, one must also consider the need for funding both in the long and short term. The Ministry of Health is not only the overall governing body of the national health sector, it is through the Ministry that public and most donor funds for Primary Health Care programs come through (Green et al, 2002). Both public and PNFP facilities access these funds. In profit-oriented service innovations, the Network Governor is usually the one with access to customers and end-user or the one that developed the service (Bouwman, De Vos and Haaker, 2008). The Ministry of Health not only has access to most of the stakeholders that is to say, health facilities both public and PNFP, but also has access to funding sources. It is therefore in position to govern the service innovation.

As discussed in chapter 2, management and governance of institutions and facilities overlaps in most developing nations' health systems, and one can realise how this will affect Network Governance and Network Complexity. Religious Health Associations and NGOs that govern PNFP facilities are also a source of funding and can furthermore facilitate financial support and maintenance of the service. The existing relationship between these associations, the Ministry and donor agencies can be used to coordinate governance of the service innovation in PNFPs facilities just as they are used to coordinate

funds for health services and programs. On the other hand, these complex relationships result into Network Complexities. Although the Ministry of Health appears as the overall governor, sub-governing institutions in reality usually have independent relationships with donors, programs and services, which creates fragmentation as earlier pointed out (Braa et al, 2007). Therefore, while we are able to assign the role of Network Governor to Ministry of Health, we must also recognise the sub-governing roles of NGOs and Religious Associations in the value network.

The partners from the development-oriented domain of rural healthcare structures are what (Bouwman, De Vos and Haaker, 2008) refer to as structural partners in a business model. They make up the core of the value network offering financial and institutional support for the service innovation. These include Ministry of Health and Religious Associations. However, value elements so far included in the service design target the community and health facilities. Basing on this strategic choice, it can be assumed that structural partners in a Social Entrepreneurship (SE) business model must be open only to development-oriented or public service providers. Therefore, the innovation's Social Value, a value, element that appeal to the partners must be included.

The fragmented programs and services that result into fragmented health information systems create opportunity for value creation and a value element targeting structural partners. Opportunity raises from what in literature (Gladwin, Dixon and Wilson, 2003; WHO, 2010; WHO, 2011) refer to as, the importance of decentralized reporting and data collection for effective management and decision making in health systems. The fact that these have been supported by WHO and donor agencies in different programs (Braa et al, 2007) indicates the value these structural partners place on health information, reporting and data collection. Data collection supports follow-up and monitoring of chronic diseases, medication procurement and reporting to government and funders (Fraser et al, 2005). The application will therefore include functionality to facilitate data collection and reporting at VHT and health facility level, which will consequently be transmitted, to the Ministry of Health, donor agencies and Religious Health Associations. With this additional value element, the partners become customers and end-users in the service design.

However, the discussions so far point to a number of challenges within these structural partners that might affect their roles in the organizational arrangements. Segall (2003) in the Vulnerabilities and Assets profile highlights challenges and faults in the structures of healthcare, including lack of a political will to support health programs. Hall and Taylor (2003) point out the same faults and includes: (1) volatile nature of developing nation states that sometimes experience civil war and natural disasters and (2) corruption and poor governance in the use of resources which has made donor agencies wary about funding broad-based programs, such as Primary Health Care programs.

The experience of ICT4D has been that of dependency on donor agencies for investment, and once funds are withdrawn, projects fail (Heeks, 2002; Dada, 2006). Moreover, donor agencies are often limited by statutory and charter constraints (Tongia and Subrahmanian, 2006). It is also reported (Braa et al, 2007) that because of donors' interest in specific programs, this contributes to fragmentation of health information and data collected. In addition, donor agencies are also pulling out of ICT4D funding and projects (Heeks, 2010). Unfortunately, even though ICT4D applications have been sectorial based (for example health, education, government); the approach has been to use donor funds and not public funds which may be more consistent (Chapman and Slaymaker, 2002). These characteristics influence the sustainability of the value network. It is of concern to note that the dominant player or network

governor may not be able to sustain the service long after the donor agencies have pulled out as Lucas (2008) reports.

The challenges that we shall refer to as characteristics related to the structural partners influence the CSFs a Sustainable Network Strategy and Acceptable Division of Roles and Responsibilities. Lack of a political will to support health programs, corruption and poor governance, volatile nature of developing nation states and limited donor funding for health and ICT4D projects directly influence the network strategy while the fragmented governing institutions influence division of roles in the value network.

There are a number of challenges that we can expect from telecommunications providers. Whereas telecommunications' providers have the technological capacity and resources to enable network traffic and data transmission, they however define value in completely different terms. The structural partners in Social Entrepreneurship (SE) business model define social growth as the intended profit, while telecommunication providers define economic or revenue growth as profit. This creates a conflict of interest in the value chain. If the value chain must include actors from opposing sectors, then this CSF Acceptable Profitability, at least for one of the contributing partners is threatened. The governing partner, Ministry of Health cannot govern telecommunications' providers. This means that there is no control over the behaviour of telecommunications' providers in the value network.

Chapter 2 in section 2.7.3 on market demand and competition discusses the imperfect telecommunication markets as the result of poor regulation. A mobile service innovation that depends on users accessing the service from different providers are subject to different and higher charges. Most developing countries and Uganda's telecommunication providers offer on-network promotional packages but high off network roaming charges. Using a GPRS of one specific network will require users on a different mobile network to pay higher SMS charges and this directly affects the CDI Pricing that is already challenged by limited finances from both sets of users, which in turn affects the Value Proposition.

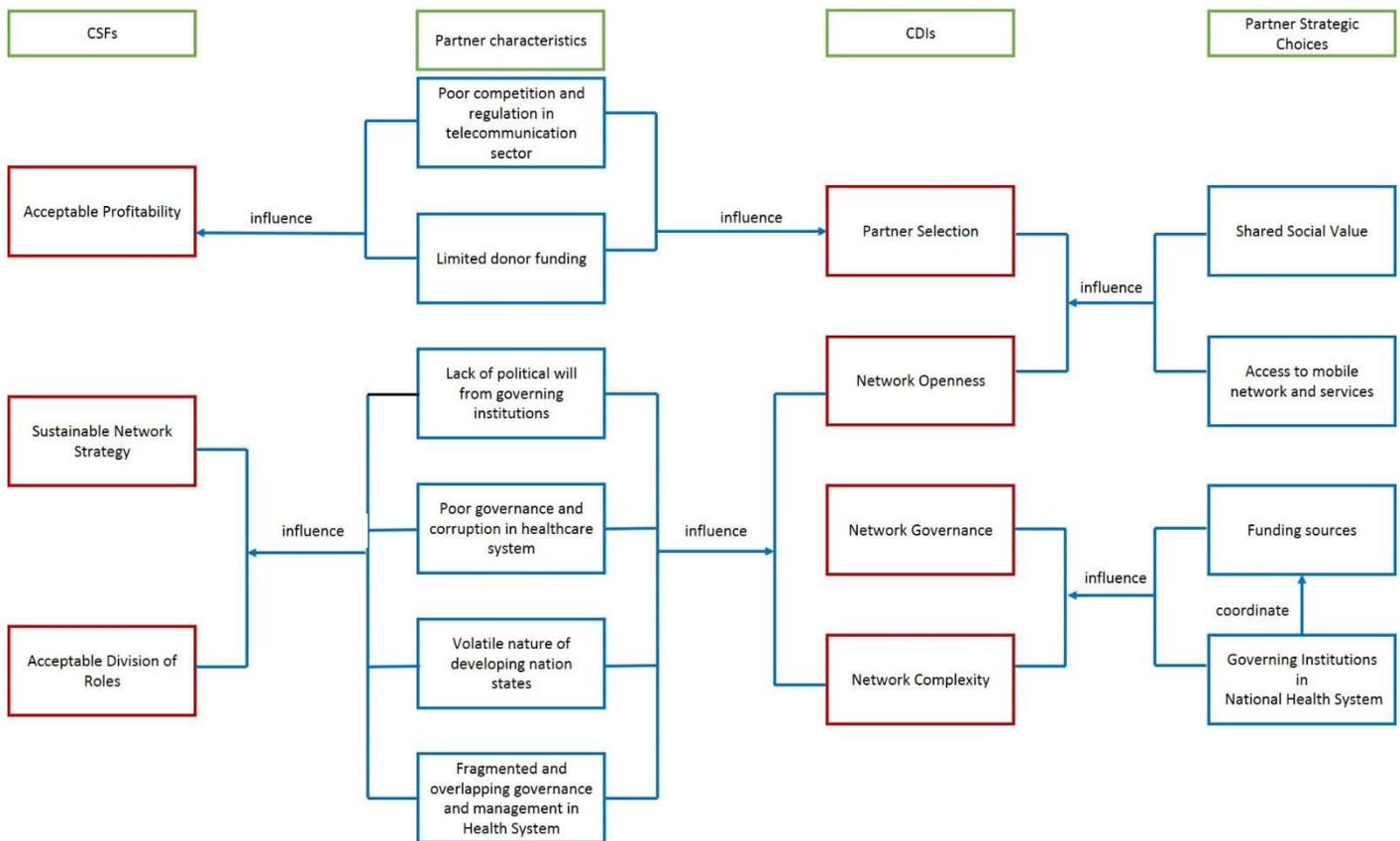


Figure 5.7: Characteristics that influence the value network offered in the service innovation (Source: Research)

In conclusion, Figure 5.7 provides an overview of Critical Design Issues and Success Factors that play a role in establishing the value network for mHealth services.

5.7 Financial Model

The Financial domain is directly related to the organizational domain. Once partners are selected, then it is possible to visualize funding sources for the service innovation. Discussions in the organizational domain refer to CDIs in the financial domain. The next section, discusses the values for the financial model and evaluate its CSFs using identified domain characteristics.

5.7.1 Pricing, Division of Investments and Risks, Division of Costs and Revenues, Valuation of Contribution and Benefits

In the service domain design, pricing is defined and evaluated characteristics in relation to the intended Target group that might influence Pricing. However, this CDI is also influenced by characteristics of the organizational arrangements. As earlier stated that, service charges may be charged to end-users in the community or to governing institution(s), however, there are already threats and challenges to funding and the value network in the organizational arrangements, which also threaten the possibility of governing institutions fulfilling the responsibility of covering user cost.

In division of revenues, costs, investments and risks, partners ensure minimum financial risks in the new service innovation (Bouwman, De Vos and Haaker, 2008). However, there is a difference in

organizational arrangements in profit-oriented service innovations and those in our development-oriented service innovation. Profit-oriented service innovations share in revenues, costs, investments and risks. However, in our development-oriented service investments, the structural and contributing partners shoulder costs and risks. It is a challenge to determine financial sustainability in a development-oriented business model, depending on community end-users that can barely sustain basic healthcare costs, health facilities that are poorly facilitated and funded and governing institutions with limited funds. However, Division of Costs can spread out service costs. For instance, equipment and installation costs are usually assigned to donor agencies (supporting partners). Service and maintenance costs is the responsibility of governing institutions (structural partners) and service access charges can be borne by community end-users. Revenue is however shared by the contributing partners (the telecommunications' providers). This creates an imbalance in the value network and especially the financial model.

Valuation of contribution and benefits refers to the contribution each partner makes to the service innovation and the benefits each partner gains from the service innovation. This CDI is related to the previous divisions of investment, costs and revenues. While at this point it is difficult to ascertain the contributions of each structural partner, it is safe to say that there is an unfair level of contribution between the structural partners and the benefits of the contributing partners. It is also not possible to balance the value of revenues vs social growth and development. The structural partners in SE business model are aiming for social growth and development, while the contributing partner is aiming for increased revenues and profit. The challenge for the Social Entrepreneurship business model is to enable the contributing partner to charge service costs sufficient to make profit while enabling the structural partners and end-users to access and operate the service at minimal costs supported by minimal public or donor funds.

The threats to these four CDIs also threaten the CSFs: (1) a sustainable network strategy, (2) Acceptable Division of Roles and Responsibilities, (3) Acceptable Risks and (4) Acceptable Profitability. The imbalance between value received by structural partners and value received by contributing partners threatens the sustainability of the network. The same imbalance fails to create acceptable division of roles and responsibilities, risks and profitability. However, just as these elements create an imbalance the strategic choices we identified in the organizational arrangements (a shared social value, access to a mobile network, funding sources and the support of governing institutions) they also create balance in the value network. The shared social objective or value between the partners' means that they may be political and institutional will to support and sustain the service especially in mobilising funds or funding sources. Although telecom providers may operate in a parallel market, existence of the infrastructure supports the technological architecture. In summary, the relationship between the core design issues and success factors are summarized in figure 5.8 below.

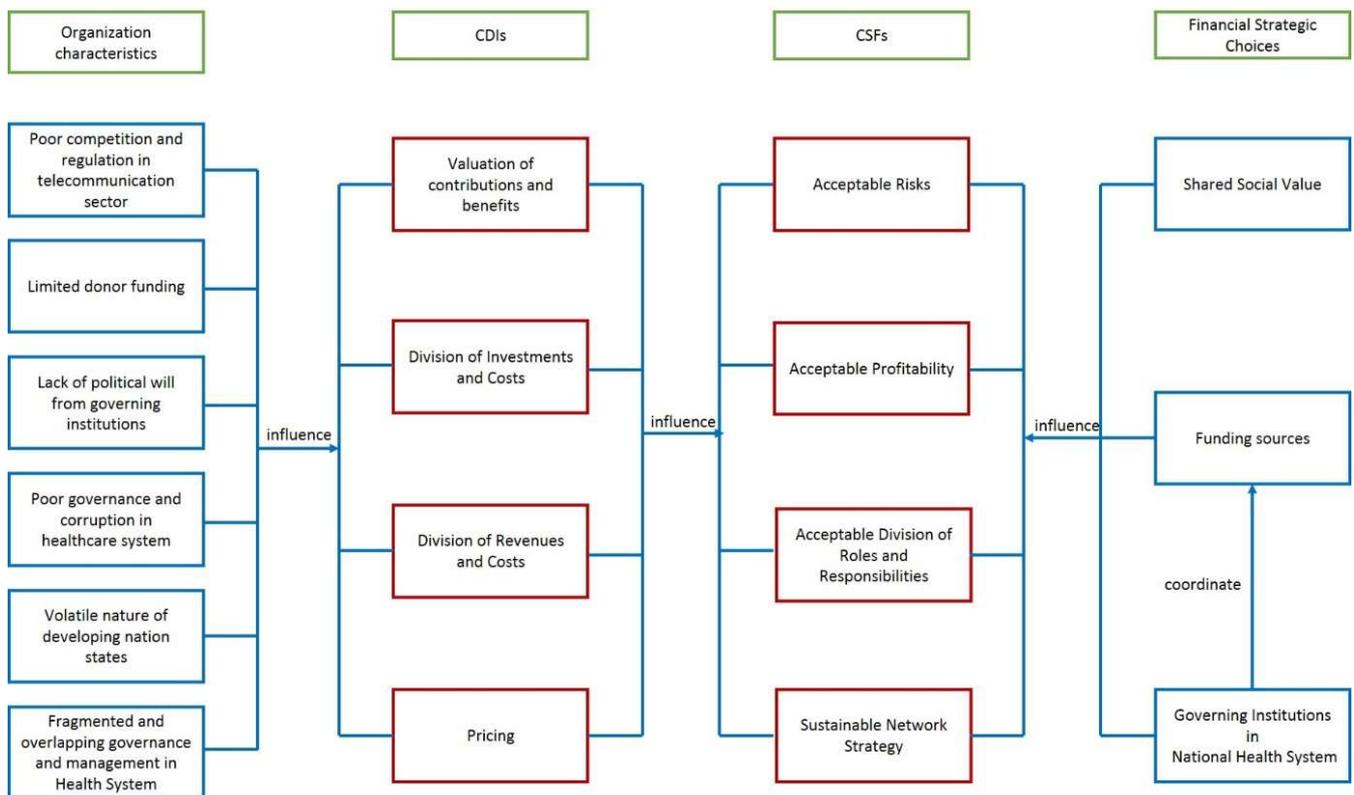


Figure 5.8: Characteristics that influence the financial model of the service innovations (Source; Research)

The next section examines the livelihood strategies and their outcomes. The CDI Valuation of contributions and benefits, the ability to measure intangible benefits is therefore necessary. Social value or development is comprised of mostly intangible benefits. The livelihood strategies and outcomes provide a criterion from which the social benefits of a service innovation can be measured. Tongia and Subrahmanian (2006) state that donor funders usually require visible solutions to development problems. They also indicate threats to the value proposition because they indicate preference of poor community members.

5.8 Livelihood Strategies and Outcomes

Livelihood strategies are ways of combining and using assets available to the poor as they pursue livelihood outcomes (Duncombe, 2006). From the rural healthcare context, three providers have been identified: (1) public healthcare facilities, (2) PNFPs and (3) private healthcare providers.

Health seekers when presented with these choices, employ a multiple-provider strategy in order to overcome illness or any healthcare related issue they may face. Basing on the discussion above, it can be seen that the choice of which provider to visit depends on, (1) accessibility and availability of facility and services, (2) affordability and (3) the need for specialized care. A facility that offers free services is the first choice. However, if this is not accessible or services are not available, then a provider with similar and affordable services is sought. In the event that further treatment is needed, the health seeker either will seek out a public healthcare facility or specialized treatment at a general hospital with qualified personnel. Depending on the choice made, there are risks, costs or effort incurred. Public

healthcare facilities and PNFPs depending on the level of training of their healthcare workers can handle most basic and locally prevalent ailments as is required by the Primary Health Care approach. This means that common ailments like malaria can be treated at almost any level of the PHC structure. Trained midwives are also available at a Health Centre III for expectant mothers, though specialized treatment is found at higher levels of the structure. However, because these are sometimes inaccessible or unavailable to health seekers, the effort involved can deter them from pursuing this course of action and opt for a nearby clinic or a locally available traditional healthcare provider. Figure 5.9 represents strategies and outcomes from health seekers.

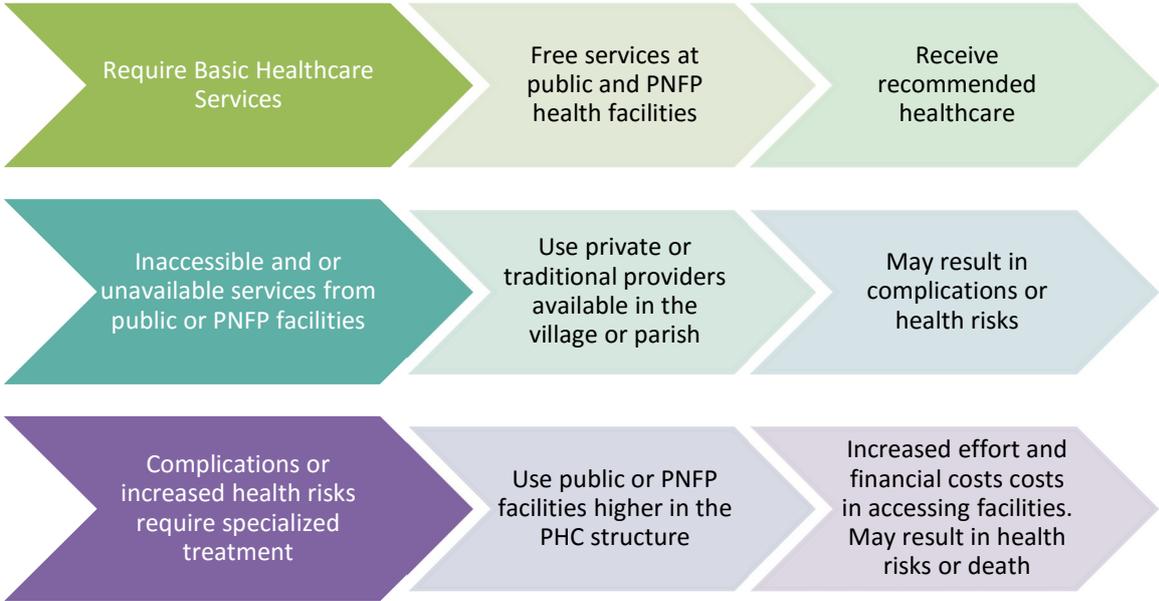


Figure 5.9: Livelihood strategies and outcomes (Source; Research)

From the diagram, it is clear that among the three outcomes identified, only one is positive and contributes positively to the overall development objective. This is when members of poor communities have access to healthcare from recommended health facilities. The last two outcomes that are a result of poor quality services at recommended facilities and accessing unregulated private or traditional providers are undesirable outcomes, the first outcomes can be used to strengthen the value proposition to structural partners. If a service innovation can motivate and increase access to recommended health facilities through health education, then institutional support and funding can be guaranteed. Likewise, the negative outcomes can be used to strengthen the value proposition of the service innovation. If the service innovation can sensitize and reduce visits to unregulated healthcare providers, also through health education, then structural partners can perceive it as contributing to the overall social value. On the other hand, the negative livelihood strategies can be a threat to value proposition. It is clear that as long as recommended facilities offer, poor services or communities perceive PNFP services too costly, they will continue to seek healthcare from unregulated facilities and providers.

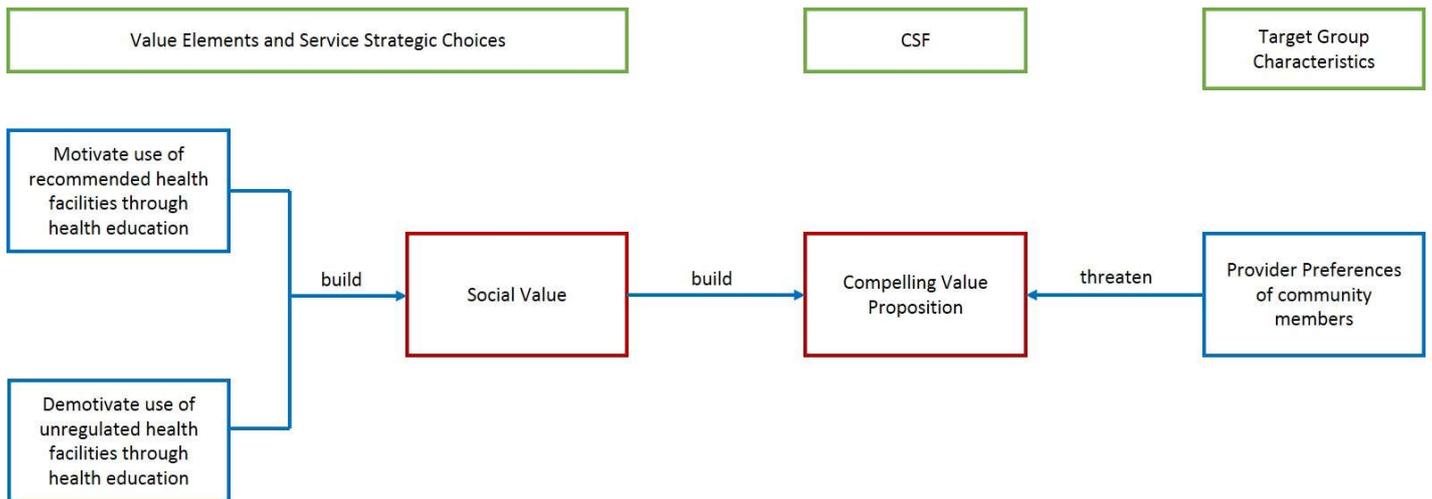


Figure 5.10: Influence of strategic outcomes on the service value proposition (Source; Research)

5.9 Business Model Sustainability and Rural Context Characteristics

The primary objective of the research is to identify characteristics in a rural healthcare context that influence sustainability of a service innovation. From the analysis above, the research has been able to identify strategic choices to build sustainability and identify those characteristics that might influence sustainability. The strategic choices are used to design the underlying business model for the service innovation and the characteristics can be used to evaluate the viability of the innovation. The discussion will also begin with the strategic choices as summarized in Table 5.5 below.

Table 5.5: Strategic choices in business model of the service innovation

| Service | Technology | Organizations and Finances |
|--|--------------|--|
| 1) Access and deliver healthcare in remote areas 2) Access to healthcare information 3) Health education on health risks and disease prevention 4) Effective management and decision making in health systems | SMS Platform | 1) Structural and Supporting Partners should have Shared social value 2) Structural and Supporting Partners are also Funding sources 3) Structural Partners should be Governing institutions in national health systems 4) Contributing Partners give Access to Mobile network and services |

Value elements that make up the service innovation are meant to generate value (social value) for community members, health facilities and structural partners. Thus, the strategic choices are the social value for the context model. It is from these that designers identify value elements for a mobile service innovation for developing rural healthcare systems. It must also be noted that value elements target two sets of actors in the business model, end-users and partners. The choice to use the SMS platform is to support accessibility of services for the target group while using low cost technology and service to maintain the interest of structural partners. The choice of structural partners is meant to solicit and

maintain support of the social value reflected in the service strategy. However, supporting partners provide initial financial and institutional support to structural partners. The choice of contributing partner is meant to enable access to mobile networks and services. The business model strategic choices are represented in figure 5.11.

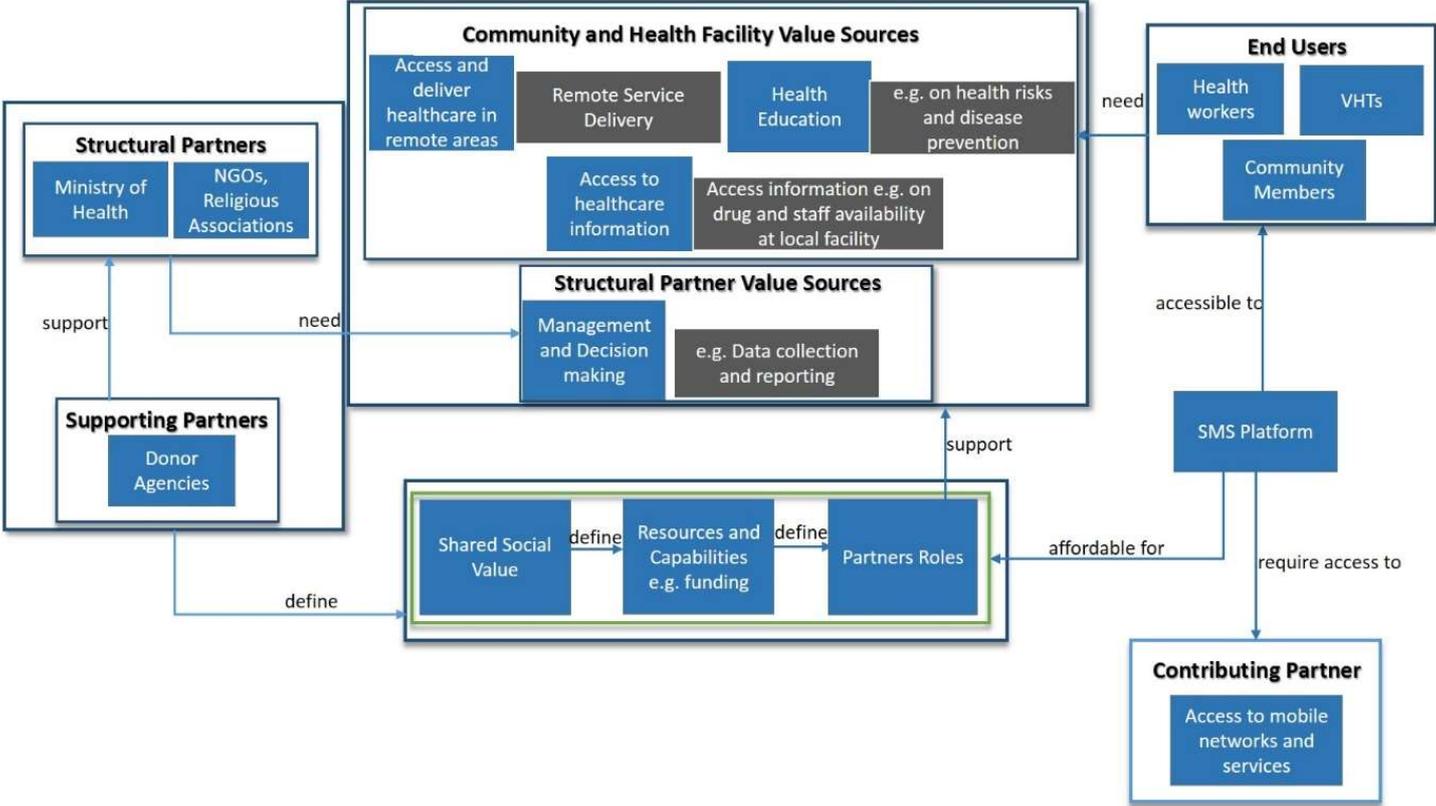


Figure 5.11: Service innovation and business model strategic choices (Source; Research)

Characteristics were identified from the target group, technology domain, finance and organizational partners. Table 5.6 below gives a summary of these characteristics.

Table 5.6: Characteristics that influence sustainability of the service innovation

| Target Group | Technology Domain | Finance and Organization Partners |
|--|---|---|
| <ul style="list-style-type: none"> 1) Limited finances and number of phones 2) Poorly facilitated health facilities 3) Limited, overworked and demotivated health workers 4) Preference for unregulated health providers | <ul style="list-style-type: none"> 1) Poor coverage of mobile network in rural areas 2) Weak wireless security protocols 3) Electronic storage and transmission of personal health information 4) Poor competition and regulation in telecommunication sector | <ul style="list-style-type: none"> 1) Limited donor funding 2) Lack of political will from governing institutions to support healthcare programs 3) Poor governance and corruption in health system 4) Volatile nature of developing nations and states 5) Fragmented and overlapping governance and management in national health systems |

Characteristics of the target group influence adoption of the SMS application, three of them in the technology domain (weak wireless security protocols, electronic storage and transmission of personal health information and fragmented health information systems in national health system) influence the ability for the service strategy to generate value for end-users. Five characteristics that include: (1) limited donor funding, (2) lack of political will from governing institutions to support healthcare programs, (3) poor governance and corruption in the health system, (4) volatile nature of developing nations, (5) fragmented, overlapping governance and management of programs in the national health systems and (6) weak ICT infrastructure in health facilities influence three strategic choices in the organization and finance domain (the governing institutions in the national system, the shared social value, and funding sources). Finally, two characteristics, one belonging to the technology domain (poor coverage of mobile networks in rural areas) and the second from the finance and organizational domain (poor competition and regulation of the telecommunication sector) influence the performance of the contributing partners in the value network, as represented in figure 5.12, as a context model.

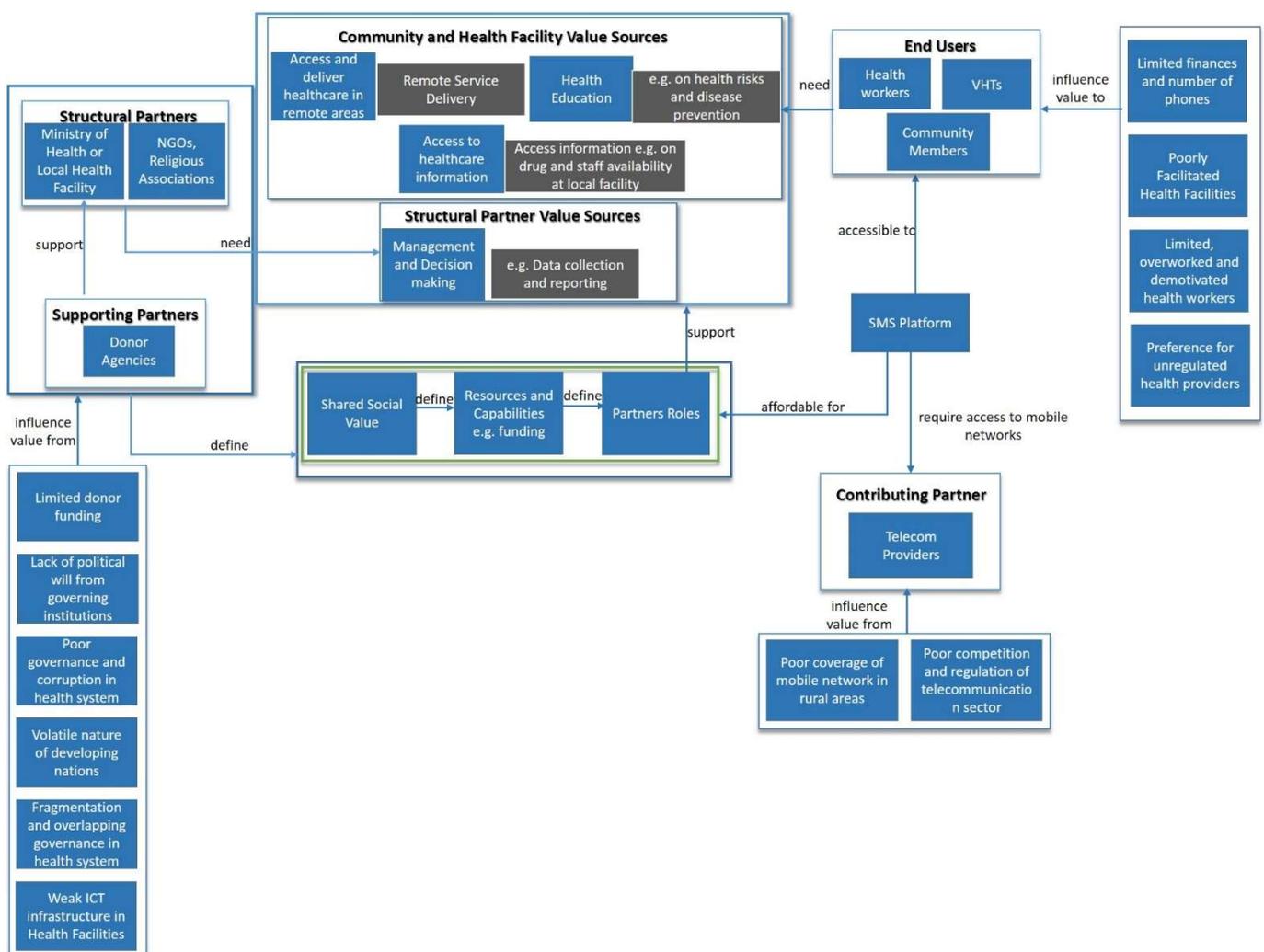


Figure 5.12: Context-aware model for the design a service innovation and its business model (Source; Research).

5.10 Conclusion

As a conclusion, it is clear that this chapter presents the first steps of design and evaluation of the service innovation and its underlying business model. The end result has been the first structure of our context-aware design model, which started the design process with the livelihood framework. The benefit of this is that it gives the research a generic view and description of the context that makes it possible to relate the service innovation with most developing contexts and therefore relate to the findings. The generic description also guides the fact-finding process in the case study. Generic descriptions from this chapter should be visible in the case study, and also gives a safety net to identified characteristics. Using these as a guide in case findings, gives validity to these characteristics and strategic choices, which can be related to similar cases. The model developed above gives us a generic tool, which ICT4D designers of m-Health service innovations can use to make strategic choices to create social value. For policy makers the framework highlights areas in the political, economic and social contexts that are not functioning properly and need attention. Finally, for development practitioners at national and international level, the model highlights support needed to sustain mobile service innovations.

What can be observed from the model is that the technology exists and is capable of fulfilling the requirements of rural healthcare. Most of the challenges however stem from the context, and are a result of, (1) poverty, (2) governance, (3) regulation and (4) limited funds. Significantly, each of these generic concepts can be found in most developing country contexts.

6. Chapter 6: Evaluation of Service Innovation

6.1 Introduction

The design and evaluation process of a mobile service innovation and its' underlying Business Model based on literature and reports in the previous chapter has resulted in, first, identification of strategic choices and characteristics in a rural healthcare context that can influence social value creation and therefore sustainability. The researcher used two components (strategic choices and characteristics) to develop a context model that can be used by designers to develop a mobile service innovation and its underlying business model. These identified criteria for service and business model design and evaluation is however broad in definition. Through the iterative process of the Build Intervention and Evaluate stage of ADR, is refined the service design, business model, and context variables that make up the strategic choices and characteristics based on findings from the case study. There is further demonstration of the effect of these identified variables to the underlying business model of our service innovation. Essentially chapter 5 evaluates the Quick Scan, and this chapter applies the last three stages of the STOF method – Evaluation of CSFs, Specification of CDIs and Evaluation. Findings are presented following the structure of the theoretical framework used in chapter 5 and present the refined context variables that make up the context-aware model. Finally, the livelihood framework is used to identify the characteristics, Social Entrepreneurship (SE) to develop the strategic choices and the STOF domains to evaluate and specify each variable identified.

6.2 Case Study Design

Yin (1994) defines case studies as empirical inquiries or examination of contemporary phenomenon within their natural context, particularly when the boundaries between phenomenon and context are not clearly evident. A case study research strategy is especially appropriate when the subject of research interest is relatively unknown, the experience of actors is important and the context of application is significant (Benbasa, Goldstain and Mead, 1987). The case study strategy complements Action Design Research (ADR) and Ethnography as presented in chapter 4. Chapter 4 also describes ADR, as a design science research strategy that recognizes that an artefact emerges from interacting with the context. A case strategy gives the research the opportunity to observe context variables that build the service innovation and its business model. On the other hand, Ethnography has been described as a research strategy that understands and describes people and their way of life in a given context. People are the stakeholders in the context and the relationship with circumstances that surround them make up the context variables that are used to design and evaluate a service innovation. These context variables are used by the STOF method to design and evaluate our service innovation and its underlying business model. It can therefore, be concluded that case study strategy is appropriate to support the two research strategies that were selected to achieve the research objective. Table 6.1 is a summary of the relationship between our research design and the case study strategy.

Table 6.1 Case Study Strategy Contribution

| Research Strategy | Case Study Contribution | Contribution to Research |
|--------------------------|---|--|
| Action Design Research | Provides context from which context variables are identified and used to design artefact | Context |
| Ethnography | Provides opportunity to study stakeholders in the context and their circumstances. It is from these that context variables are identified | Context Variables |
| STOF | | Use context variables to design and evaluate service innovation and its business model |

The previous chapter identifies actors and characteristics from literature that could possibly exist in a developing rural healthcare context, and there need to determine if these actors and characteristics exist in their natural context. Traditionally, mobile service innovations are applied in modern and profit-oriented contexts. As a new phenomenon in ICT and mobile service innovation research, a case study strategy has been perceived as the best possible approach to understand this new phenomenon in a rural healthcare context.

A research study must also make a decision on whether to use a single case or multiple cases. A single case can be used when investigating a unique phenomenon to science and to enable a rich description (Cavaye, 1996). A case study strategy also involves studying specified dynamics in single settings with multiple levels of analysis (Eisenhardt, 1989). It should be noted that a single case with multiple levels of analysis was used. The first level is the rural healthcare context which allows the research to examine the variables previously identified and determine if they really do have an influence on our business model. The research therefore uses Nindye Parish community, Nindye Health Centre III, Nindye VHTs and Nkozi Hospital as the single case representing a rural healthcare system.

Furthermore, the second level includes two m-Health service innovations: (1) mTrac and (2) FrontlineSMS application. The research used two services primarily because of a Ministry of Health directive at the time of research. Due to multiple and duplicate m-Health and e-Health innovations in the country, the Ministry placed a ban on new innovations at the time of the research. This led the research to use the first service, mTrac which was a Ministry led SMS service innovation. mTrac was implemented in several districts to be used by health workers and community health workers (VHTs) for data collection, reporting and medical alerts, and by community members to report poor service delivery at local facilities. mTrac uses RapidSMS as its platform. It is a web based application using a GPRS modem to send and receive messages from and to mobile phones (Adewumi and Daramola, 2010). The central functionality is that mTrac receives weekly reports from health workers and VHTs weekly in the form of text messages, which are sent to a centralized database at the Ministry of Health. Reports are then viewed by district health officials who supervise health facilities in their respective districts. The service architecture is represented in Figure 6.1

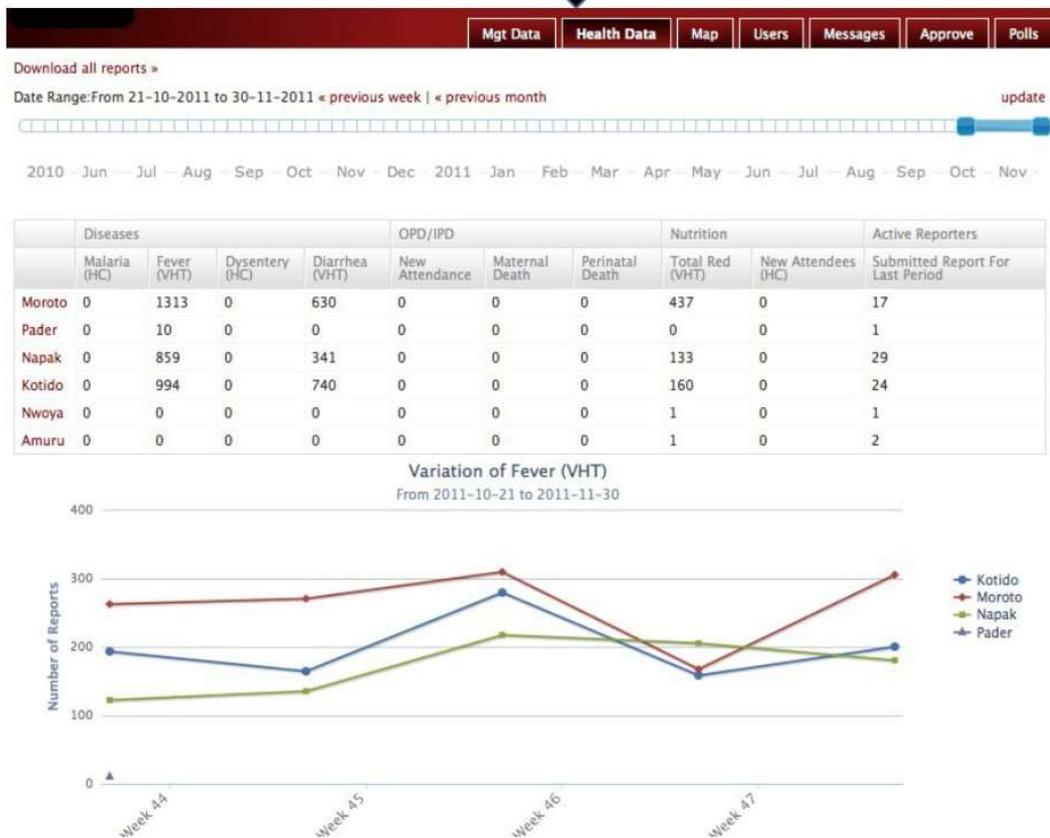
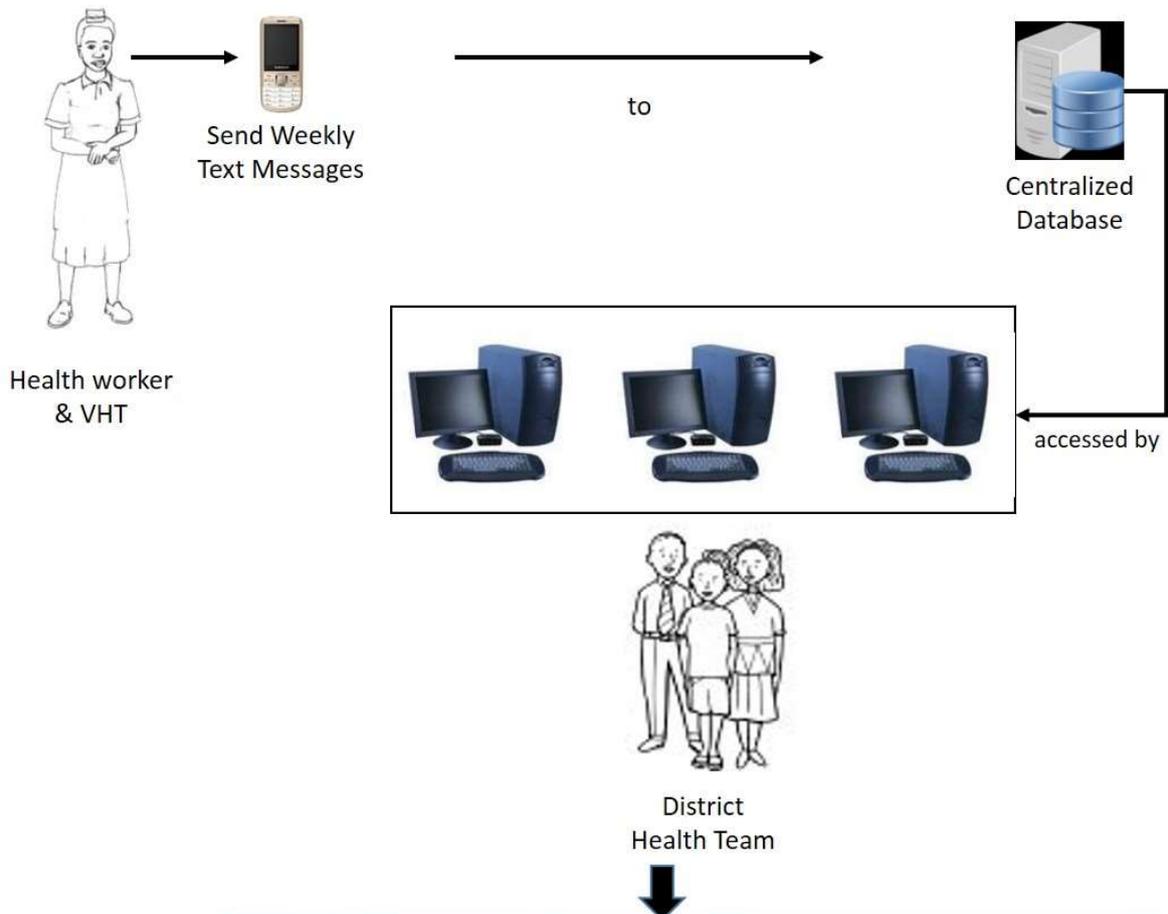


Figure 6.1: mTrac Service Architecture

mTrac also receives medical alerts from health workers on disease outbreaks or need for emergency medical supplies. Figure 6.2 is a web interface that displays alert reports that have been made to the system.

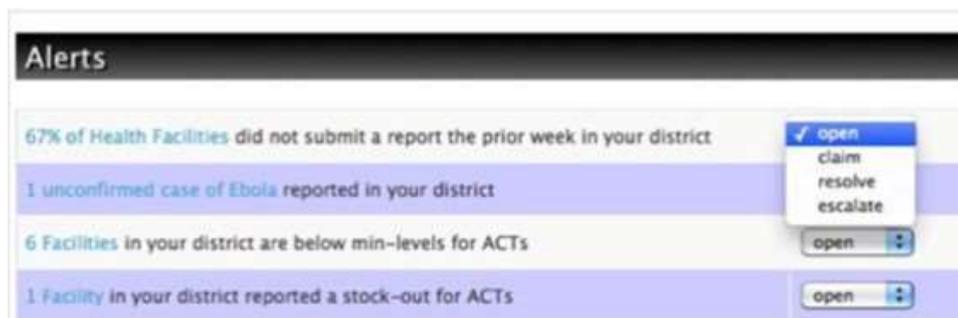


Figure 6.2: mTrac web interface reporting on medical alerts and reports made to mTrac

Other features include setting up SMS polls directed to a specific area or issue and an anonymous complaint hotline for community members on quality of services they receive at their local facility. The SMS polls may be set up as a question directed to VHTs or community for instance “How many functioning pit latrines [toilets] are in your community?”

mTrac however, is essentially a top down design, that is to say, the value elements are representative of governing and donor institution interests. Most of the value elements identified from the rural context are not represented in the service. The research later on implemented a bottom up design; a FrontlineSMS based innovation that includes the needs of local facilities. FrontlineSMS is also web based and open source like RapidSMS. It also uses a GPRS modem to send and receive messages to and from mobile phones as is demonstrated in figure 6.3. The primary functionality of FrontlineSMS is also reporting. mTrac web reports are not available to health facilities which they too need to access. Nindye health facility made the request for this service primarily to have VHTs send the same messages as those sent to mTrac on a monthly messages basis to the facility. These messages are viewed by health workers at the facility as represented in Figure 6.4.

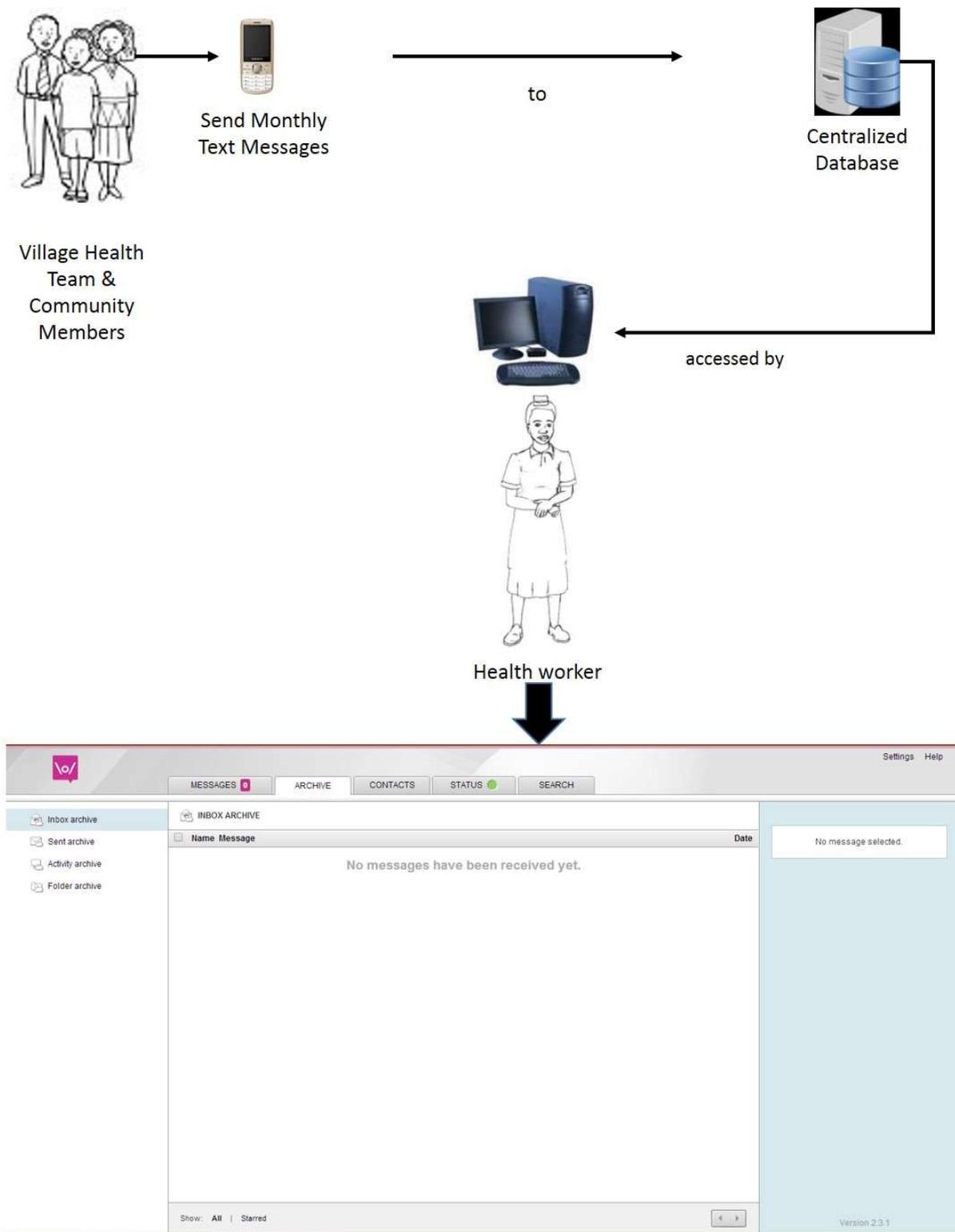


Figure 6.3: FrontlineSMS- Service Architecture

| # | Date | Total Cases for Under 5s | Malaria Cases | Red MUAC | Referred Cases | Newborns seen within 24 hours | Service Provider |
|---|--------------------------|--------------------------|---------------|----------|----------------|-------------------------------|------------------|
| 1 | Jan. 21, 2016, 2:46 a.m. | 27 | 7 | 2 | 9 | 3 | Sheba Nyakasiki |
| 2 | Dec. 22, 2015, 9:59 p.m. | 6 | 5 | 4 | 3 | 2 | Sheba Nyakasiki |

Figure 6.4: Nindye System web interface report view.

Notably, automated responses were also set up to respond to messages sent to the system. These were meant to respond to VHTs' sending in their messages and to inquiries. However, this functionality was also affected by the lack of funding to support SMS charges sent to the inquirer or a VHT. Receiving messages supports reporting by VHTs to the health facility. This service is supported by VHTs covering the cost of individual SMS messages sent each VHT sending in his/her report once a month. The two cases gave the study the opportunity to observe all actors, that is to say, the community, VHTs, local health facilities and the partner institutions and their interaction with the services. mTrac was observed at the VHT and facility level and the national and international partner levels. The FrontlineSMS application was observed at the community, VHT, facility and local partner institution levels.

6.2.1 Unit of Analysis

Benbasat, Goldstein and Mead (1987) outline guidelines on how to select the unit of analysis in a case study research, and these include: (1) focusing the study on individuals, groups, organizations or project, (2) examine the research question pursued to guide what the focus of your study will be and (3) what is to be generalized to similar contexts. The research question intends to identify those characteristics within a developing rural context that influence business model sustainability of an m-Health mobile service innovation in Nindye Parish. The unit of analysis therefore is a developing rural area and its healthcare system. Findings are related to those characteristics identified in chapter 5. We therefore observe Nindye Parish's health system which includes: (1) the community, (2) the health facilities, resources, health workers and (3) healthcare programs currently in progress in the health system (Gilson, 2012). The units of observation include: the community members, VHTs, health workers and health facilities in and used by Nindye community (Nindye Parish Health Centre III and Nkozi Hospital, that is a Health Centre IV and a referral hospital). To validate our findings in Nindye Parish health system, there is comparison of findings with the same units of observation found in Nkozi area that include community members and VHTs in the Nkozi area.

6.2.2 Data Collection

Field data collection began in 2010 as a stage of exploration and included presenting the initial FrontlineSMS application to key individuals and informants. Reactions and advice from these initial discussions were incorporated into the initial design and then led to a period of observation, group discussions and interviews with community members, VHTs and health workers to determine healthcare needs, challenges and possible communication and information needs that ended in September 2012. From these activities, it was made possible to develop a general idea of healthcare, challenges to healthcare and initial perceptions to the proposed m-Health service innovation. To

validate the findings from Nindye community, opinion of VHTs related to Nkozi Hospital and a community member close to Nkozi Hospital was sought.

The implementation of mTrac in Nkozi sub-county health facilities was scheduled in October 2012. Observation sessions and interviews with VHTs participating in training sessions were carried out during the two days of training they received. Five months after implementation, a series of interviews with individuals who had used mTrac were carried out. These include one VHT, one health worker and two record officers at Nkozi Hospital and Nindye Health Centre III, and also interviewed a key informant from Malaria Consortium, a Supporting partner in healthcare and mTrac. In addition, six months after implementation we carried out a survey with VHTs that had been trained and were using mTrac to determine their perception of the service, especially in relation to challenges that we had identified from the first phase of evaluation. The implementation stage drew our attention specifically to the mobile phone and community members, then organized mobile literacy classes for community members and VHTs in preparation for the implementation of FrontlineSMS, also these were used as observation sessions and supplements to findings with Mobile Literacy tests.

The last group of interviewees includes five key informants that gave us expert insight into the context. The first is a community healthcare expert that was involved not only with the group of VHTs in Nindye, but also in other parts of rural Uganda. The second is, the medical officer in-charge of Nindye Health Centre III that has led the health development program with Nindye Health Centre III. The third is, a development worker that has had extensive experience with the Nindye community. The fourth is, a key informant and participant from Malaria Consortium and was instrumental in the implementation phase of mTrac. The fifth is the Health Systems Strengthening Specialist in UNICEF. UNICEF is a stakeholder in mTrac. The respondent was therefore a key informant on the design and deployment of mTrac. All the sources of data collection are summarized in table 6.2 below.

Table 6.2: Data Collection

| Code | Unit of Observation | Respondents | Data collection Method |
|-----------|---|---|---|
| HF-1 | Nkozi Hospital, Health Centre IV | Nkozi Hospital Management Team, Nkozi Hospital Surgeon, Nkozi Hospital Governing Board Member, Outpatient Department Head Nurse, Midwife, Antenatal Department, Nkozi Hospital VHTs and a Records Officer | Group Discussion, Interviews |
| HF-2 | Nindy Health Centre III | Medical Officer in-charge, Records Officer and Board Member Nindy Health Centre III | Interview |
| VHT-Nindy | Nindy VHTs | Nindy Health Centre VHTs | Group Discussion, Interviews, Observation Sessions, survey questionnaire (25), Mobile Literacy Test (24) |
| VHT-Nkozi | VHTs | Nkozi Hospital VHTs | Survey questionnaire (23) and Interviews |
| CM-Nindy | Community Member(s) | Nindy community members (adult men and women) | Group Discussions, Interviews, Observation Sessions and Mobile Literacy classes (378), Mobile Literacy Test (186) |
| CM-Nkozi | Community Member | Community Member Nkozi Trading Centre | Interview |
| SP-1 | UNICEF, Social Value Partner | Health Systems Strengthening Specialist UNICEF | Interview |
| SP-2 | Malaria Consortium, Social Value Partner | Technical Officer, Malaria Consortium | Interview |
| SP-3 | Uganda Catholic Medical Bureau (UCMB), Social Value Partner | Project Coordinator Uganda Catholic Medical Bureau (UCMB) | Interview |
| KI-1 | Uganda Martyrs University, Health Science Students and VHTs | Healthcare workers and Community health promoters part of a diploma in community health course in Uganda Martyrs University | Group Discussion |
| KI-2 | Uganda Martyrs University, Outreach Department and Health Science Faculty, Key Informants | Lecturer and course coordinator | Interviews |

Table Key

| Code | Code Key |
|------------|---|
| HF-1 | Nkozi Hospital |
| HF-2 | Nindye Health Centre III |
| VHT-Nindye | Nindye VHTs |
| VHT-Nkozi | Nkozi Hospital VHTs |
| CM-Nindye | Nindye Community Member(s) |
| CM-Nkozi | Nkozi Community Member(s) |
| SP-1 | Social Value Partner; UNICEF |
| SP-2 | Social Value Partner; Malaria Consortium |
| SP-3 | Social Value Partners; Uganda Catholic Medical Bureau (UCMB), |
| KI-1 | Key Informant(s); Uganda Martyrs University, Health Science Students and VHTs |
| KI-2 | Key Informant(s); Uganda Martyrs University, Outreach Department and Health Science Faculty |

6.2.4 Data Analysis

Qualitative data analysis has been done in five stages. Recorded meetings, group discussions, interviews, and observed training sessions were transcribed. In the first stage, transcribed data was open coded according to emerging themes. The data and open codes were then transferred to Atlas Ti where themes were transformed into codes. Codes that highlighted or described the same element or characteristics were merged. This was the second stage of coding. In the third stage of coding, themes were refined into characteristics and effects of rural poverty, rural healthcare and rural mobile phone usage. Separating the codes into these three general domains enabled us to see what characteristics have a causal effect - positive or negative to other elements in the each domain. We developed this understanding by creating networks between codes that had a causal effect on each other. In the fourth stage, memos were created basing on the three sections of a livelihood analysis: (1) Vulnerabilities and Assets, (2) Structures and Processes, and (3) Strategies and Outcomes in rural healthcare. The codes that describe each section were linked to the memos. At this stage we could visualize not only the livelihood network but the underlying effects on vulnerability and therefore underlying elements that will affect a mobile service innovation. In the fifth stage, we created families of Critical Success Factors (CSF) and assigned memos and codes that best describe or influence the CSF(s). This process helped us to begin evaluation of the mobile service innovations according to characteristics emerging from the analysis. These characteristics are further defined on a more generic level so as to relate the findings to other rural mobile service innovations in healthcare.

Quantitative data collected using a questionnaire and a mobile literacy test is used to support qualitative findings. In presentation of qualitative data, frequencies are used, descriptive statistics and cross table analysis of the quantitative data to support the presence and influence of characteristics identified from the qualitative analysis. Findings were presented basing on the three sections of a livelihood frame with each section providing an evaluation of CSF(s) using the livelihood section as criteria for evaluation.

6.3 Vulnerabilities and Assets

In the initial livelihood analysis, there was analysis of literature, on what assets poor households have at their disposal in the context of prevailing health risks and how they may use these five assets including financial, social, human, natural and physical to overcome disease outbreak. Agricultural land was identified as the main source of financial wealth, human capital made up of mainly manual laborers, natural resources, land and water as scarce, and a social culture made up traditional and indigenous knowledge, also identified physical capital as public, PNFP and private providers and due to weaknesses in social political policy, the existence of unqualified private and traditional providers. Findings from the case study enabled the research to develop a more in-depth understanding of each asset, thus enabling us to portray a more accurate description of each asset and its causal effect on healthcare vulnerabilities. The descriptions in turn further develop CDIs and CSFs first defined in chapter 5.

6.3.1 Low Incomes and Earnings

Literature reveals that financial capital for poor communities include land used for farming and income generation. In relation to healthcare, poor households sell off their land or borrow to pay for healthcare costs. This relationship between land, income and healthcare costs was visible in the case study findings, and emerged as low incomes and earnings. In a VHTs-Nindye Interview, a respondent was asked what he perceived did community members in relation to healthcare experience the biggest challenge, his response was: *“The biggest problem is finance. And again, as most people, we don’t have enough land.”* It was also clear through group discussions that limited incomes and means to generate incomes were a catalyst to most healthcare challenges. This was the underlying factor behind women choosing to give birth at home, failure to visit the better-equipped local PNFP facility and failure to possess disease preventive resources in households. Incomes and land were also linked to infertile soils and changing weather patterns as stated by a participant in the CM-Nindye group discussion:

“Shelter and sleeping conditions for children is poor because of poor livelihoods. [Some begin to argue about this point. Representative responds] Do you think incomes can be good and yet you have changing seasons? Why shouldn’t conditions at home be bad if we have a constant dry season? How will you increase your income? How will you drive a car or a motorcycle and yet all I can do is farming.”

In an interview with a community member from Nkozi, the respondent was also asked to give her opinion of the biggest challenge community members experience in healthcare, she states:

“Money. Money is a problem. You might have Shs. 50,000 [\$ 15]. Then you have to buy food, then your daughter falls sick, you don’t have paraffin. You start to think about all the things you have to buy, and wonder “how will I manage to take my child to hospital and yet they will charge me more money”. That’s when you can say no. I have to buy paraffin, I have to buy food. So let me go to the clinic. If I fail, then I will look for money to go to the hospital.”

It is apparent low incomes influence the ability for heads of households to provide and protect their families from ill health. During the CM-Nindye group discussion, men defend their failure to fulfil their responsibilities when their representative states:

“Women please do not blame us men sometimes we do not have money. The means of earning a living are not there.”

Limited incomes and earnings are central in the lives of poor communities. The fact that it was pointed out first by respondents and is related to most healthcare challenges indicates that it might also be a challenge to the service innovations. With regard to the FrontlineSMS innovation, when the service was presented to a community member and asked if he would be willing to use the service at a fee to make inquiries at the local facility he responds:

“If I have credit and the phone is charged, then it is possible. But that [mHealth service] can be helpful, like the police emergency call. That can also be helpful.”

As discussed in chapter 5, SMS services are charged. This charge may be paid for by a donor agency or government funding, as is the case with mTrac, or it may be paid by an individual user. For a community with limited income and earnings, targeted users may not have phone credit when the need to use the service arises. Charging a phone as the respondent also stated is a challenge and is related to limited income and earnings. Most rural phone users need to keep their phones charged. However, because they do not have easy access to electricity, people depend on retailers in the community who charge them a fee. It is explicit limited income and earnings therefore affect the CDIs Pricing and Accessibility for Customers, which in turn affect the CSF Compelling Value Proposition.

6.3.2 Inaccessible Healthcare Services

Literature describes public and PNFP health facilities as poorly facilitated and private facilities as expensive, and facilities are limited in number and relatively scarce in poor communities. As a result, health seekers have to travel long distances to access healthcare or seek healthcare from unqualified providers in their community. Field data reveals the same characteristics as literature data. Nindye’s only Health Centre is a public facility, which is poorly facilitated with limited number of services, frequently absent health workers and limited number of hours of operation. Poor facilitation is especially evident in poor drug supply. During the group discussions with community women, men and VHTs, each group as well as interviews raised these challenges with individual stakeholders. A respondent explains that part of the reason for the limited supply of drugs is the fact that there are not more public health facilities in the area to distribute drugs to the community. The respondent states:

“The coartem [malaria medication] in the hospital should be available. The challenge is, they [Ministry of Health] are supplying a fixed amount to the health centres as per their [facility] level. That means there should have been a health centre II nearby which should have a similar amount of medicine. Now that the health centre IIs are not there, that is why people come and consume what is sent here and it runs out.”

Lack of equipment and facilities limit the number of services available at the public health facility and therefore access to healthcare. In the VHTs-Nindye group discussion, the VHT group representative states:

“There isn’t a lab at the health centre. They cannot determine the exact illness one is suffering from. They cannot determine the cause of fever one has. There are no beds that you can be admitted for treatment. Therefore, this is why we think that the number of services offered are too little. They are not enough”

Absenteeism of public health workers and specified hours and days of operation also limit access to healthcare services. A respondent in a CM-Nindye interview revealed:

“You know sometimes, a child might fall sick in the night. They [Ministry of Health] helped us and brought medicine nearer to us in the villages for the very young children. However, we are asking that for children from the ages of six and onwards, should be given medicine in the village. Because a child can fall sick at night, or it could be an adult and yet the health facility does not open on Saturday and Sunday.”

The PNFP facility, Nkozi Hospital’s services are hindered by perceived high service and transportation costs. Because the facility is also a referral hospital for the county, it is congested, thereby unattractive to health seekers. These limitations prompt healthcare seekers to solicit for health services from private health practitioners who are nearer to their settlements. Qualified private clinics run by health workers from public facilities are a recommended source for healthcare where public and PNFP facilities fail to provide services. These however, may charge more than a health seeker can afford as the interviewee from CM-Nindye points out when asked what she would do if she failed to access the free services in public health facility:

“You go to a private clinic and realize that medicine for a sick person for instance for malaria, and an adult, is at about 4000.”

These findings affirm what was revealed by literature but also expands our knowledge on healthcare services, plus refining our definition of this asset to inaccessible healthcare services due to the challenges experienced by both community health seekers and health facilities, as also represented in figure 6.5.

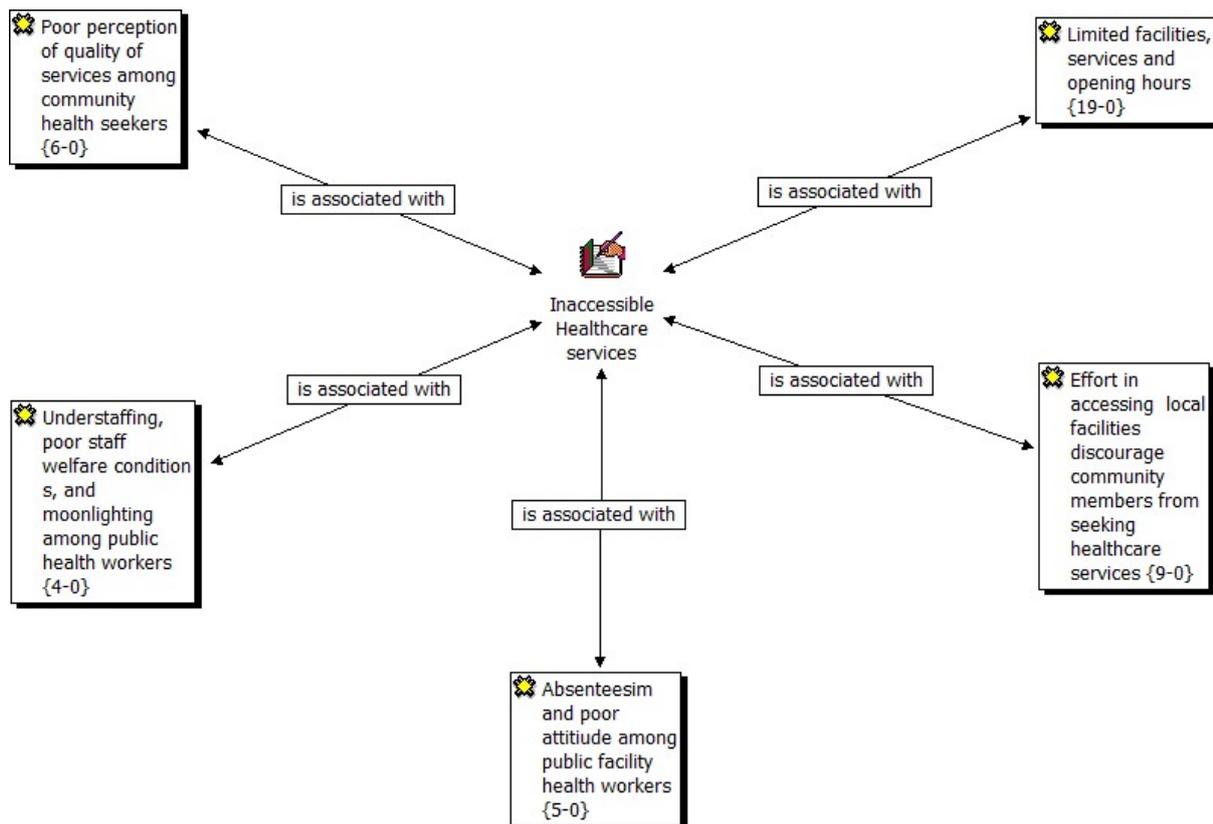


Figure 6.5: Characteristics that describe inaccessible healthcare services in poor communities

6.3.3 Unqualified Healthcare Providers

Literature reveals the presence of unqualified healthcare providers, and simply affirmed in the case study. Due to inaccessible healthcare services and poor regulation, there is a presence of unqualified private clinicians and pharmacists that are sometimes a source of health risks because of poor diagnosis and treatment. In the HF -1 interviews with an outpatient nurse of Nkozi Hospital, she describes the problems they have experienced with unqualified private practitioners: “some can give poly-pharmacy hoping to cure the patients. They can give a lot of drugs”. Women that use traditional birth attendants are also open to health risks. The nurse narrates:

“But you find that many mothers go to TBAs [Traditional Birth Attendants]. But after they [TBAs] realize that they cannot handle the case, they decide to bring them [mothers] to the hospital. By the time the mother gets to the hospital, she is tired, she cannot push, and unfortunately anemic. Then it becomes a hospital problem.”

6.3.4 Natural Resources: scarce and a source of health risks

Literature in chapter 5 identifies land, water and climate as the natural resources that poor communities rely on for livelihood. Water is scarce and some sources are polluted, posing a threat to community health. Literature further reveals that some diseases thrived in tropical climates are experienced by most poor communities. Land as an asset was not clearly discussed in literature, but earlier discussions on case study findings revealed that it is scarce. It has also been observed within the Nindye community that there is need to identify communal land where groups of households could carry out large-scale farming for commercial purposes. Soil fertility levels are also diminishing and challenging livelihoods. In an interview with an Nkozi community member, the respondent states:

“I am a cleaner. I also farm, but the soil is not fertile. That is why we are always buying food. You can plant sweet potatoes and you fail to harvest anything. So you end up buying food.”

Changing weather patterns frustrate the rain dependent farming practises, which affect land as an asset directly and also affect income levels and financial capital. Access to safe water however is a major challenge for this poor community because it raises health risks that are raised when ignorance and poor practises pollute the scarce sources of water. A VHT in one of the VHTs – Nindye training sessions states:

“In our area, they constructed for us a well. But some people started grazing their animals from the well. We as VHTs decided to raise awareness about this. But when we asked for support from the chairman, he did not put in any effort until we also were discouraged and lost hope in the addressing the issue. We realized that we did not have the authority to do anything about it. There was even one man who brought a jerry can that he cut and used it get water from the well. Then used it to give water to the cows to drink. The animals have really contaminated the place.”

The three assets, water, land and climate either pose a threat to health or income levels. From these threats, we derive opportunities and threats to a mobile service innovation. For instance, in addition to health education to be given to unqualified providers as earlier discussed, health education on water conservation is necessary. However, threats to incomes levels also threaten service access and costs as discussed in the previous section. Figure 6.6 below represents the characteristics related to Natural Resources in poor rural communities.

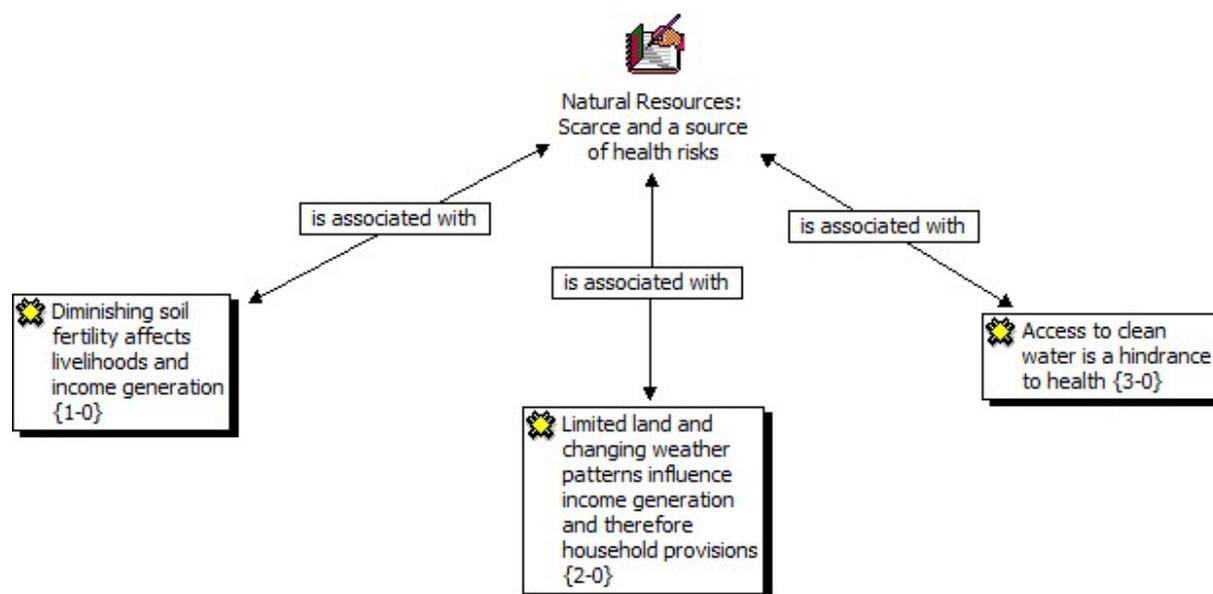


Figure 6.6: Description of natural resources in a poor community

6.3.5 Traditional and Information Isolated Society

Literature in chapter 5 indicates that poor communities rely on indigenous / cultural knowledge and practises for healthcare. Due to the fact that majority of diseases making up the disease burden are preventable, the discussion in chapter 5 concluded that poor communities may have limited knowledge on modern healthcare. Findings also revealed reliance on traditional and indigenous knowledge for healthcare, especially in cases where free public healthcare was not accessible. A

respondent in the HF-1 interview with a community member reports that some health seekers resort to herbal medicine when they do not have sufficient funds for hospital charges. She states:

“And some people who don’t have money, they get herbal medicine... Aloe Vera.... Then when it fails, then the person will be rushed to hospital. However, this is all because the person does not have money. A person can spend 4 days using that herbal medicine.”

Reliance on traditional providers is also evident, but mostly because of a shortage of personnel in the local public facility or because they perceived the PNFP facility charges as too high. In an interview with a VHT from Nindye, when asked if women use traditional birth attendants as was the case in the Nkozi area, he states:

“Even here. We have village doctors. Someone says, “I don’t have twenty thousand to pay in Nkozi” Plus another twenty thousand for transport. That is forty thousand. They fail to pay that money. That is why some are giving birth at home”.

The statements however do not indicate that the community members reject modern healthcare, but fall back to indigenous knowledge and traditional providers when they perceive that the cost and effort of accessing modern healthcare is high. There are however indications of ignorance about modern healthcare, especially in relation to HIV, pregnancy, family planning and public healthcare services. Women participants during the CM-Nindye group discussion stated:

“The second problem is pregnancy and giving birth. We have observed that you men do not allow your wives to go for family planning. For instance you find a woman is breast feeding and she gets pregnant because you have refused her to go for family planning. Our husbands do not accept family planning”

The VHTs-Nindye group discussion also raised a similar complaint, stating:

“We said that majority of the pregnant women give birth at home. This is because they do not have the means to get them to the health centre. This is what VHTs experience most in their villages. A woman goes into labour, for most husbands they are not concerned whether the woman is in labour or not. We get to know this when we go into a home and we ask the woman why she doesn’t go to the health centre and she explains to you how she has no means to get there. You ask her if she has her antenatal card and she does not have it. Therefore, husbands are not taking care of their wives, taking them to the health centres to get treatment and to give birth.”

Ignorance about how the healthcare system operates and services offered was a major source of misunderstanding between community members and health facilities. In the VHTs-Nindye group discussion, the Health Centre in-charge explains the information gap that exists by stating:

“For instance someone might diabates.... But the drugs are not available. Maybe we have not been able to explain to the community members which services are at the health centre. Because someone might come expecting treatment for pressure, diabetes and any other disease, and expects to receive the drugs for that disease. Someone might come expecting to be x-rayed. They will get angry when they realize that they cannot get these services.”

Illiteracy and more so functional illiteracy were also identified. Although it was observed during training sessions with VHTs that they could write their names and were able to read sentences in their

local language there were massive indications of functional illiteracy. For instance, in the VHTs-Nindye interviews a respondent points out that VHTs fail to use registers because they were written in English. Illiteracy among community members was also observed. During the VHTs-Nindye group discussion, a participant from the health facility explains the challenge of disseminating information to the community, highlighting at illiteracy when he states:

“Well I was telling them that there is an information gap about the range of services that are supposed to be offered at this place. So I was trying to tell him [VHT] that it is us [health workers] first to tell them [VHTs]. And it is them [VHTs] to tell the wider community. Because I cannot move village by village telling them what we are doing. I can display the services at the facility, but many people are not literate.”

The aspect of illiteracy together with a tendency to rely on traditional practises among community members is believed to be an obstacle for ICT4D and a mobile service innovation. A participant in a discussion group (KI-1) with health workers and community health promoters states:

“Modern technologies came with privatization. Much as this ICT is a product of modern industrialization, it cannot work where there is no modernity. I do not know how you have defined a rural place, but rural may be out of the context with modernity. As much as we might push this technology into the rural area, it might be a problem..... Sometimes, taking these modern technologies and these modern enterprises into rural areas is still out of the norm. The question might be ignorance. In rural areas you find people without education. In Africa, the rural areas are principally for poor people, and poverty is 95% associated with ignorance. Because when someone is ignorant, even his reasoning is below the standard. Someone will fail to receive a message and even understand the meaning of a message.”

In the CM-Nindye mobile literacy classes, trainers observed that participants were hindered by illiteracy while using their mobile phones. It was observed that while most were able to make and receive a call, using the SMS application was a challenge because it requires literacy skills to operate. The trainer states in a report:

“Many people have mobile phones but do not know how to use them for easy communication, especially the grownups. The interest however demonstrated indicated the value village community members have for the technology. The environment however challenges adequate use including poverty, illiteracy, unstable mobile services and age groups.”

It is clear that these challenges refine our definition of the Social Cultural asset from reliance on indigenous / cultural knowledge and practises to traditional and information isolated society. Further, these characteristics together define a traditional and information isolated society. Figure 6.7 is a summary of this asset. The individual characteristics that make up this generic characteristic present opportunities and threats to a mobile service innovation’s business model and ignorance on available services and health care present opportunities for health education and promotion, while illiteracy and a poor culture of reading are a threat to adoption of a service innovation. However, the key issue is what effect this will have on the services. Like low incomes and earnings, this challenge affects Accessibility for Customers. If community members cannot use the SMS application, they are therefore hindered from using the service which in turn affects the CSF Compelling Value Proposition.

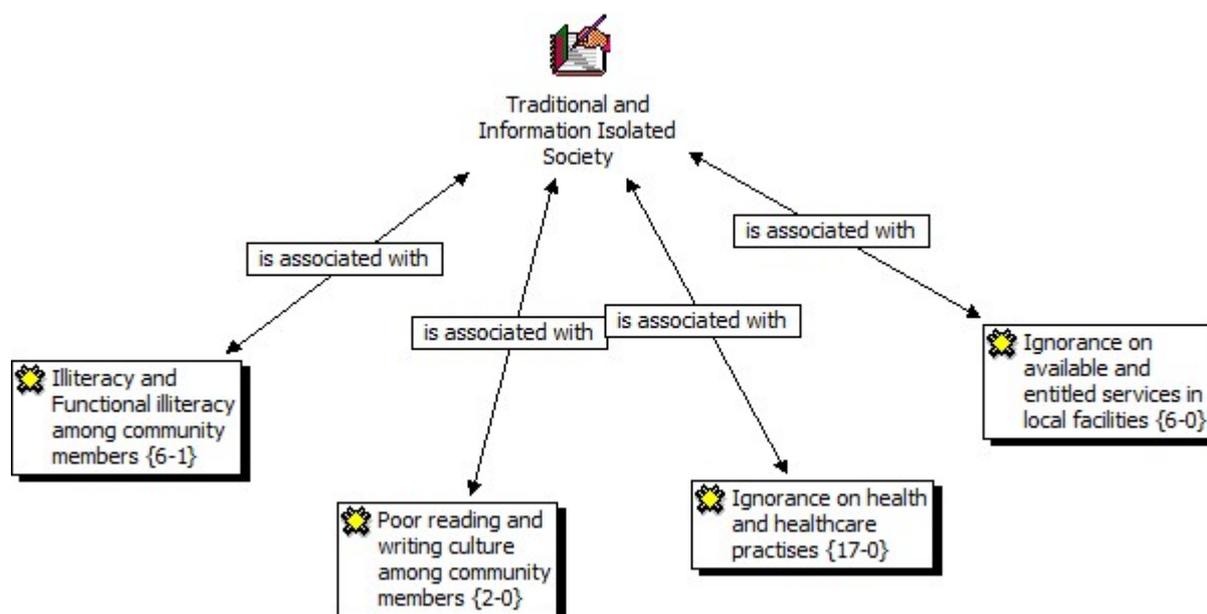


Figure 6.7: Description of the social cultural assets of a poor community in rural healthcare

6.3.6 Disempowered Community

While literature defines poor rural community's human capital as, 'subsistence farmers with multiple jobs,' the findings redefine as a disempowered, a redefinition which is a consequence of the collective characteristics from financial, natural, physical, social political and social cultural assets presented previously. Figure 6.8 represents the collective characteristics that describe the human capital of a poor community. A pregnant woman might be aware that she needs to visit the health centre for antenatal care, but she and her husband may not have the means to be transported to the health facility. In the VHTs-Nindye group discussion, it was pointed out that communities were powerless to repair boreholes for safe drinking water because of lack of skill and sufficient income. Participants stated:

"those who have bore holes, they break down and they do not have the means to repair them. And the mechanic.... We have only one in the whole sub-county. When the mechanic comes, because he is the only one that can repair the bore hole, he will charge us Shs. 100,000. It is a challenge raising that amount of money."

Disempowerment is especially felt by vulnerable groups in the community that include the elderly, women and children. In the CM-Nindye interview, a community member involved in a local religious NGO with the elderly and children points out the different challenges these groups experience with health and healthcare. For the elderly he states:

"Some of them go to our health centre, and sometimes they leave there without drugs because they are not enough. And sometimes they are told to buy the drugs and yet they don't have money. And they come back to us with these problems. Even us we are not well-off to solve these problems"

Regarding the children he states:

“Most of them are coming from poor families. Their guardians are widows. They do not have good jobs. Some have old parents. They have poor eye sight. They are not completely blind but their sight is failing and those children are affected by jiggers. When they come to school, some of our classrooms are not well cemented. So from that dust, the infection is increased. Some lack school materials like books. Although we are paying for them school fees, we are not buying for them books. We also need sponsorship. Moreover, we also are in need. So we find a challenge with scholastic material... you know... text books, uniforms. But we give them time to get these things”

The combined characteristics that make up a disempowered community have been discussed in relation to the mobile service innovations. Whereas social value and value elements can be identified and generated from these characteristics, there are also threats to this value creation.

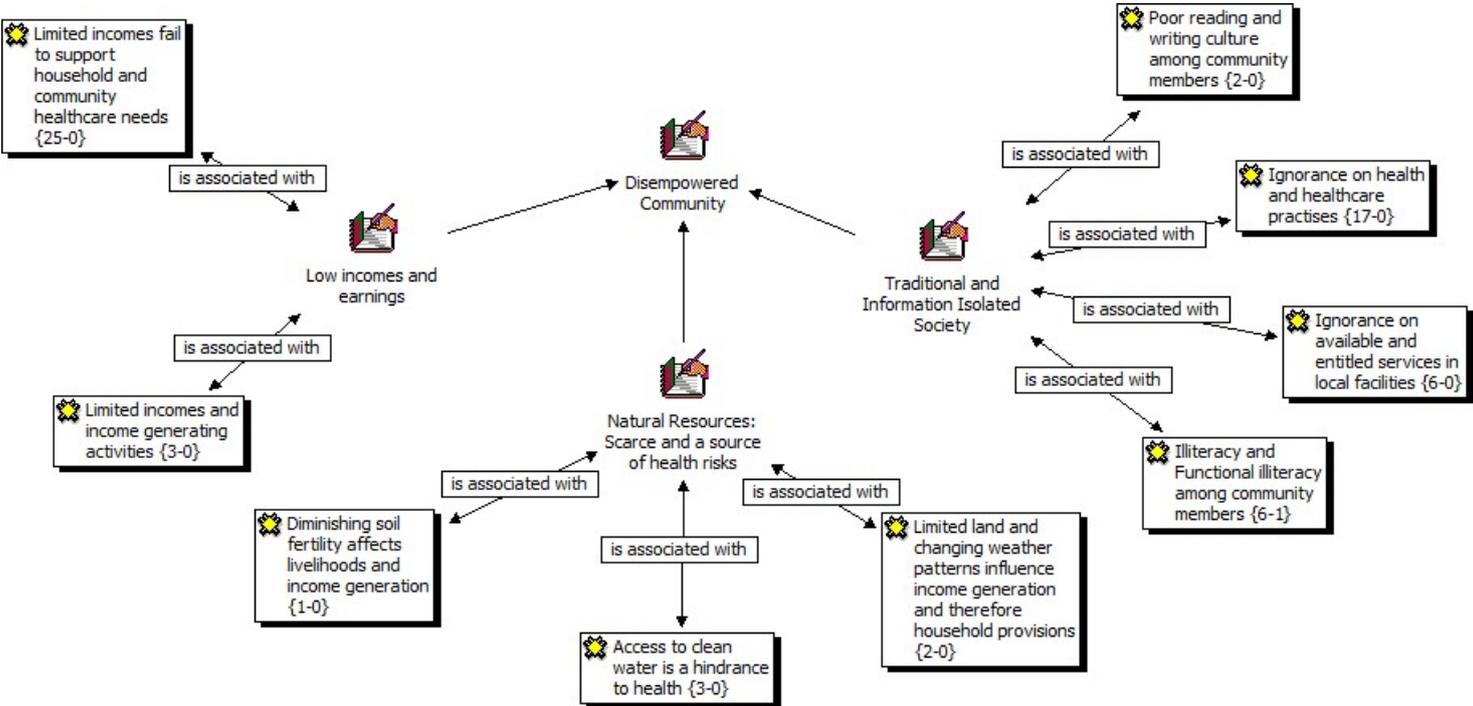


Figure 6.8: A description of human capital in a poor community

In the next section, we evaluate the assets so far discussed and the present opportunities and threats they pose for service innovations.

6.3.7 Evaluation of Vulnerabilities and Assets

So far, the discussion has presented the refined descriptions of assets found in rural healthcare, and Table 6.3 provides a summary of these assets whereas figure 6.9 represents the relationship between these assets.

Table 6.3: Summary of asset descriptions

| Assets and Vulnerabilities | Livelihood Analysis | Description |
|----------------------------|--|--|
| Financial | Borrowing strategies to cover medical costs | Low incomes and Earnings |
| Social Cultural | Indigenous and cultural knowledge. Limited knowledge on modern health and healthcare | Traditional and information Isolated Society |
| Natural | Disease Catalyst Climate and scarce water | Natural Resources: Scarce and a source of health risks |
| Human | Manual labourers, affected by Death, Disability, Child Development and Low Productivity | Disempowered Communities |
| Physical | Poorly Facilitated public facilities, expensive private and PNFP facilities, unqualified private and traditional providers | Inaccessible Healthcare Services |
| Social Political | Unqualified Healthcare Providers | Unqualified Healthcare Providers |

It is clear that central to the analysis of rural healthcare is human capital, and all other assets must be viewed in relation to the core that human capital plays. It is from the perspective of human capital that characteristics that generate or threaten social value are identified. The relationship describes, (1), the state of poverty the community experiences and (2), vulnerabilities that they experience through these assets. Financial capital limits human capital from attaining or accessing healthcare. Physical capital is inaccessible to human capital either because of inadequate service provision or high service costs. Social political capital fails to protect the rural healthcare market from unqualified providers and outdated cultural practises create health risks in the social cultural assets. Natural resources fail to support income generation while creating health risks, a relationship represented in Figure 6.9. Through these relationships, we also identify value elements that can correspondingly affirm value elements identified from literature review or refine them. For instance, health education as a value element can be used to reduce health risks associated with ignorance and poor health practises in households, and similarly, information services can be used to improve service delivery for the poorly performing public and PNFP facilities.

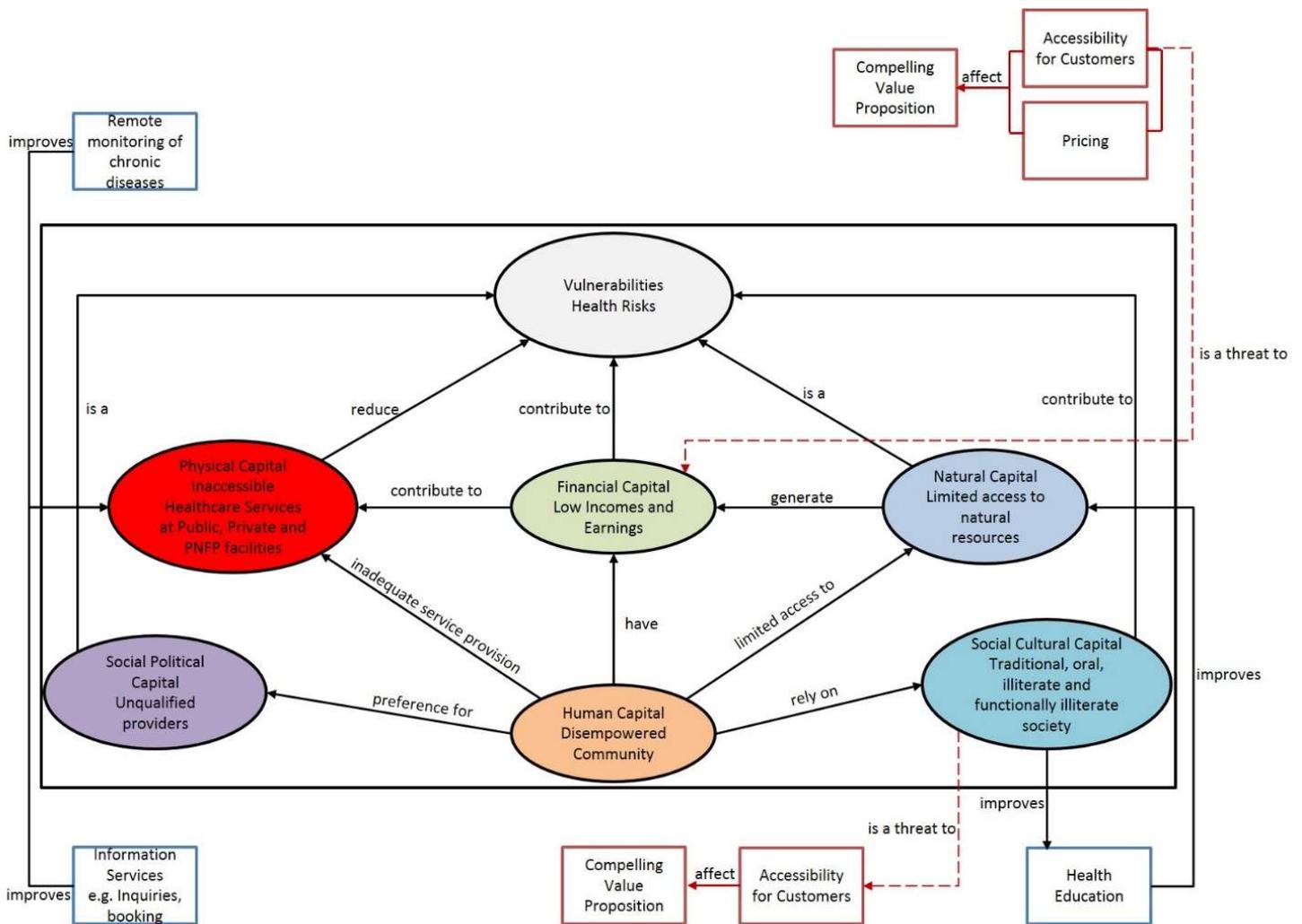


Figure 6.9: Vulnerabilities and Assets in Rural Healthcare (Source; Research)

It is from these relationships with human capital as the central asset that we derive social value and value elements. In the next section, is a discussion of the value elements identified from the findings and characteristics in the context that might influence them.

6.4 Service Design: Target Group, End Users, Customers and Value Elements

From literature, the service design defined the target group who are also the customers and end users. This group includes poor communities and health facilities that serve the poor communities: public and PNFP facilities. Value elements identified from the literature livelihood analysis include: (1) access and delivery of healthcare services, (2) access to healthcare information and (3) health education on health risks and disease prevention. Findings affirm some of the value elements and refines others.

Access and delivery of health care services was refined to Remote Monitoring of Chronic Diseases, and Literature reveals that healthcare mobile service innovations were sometimes restricted by the traditional nature of health provider attitudes towards remote healthcare delivery. This was evident from the reaction to the FrontlineSMS application that proposed remote diagnosis and treatment of

patients. During the group discussion with health workers and community health promoters (KI-1) one of the participants' states:

"I don't know if you have found out the health policy in relation to the kind of information you want to take. And what kind of health can be done with SMS"

This was further elaborated by another participant in the HF -1 discussion with Nkozi Hospital management team who states:

"Health is kind of a conservative profession. You must see what you are dealing with. Most times people won't describe what they have effectively. And actually from my observation from radio, newspapers the conclusion the doctors always give is seek medical advice. Because rarely will a patient describe very well. They may just describe one symptom. And all in all, it still comes down to the same point. It's the same answer. Whether it is via SMS or voice, it's the same answer. Go and see a medical doctor."

The nature of healthcare requires a dynamic platform to allow thorough diagnosis, which an SMS platform does not provide. Because of this, using an SMS application for remote diagnosis and treatment is not possible. It was however, suggested that monitoring of chronic illnesses was possible for instance TB or HIV patients. This is normally in the form of reminders of when to take medication or the next appointment with a health worker. The same suggestion was also raised during the HF -1 interview with Nkozi Hospital governing board member, and thus were able to refine the value element from access and delivery of healthcare services to remote monitoring of chronic diseases.

Findings also reveal the kind of information the community could access from the health facilities. For instance, community members welcomed the idea of using information services, such as inquiries on the availability of staff or medication at Nindye Health Centre rather than traveling long distances and finding that the health workers or medication is unavailable. A Nindye community member in the CM-Nindye interviews states:

"That would be helpful [mHealth service], because remember that you have walked a long distance to the health centre... you have gone to the health centre hoping to get medicine and yet the medicine is not there. That is really a problem. And it annoys people a lot, to walk that distance and yet there is no medicine."

A community member that uses Nkozi Hospital suggests booking services to reduce waiting time due to congestion at Nkozi Hospital. She states:

"If I am sick, then I know that I can give the nurse my medical forms, then she can help me and take me to doctor first. Because we spend a lot of time in line. Your sickness can worsen from there. Because while lining up, this one is coughing, this one is throwing up. Everyone has a different disease."

The perception of high service costs creates negative feelings towards the local PNFP facility even though these costs are subsidized. There were suggestions from the PNFP facility to avail cost details to patients. The Project Coordinator from Uganda Catholic Medical Bureau (UCMB) in the SP-3 interview states:

"Patients normally complain that services are expensive. I think the problem is that patients do not have access to their own information. For instance, patients receive a bill but do not have any idea what

makes up the total bill. If a patient was able to see the breakdown of the bill, the patient would realize that the actual cost of the medicine is low.”

It is important to note that Health education as a value element remains the same, as affirmed by the evidence of limited modern healthcare knowledge in the community and health risks from unqualified providers. During the HF -1 interviews with Nkozi Hospital’s midwife, when asked what can be done to improve the situation with unqualified providers, she states:

“Health education. Some have seen the problem of delivering from the village. And they have changed. It is better than before”.

In addition, the designers of mTrac picked up on the value of health education. In the SP-1 interview with UNICEF’s Health Systems Strengthening Specialist, he suggests that mTrac will be used as a communication tool between the National Health Records and pregnant women. He states:

“What we probably will see is mTrac settling in as a communication engine. To give you a couple of examples, the National Health Records program at the Ministry launched fairly recently. It’s driven by a different software stack called ICT foreign power. It will have, for example, SMS messages going out to pregnant mothers. And mTrac will plug into the architecture of software stack as the SMS communications.”

However, the target group has developed to include VHTs and health workers, as derived from the value elements so far identified in the vulnerabilities and assets analysis and summarized in figure 6.10. A summary of all the value elements identified for the mobile service innovations are summarized in figure 6.11.

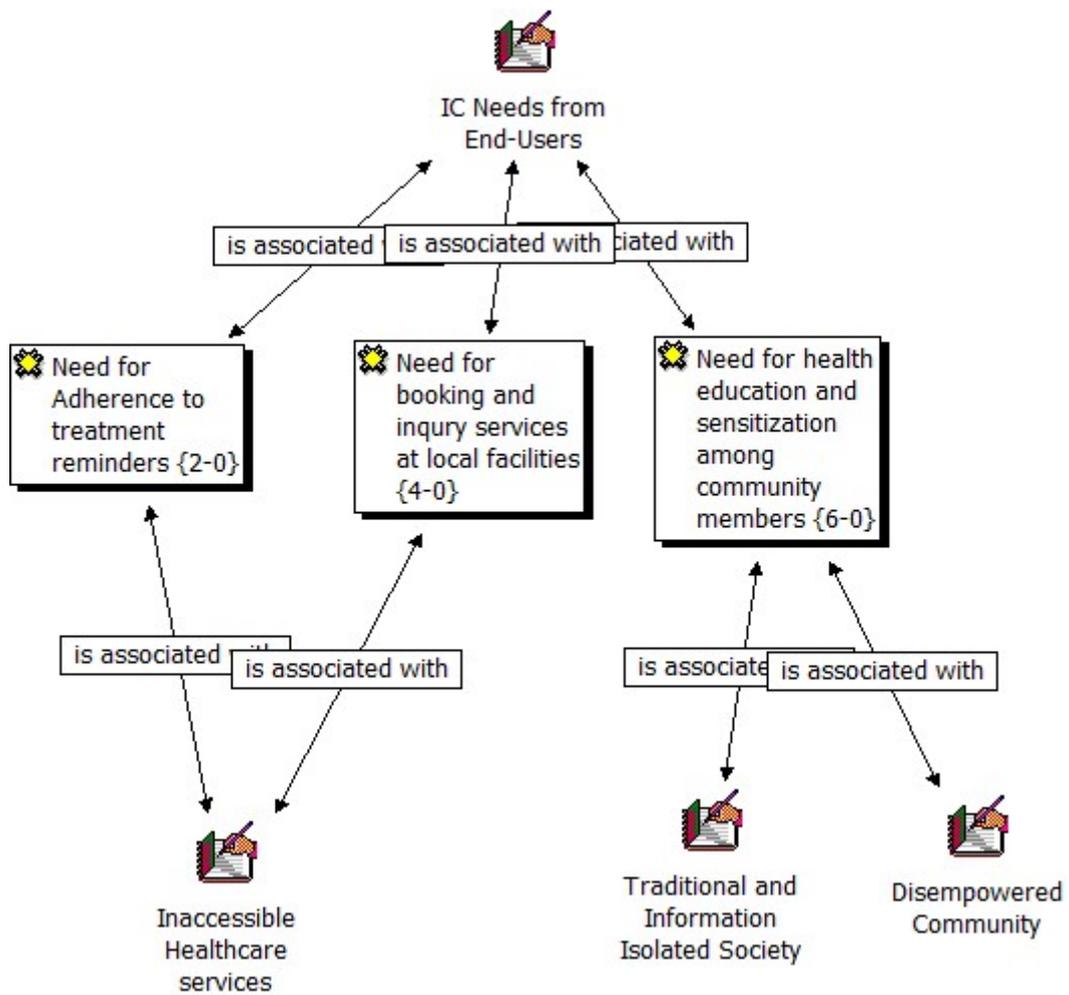


Figure 6.10: Mobile Service Innovation Social Value and Value Elements

Below, figure 6.11 demonstrate value elements the research identified they affect social development goals in healthcare.

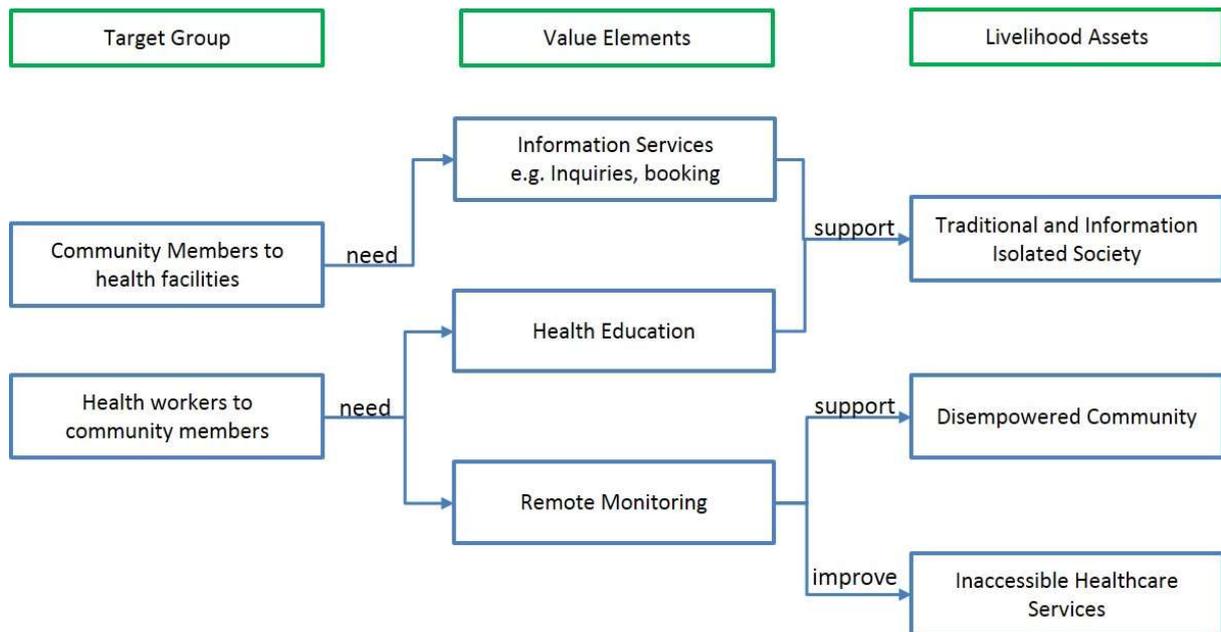


Figure 6.11: Information and Communication needs in a rural community (Source; Research)

6.5 Defining the Target Group, Pricing and Accessibility for customers

In chapter 5, we defined the target group using the asset descriptions in Table 5.4 section 5.3.2. These characteristics were refined in the vulnerabilities and assets section of this chapter and include: (1), low incomes and earnings, (2), inaccessible healthcare services and (3), unqualified healthcare providers ,(4), traditional and information isolated society ,(3), scarce natural resources which sometime are a source of health risks and (4), disempowered communities. In addition to the refined generic characteristics, are also identified unique characteristics that define community members, VHTs and health workers and health facilities as mobile service innovation users.

6.5.1 Motivation and attraction of End-Users

It was discovered that end-users need to be motivated to use the m-Health service. The first indication of this was in relation to the nature of healthcare and the limitations of an SMS platform discussed in the service design. It was evident that while health workers were unwilling to use an SMS and voice platform for remote diagnosis and treatment, they were however willing to use a video platform in collaboration with other health facilities. This was first revealed through meetings and discussions with Nkozi Hospital both at management level and during interviews. However, due to high costs related to the platform, it was not perceived to be an appropriate financially sustainable choice. The SMS platform however, is a relatively cheaper investment and with lower costs in its operation, although more affordable, is not able to fulfill the more dynamic demands and needs of a rural health facility. The limitations of the SMS application compromise the CDI Value Elements and therefore the CSF, a Compelling Value Proposition for health facilities.

In chapter 5, figure 5.3 heavy workloads among health workers present a challenge to the value proposition of the service innovation, and more specifically to the operation of the service. This was the first characteristic pointed out by participants in a group discussion with health workers and community health promoters (KI-1). A participant shared a story about a failed ICT4D innovation in a health facility:

“Our problem here is understaffing. Just like with us there [health facility], the newvision [national newspaper] project is also failing there. The fact that the computer was given, the modem was given, all those kind of things, and the power line, still the person who is supposed to operate is not there.”

It is also heavy workloads that was identified as the first challenge raised by the HF -1 group discussion with Nkozi Hospital’s management team, in reaction to the FrontlineSMS application. One of the members of the management team states:

“First of all you must consider time. Because, doctors are not just there waiting. It might need a specific time for people to use it”

Thus, the aspect of rural health facilities requires a service innovation to integrate value elements that require minimum operational activities from health workers. Each of the value elements strategically requires, either pre-set responses, for instance, information inquiries require pre-set responses or batch processing, for instance, requests for health education and remote monitoring.

Furthermore, the factor of heavy workloads among health workers has led to poor work ethics and absenteeism from work. Community members and VHTs complained about this in the VHTs-Nindye and CM-Nindye group discussions. A male participant states:

“We also observed that some health workers treat our children badly. We are saying some health workers and at the health centre when we have brought them to the health centre.”

Earlier, while the men discussed in a separate group, one of the participants narrates an incident to the participants:

“There was a time we were taking our child to health centre. We found the health worker...One of the ladies was washing cloths...She said she would not leave her chores to assist. Yet the child was vomiting. The health worker refused to assist...”

In the women’s discussion, one of the participants’ states:

“The health workers are very proud and treat us with disdain...”

Another woman in the same group discussion narrates her experience with the local health facility stating:

“I leave home when I am sick, I go see the Doctor, only to be told “He is not here. He has not come in today”. I don’t even have his phone number. Where is he? I am ill, I have walked a long distance.”

These statements reveal a work force that is demotivated by heavy workloads, understaffing, poor working conditions and little pay. It was therefore necessary to find out if a service adds or reduces the workload of health workers. In the HF-1 interview with the records officer of Nkozi Hospital, he reveals that a total of five health workers (nurses) in the hospital were trained for mTrac but they refused to do the work after the training session. He states:

“Because we trained as a team. We were five people that were trained to compile that data and send it via mTrac. But people refused. They left the burden of compiling this data on me. They don’t even remember what they were trained.”

These reactions to both mTrac and FrontlineSMS indicate that the working conditions and attitude of health workers may compromise value creation. They particularly affect the CDI Customer Retention as found true with the health workers that refused to use mTrac after training. This affects the CDI Acceptable Customer Base and the CSF Acceptable Profitability (i.e. social development).

VHTs on the other hand also experience heavy workloads although not in the same category as health workers. The heavy workload experienced by VHTs is in relation to their volunteer status as opposed to paid health workers. The reason for using community volunteers falls back to the PHC idea of community involvement. VHTs who are also part of a poor community are expected to carry out their duties as VHTs alongside their personal income generating and domestic duties. It however emerged that these duties are ever increasing. As a direct supervisor for Nindye Parish VHTs, the facility in-Charge was the first to point out this challenge. He states during the HF- 2 interview:

"...many of them still complain that things are getting to them, it is so big, whereas they are not supported in any way. Especially when it comes to the fact that they are working as volunteers. They feel that they are engaged in too much community work at the expense of their private work."

The VHTs – Nindye survey indicates that Nindye VHTs participating in mTrac may be involved in a minimum of two (2), and a maximum of four (4) programs, while the VHTs – Nkozi survey indicates that Nkozi VHTs that participated are involved in a minimum of three (3) and a maximum of four (4) programs. When VHTs spoke about their workload, it was always in relation to their volunteer status and the fact that the work keeps them from their personal duties. In the VHTs-Nindye group discussion VHTs state:

"VHTs have said that they do a lot of work and give up a lot of their time as they move about in the villages, giving out medicine for deworming, bilharzia and all of that. And yet they do not receive payment and they are failing to do their farming activities. They are called for training sessions, and they are not given an allowance. This causes them to loose heart for the work they are doing, because they are not being given a chance to do what can give them money."

VHTs attached to Nkozi Hospital were interviewed so as to ascertain if they too experience the same challenges as those in the case study area. One of the respondents in the VHTs – Nkozi interviews describes what she perceives as a financial loss because she had to come for the mTrac training session at the expense of her work:

"The point is that it is not that the work is too much, but you could be with a customer, but you find yourself in healthcare work. And yet the money given is very little. If this was like a real job given to us and the money given to us was enough, for instance now like today. We have spent the whole day here and we have been given only 15,000. Now I came here using 4000. Back and forth that is 8000. Now I have left the saloon closed today. That means I will not earn anything today. Now if they call us, the amount of money given to us should be substantial. They cannot claim that because they have given us food and 15,000, and yet if I had been at my station of work, I would have made 50,000. All of us if we were at our homes or in our villages, we would have been working. They should increase the allowance."

Whereas health workers' demotivation was evident basing on their poor attitude and absenteeism from work, VHTs and community members' disinterest and demotivation was also evident in poor

report / register submission and absenteeism from meetings and training sessions. During the HF-2 interview with Nindye Health Centre Medical officer, he explains how the workload affects VHTs and their duties. He states:

“So you find the VHTs with more than five registers, they are supposed to look at. And these are supposed to be volunteers. Ok. So they normally say no, and some of them return them empty. Some of them[registers], they are empty. They bow down and say no. This is too much for us.”

Training sessions for VHTs were usually poorly attended. At one of the health training sessions organized for Nindye and the community, it was agreed that all participants, both community and VHT members would return at a later date to continue with discussions on community healthcare needs. On the return date, only five (5) VHTs attended. There was an attempt to find out if absenteeism might affect a service innovation. The VHT-Nindye survey carried out after the implementation of mTrac sought to find out how many VHTs attended the initial training where they registered as users and started using the service. Only 16 (64%) of the 25 VHTs followed the official training, 6 (24%) did not attend the training session and thus were not using the service, whereas 3 out of 25 (12%) were trained by co-workers.

Furthermore, there was an observation of the community’s motivation during the CM – Nindye mobile literacy training sessions. Twelve villages and a total of 378 community members participated in the sessions. However, the youth turned up in only one village, Lubanda A. They were also absent from the CM-Nindye community group discussions. However, those community members that attended demonstrated enthusiasm towards the literacy classes. It was however perceived that this was towards the technology and not the service necessarily. During the training session participants from all villages raised concerns about mobile service providers and the need for more training on how to use the mobile phone. They demonstrated a lack of knowledge about mTrac, which had been launched in their parish a year earlier, a state established through a mobile literacy test in which 186 participated. The first question tested their knowledge of the mTrac number community members send complaints to and the second question tested their knowledge of the purpose of mTrac. However, despite the marketing campaign launched for mTrac (including adverts on local radio stations, a poster at the health facility and on T-shirts worn by VHTs) none of the participants was able to answer either of the two questions correctly. It is perhaps not enough to arouse the interest in community members for an m-Health service using conventional advertising strategies. It is noted that demotivated end-users limits the number of customers both applications can attract, which affects the CDI Acceptable Customer Base and ultimately affects the CSF Acceptable Profitability (i.e. social development).

There were suggestions given by respondents on strategies to motivate health workers, VHTs and Community members in the adoption of the service innovation. The first is to include health workers and VHTs in the design process. During the group discussion with health workers and community health promoters (KI-1), a participant states:

“I think before going to the community, you should first go to the hospital. They can give you a picture of what is in the rural community. Because, I do not remember properly but, either in 2007 or 2008, these communication companies tried to connect hospitals, but what made it fail was that the money they were demanding from the hospitals... I mean the health workers could not raise that money. So that is why the whole thing failed. I don’t know what other difficulties they might have had.”

It was also observed during the design process that health workers and VHTs were instrumental in, (1), establishing healthcare needs and defining the community as potential end-users, (2), providing insight into healthcare processes and the context in which both VHTs and health workers operate healthcare processes. In other words, it is from these two end-users that value elements and defining the target group is done.

The second strategy suggested was in capacity development of VHTs and youth with computer literacy skills. In the HF -2 interview the respondent suggests this as an incentive to the VHTs and youth:

“Before you go any further with the computer, you can give a chance to those VHTs who are educated also to learn that media. Text messaging can work, and now that you are bringing a computer to the health centre, bring the youth on board and the VHTs that can manage. Teach them how to use the computer.”

The idea behind motivation of health workers, VHTs and the community is that the social value offered by the service may not be a priority for the end-users although there is a clear social need. For each of these end-users, economic value is probably their first priority. If we take note of what demotivates each set of end-users, it is low income that leads to poverty. Health workers are demotivated because they are underpaid and overworked. VHTs are not facilitated and kept from their income generating activities. Motivation therefore serves as an incentive to end-users who are disadvantaged by a poverty context.

6.5.2 Ownership and maintenance of mobile phones

Literature reveals that ownership of a mobile phone among poor rural communities is not a guarantee, as correspondingly affirmed in the findings from the case study. In a VHT-Nindye interview before implementation of mTrac, when a respondent was asked if his fellow VHTs own phones, he responded *“Yes. But others don’t have phones”*. It was observed that three (3) VHTs during the VHTs – Nindye training and implementation of the service innovation did not own a phone. After implementation, in the VHT-Nkozi interviews, a respondent when asked to give his opinion on mTrac states:

“mTrac is OK, the only problem is some of our members do not have phones. So they need to travel a distance to look for someone with a phone to send reports. In some cases, because we are supposed to send messages weekly, someone might forget. If someone has a phone, then it makes things easier.”

When the survey questionnaire were administered to Nindye’s VHTs, findings reveal that there were some VHTs that did not have personal phones, but resorted to using a phone belonging to a member of their household. The same survey to Nkozi VHTs reveal that some of the VHTs without phones were actually not able to access any phone and therefore were not able to use mTrac. The results of these two surveys are demonstrated in figures 6.12.

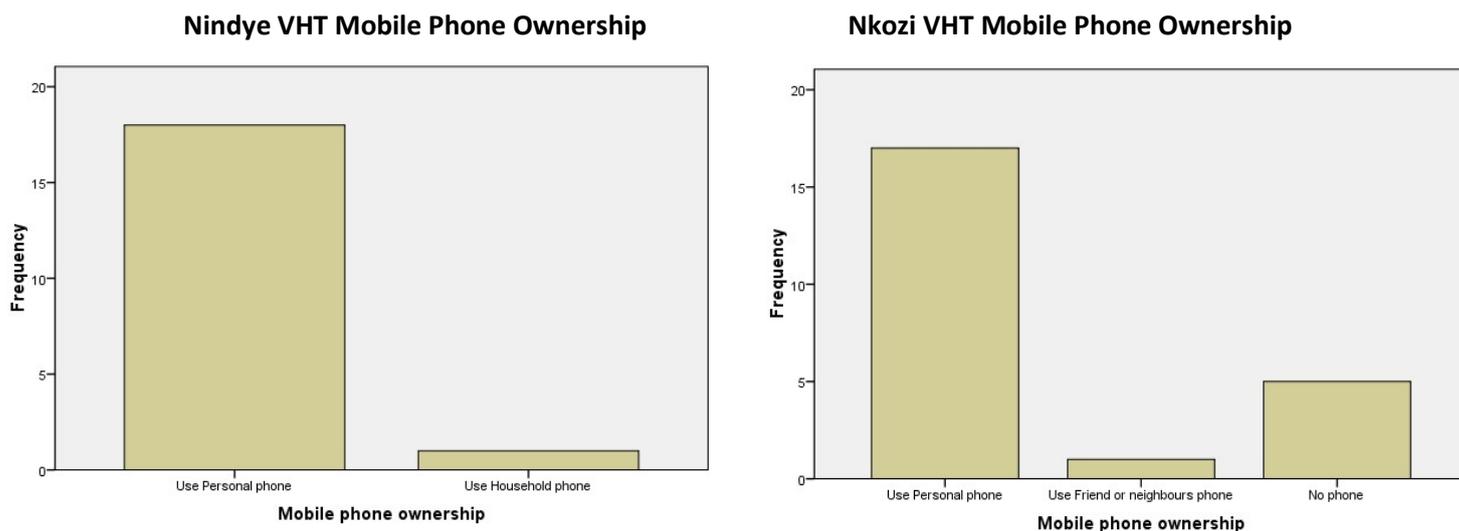


Figure 6.12: Mobile Phone Ownership and Access to mTrac among VHTs

The two graphs above indicate that while ownership may affect access to the service innovation, sharing of mobile phones especially in a household or among friends and neighbors may support service access. During the mobile literacy classes with community members, almost half of the 378 participants did not own personal phones. While VHT end-users adopted strategies in order to access the service, it is clear that this challenge can affect Accessibility for Customers which in turn affects the CSF, A Clearly Defined Target Group and therefore a Compelling Value Proposition. This gradually affects the number of customers that both services attract which in turn affects the CDI Acceptable Customer Base which subsequently also affects the CSF Acceptable Profitability (that is to say, social development)

Ownership of mobile phones was not the only characteristic observed. Taking care that a phone works in a poor rural context is a challenge in itself. Community members with mobile phones need to charge their phones. However, with limited access to public infrastructure like electricity, they usually depend on service providers within their communities who charge a fee, and this coupled with limited finances, maintaining a functional phone becomes a challenge to a rural mobile phone user. In the KI-1, group discussion with health workers and community health promoters, a participant states:

“May be ICT increases poverty. Because in my community, most of us from the community, you buy a phone, it develops a problem.. there is no where you can take it for repair... What do you do? You just keep it...Maybe you find means to buy another. So you are spending money...Sometimes you don’t even know how you will charge it”

When mTrac was implemented and during mobile literacy training sessions with VHTs and community members, it was observed that those with phones had mostly old handsets. Figure 6.13 shows a community member with an old handset during the mobile literacy class. An old handset is more likely to breakdown which then creates a financial challenge for the owner. After the implementation of mTrac while we interacted with VHTs in mobile literacy classes and in the VHT-Nkozi interviews, it was noted that there were some VHTs that were not using mTrac because their phones were faulty.



Figure 6.13: Community member with an old handset during a mobile literacy class

Maintaining a usable phone also implies that the owner has the ability to purchase credit to access the mobile service. If a user cannot afford to purchase credit at a time when he or she needs the service, then it is impossible to use the service. Some of the value elements included in the FrontlineSMS application require a community end-user to have credit before accessing the service. In the CM-Nindye interview with a community member, when asked what he thought about the proposed information services, he states:

“If I have credit and the phone is charged, then it is possible. But that can be helpful, like the police emergency call that can also be helpful.”

The same challenge was observed with Nindye Health Centre whereby the FrontlineSMS application was set to respond to reports acknowledging receipt of reports sent. These responses are sent at a fee and require the modem used by the application to have credit in order to send the automated response. However, the facility was not able to maintain credit on the modem, especially after the project came to a close.

These combined problems for example, ownership and maintenance of a mobile phone, affect accessibility for customers / end-users and therefore affects Acceptable Profitability. However, it must be noted that strategies like mobile phone sharing among community members can be used to extend services to those without personal phones as the behavior of VHTs indicates. It must also be noted that this strategy does increase effort in accessing the service and will ultimately influence the value proposition to end-user.

6.5.3 Mobile Phone Literacy

Mobile phone literacy among community members and VHTs is another dynamic in rural phone use, especially SMS literacy. In the VHTs-Nindye interviews, when asked what his level of experience is with a mobile phone, a VHT states:

“Only making calls and to check the amount of money on the phone, to load airtime. Only that. But they [referring to other VHTs] know how to read a message when they receive it. And also, many of the messages we get from the companies, they are in English. We can’t read it.”

This problem is compounded by illiteracy as already discussed in the vulnerability and assets section that is found among community members and VHTs, a factor that contributes to the inability to use the SMS application and therefore may limit use of a mobile service innovation. For VHTs, using a

mobile phone and SMS application is influenced by their age and capabilities. The position of VHTs in Uganda is based on volunteerism, which attracts mature members of a poor community. During the HF -1 interview, the health worker points this out when she states:

“Because I was going to tell you that some have grown old [VHTs] and there are those who cannot see very well. For them, they just know how to make a call but don’t know how to write a message. Now remember, it is mostly the mature that have the interest to do VHT work. But the young say “No, for me I don’t have that time”. Remember it is volunteer work.”

The VHTs-Nindye survey reveals that among those VHTs that had participated in the training session and were using the service, there is some attained experience in using SMS. Among the nineteen that had participated 68% (13 out of 19) had sent and read messages before the training on mTrac. The survey also reveals that younger VHTs are more likely to have experience with sending and receiving SMS, while the older ones have considerably less experience. Female VHTs are more experienced than male VHTs as Figures 6.14 and 6.15 demonstrate SMS experience according to age and gender among Nindye’s VHTs using mTrac.

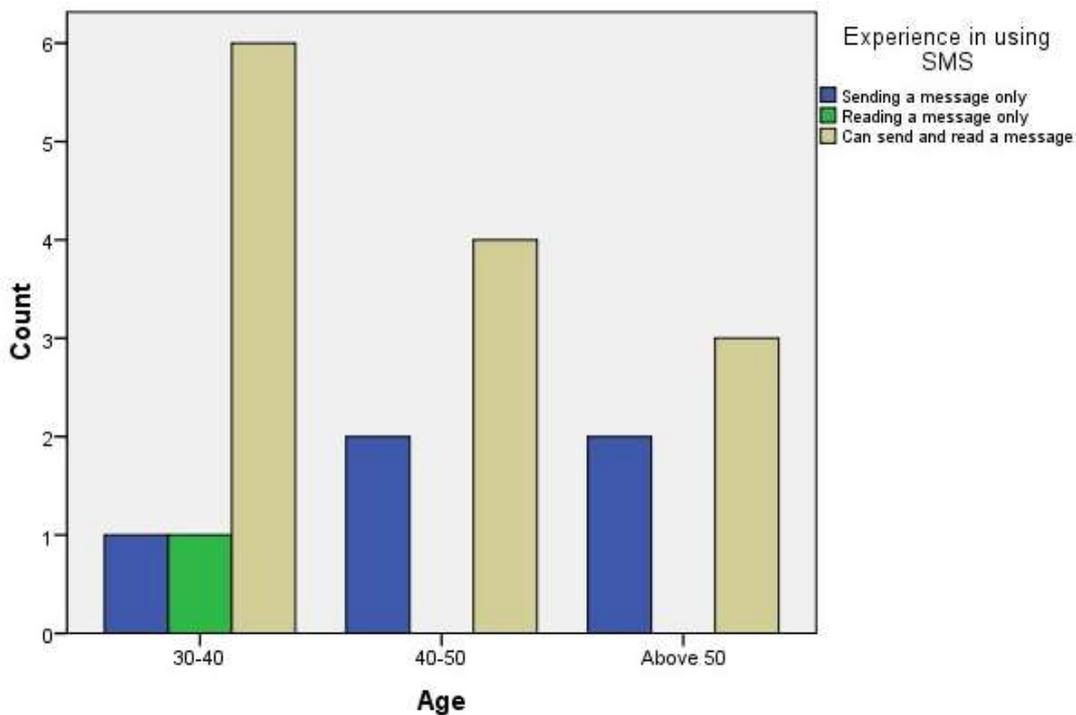


Figure 6.14: Experience in SMS according to age among Nindye VHTs

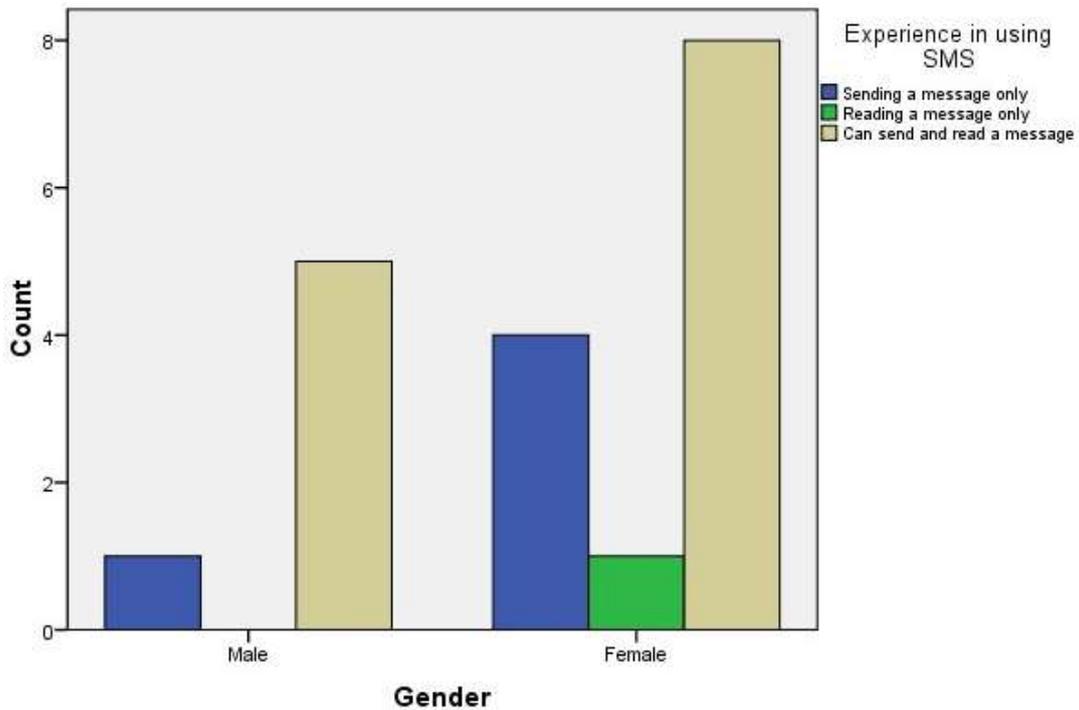


Figure 6.15: Experience in SMS according to gender among Nindye VHTs

From the above tables, although the statistics are not representative for all VHTs, they do however indicate that there are VHTs with limited SMS literacy skills. During the VHTs – Nindye training sessions, it was observed that especially for the older VHTs, using the SMS application was difficult. Some VHTs failed to carry out the registration processes and asked trainers to assist them to register their numbers. In addition, during the VHTs – Nindye training sessions a VHT reported that her eye sight was failing, with a claim that she was not able to perform the activities of register updates and report writing and could not clearly see the letters typed in the SMS application. Although anecdotal in nature, it shows the issue at hand.

The survey also attempts to determine if VHTs personally type out their weekly reports, and reveals that although most of the participants claimed to have experience in using SMS, some VHTs asked others (22% - 4 out of 8, all female in the age category of above 40 years old) either in their household or a friend to type out their weekly reports.

There was also conclusion of this question in the survey after it was discovered during the VHTs-Nkozi interview with a respondent who revealed that she did not type out the report herself, but asked her son to type them for her. The fact that some respondents ask others to type out reports for them indicates that their SMS literacy skills may not be sufficient. This leads us to conclude that functional illiteracy influence on end-users might play a role in accessibility for customers.

Among community members mobile phone literacy was observed during the mobile literacy classes and test results, test which reveal that most of the participants could identify the keypad buttons to make and end a call. 77% (145 out of 186) answered the question on how to make a call correctly, while 79% (147 out of 186) answered the question on how to end a call correctly. However, 133 participants out of the 186 (71%) were not able to identify correctly when a message has been received on a phone. There is a slight difference between male (25% pass) and female respondents (31% pass).

The aspect of mobile phone use represents a threat to ability for community and VHT end-users in accessing the service and therefore affects the CDI Accessibility for Customers. This in turn affects the CSF a Clearly Defined Target Group and a Compelling Value Proposition. It also affects Acceptable Customer Base and the CSF Acceptable Profitability (that is to say, social development). However, the strategy to use someone else in a household in the case of community end users to access the service innovation can be used to increase accessibility.

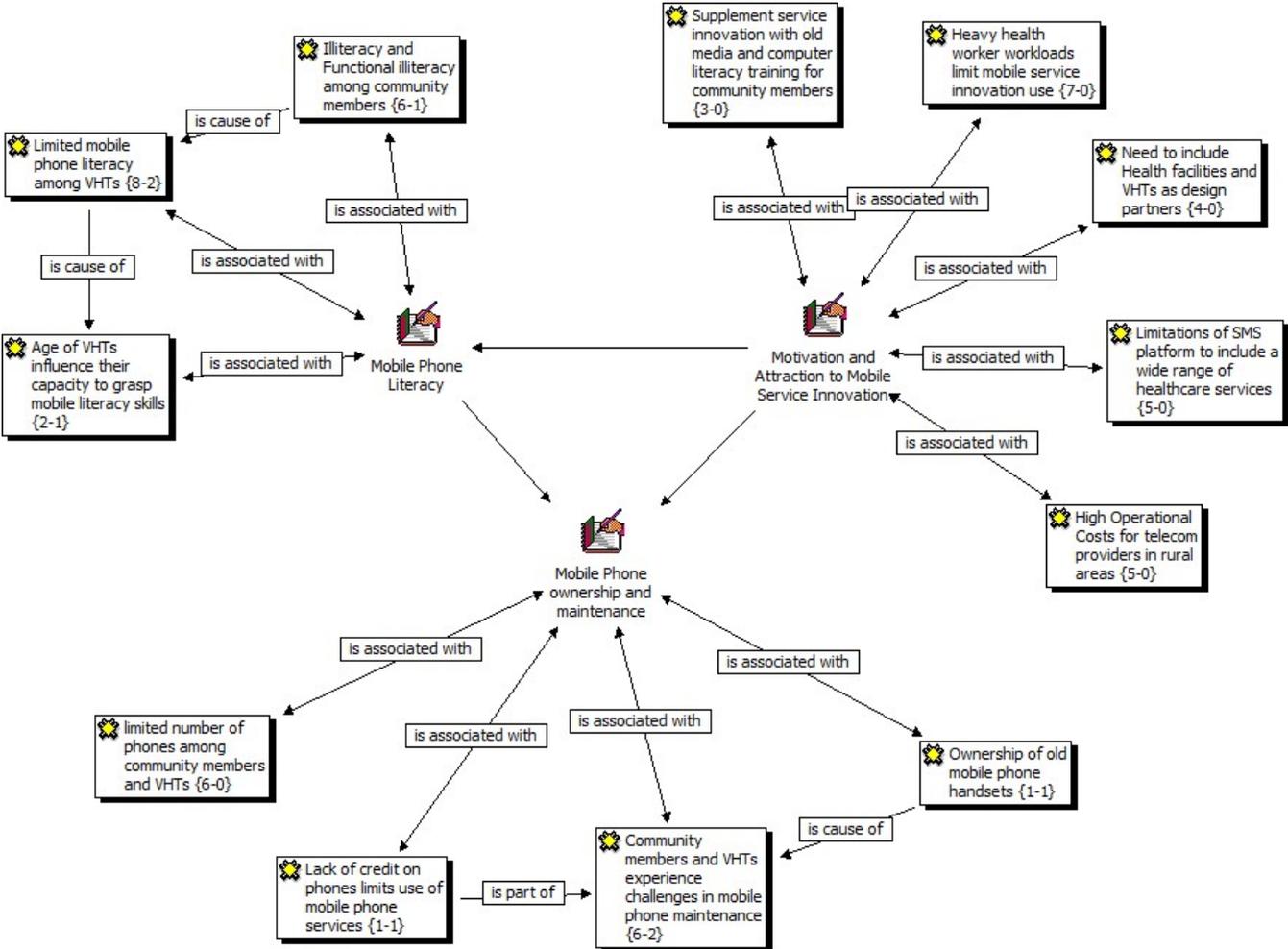


Figure 6.16: Characteristics Defining Mobile Service Innovation End – Users in rural healthcare.

The three emerging issues summarized in figure 6.16 include: (1) mobile phone ownership and maintenance, (2) mobile phone literacy and (3) motivation and attraction of end-users all related to the overall descriptions of assets previously discussed. For instance, mobile phone ownership and maintenance can be explained by low incomes and earnings. Mobile phone literacy is a result of a traditional and information isolated society and the need to motivate and attract end-users to the service is a result of: (1) inaccessible healthcare service and (2) a disempowered community. It can therefore be concluded that, these are the underlying social and economic structures that influence viability of m-Health applications in a poor rural context.

6.6 Compelling Value Proposition, Acceptable Profitability and Clearly Defined Target Group Evaluation

In chapter 5, when there was evaluation of the value proposition of a m-Health service using the defined target group characteristics, identified social value and value elements. Findings have refined the target group characteristics, social value and value elements, and also traced the target group characteristics to the social-economic structures that cause or influence characteristics. It is possible then to re-evaluate the value proposition of the mobile service innovation using these CDIs (Social Value and Value Elements and the CSF, Clearly Defined Target Group) refined so far.

Literature analysis had identified: (1) long distances between the community and facilities, (2) limited drug supply and absenteeism of health workers and reliance on indigenous knowledge as characteristics of a poor healthcare context from which social value or needs derived to formulate four value elements that include: (1) Access and delivery of healthcare services ,(2) Access to healthcare information and (3) Health Education on health risks and disease prevention. From the findings, it is revealed that low incomes and earnings, a description of the financial asset for poor communities is also a characteristic of poor health context, hence included in the set of healthcare context characteristics.

Findings also reveal the relationship between the above mentioned healthcare context characteristics and socio-economic structure: (1) Inaccessible Healthcare Services, (2) Disempowered Community and (3) a traditional and Information Isolated Society, as the redefined physical, human and social cultural assets of poor communities. Findings also reveal the core characteristics that define the healthcare context of poor rural areas, are a result of these three socio-economic structures. This is demonstrated in figure 6.12 and 6.13 in the service design section.

The value elements refined from chapter 5 include: (1) remote monitoring of chronic diseases, (2) Information services for example, inquiries, booking and billing information, (3) Health Education and (4) reporting and medical alerts within the District Health system. These build a compelling value proposition to the end –users that includes community members, health workers and VHTs. However, there are underlying social and economic structures that include: (1) low incomes and earnings, (2) a disempowered community and inaccessible services that are responsible for influencing undesirable characteristics that challenge adoption and sustainability of the service innovation. These include: (1) mobile phone ownership and maintenance, (2) mobile phone literacy and (3) motivation and attraction to mobile service innovation. As a result two of these issues (mobile phone ownership and mobile phone literacy), there was an observation of strategies particularly adopted by VHTs to overcome them. These include mobile phone sharing and seeking assistance from others to access the service. Figure 6.17 summarizes this evaluation of a compelling value proposition in the context of rural healthcare.

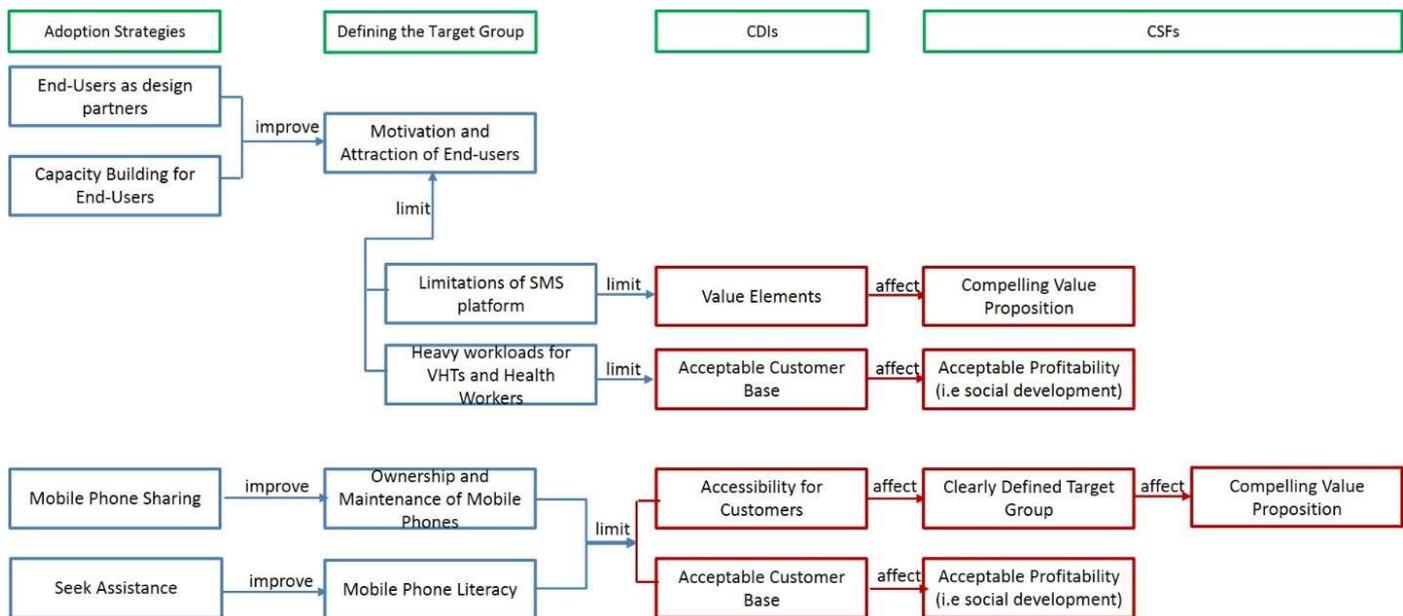


Figure 6.17: Evaluation of Compelling Value Proposition, Acceptable Profitability and Clearly Defined Target Group (Source; Research)

It was observed that while evaluating the value proposition, especially with regard to mobile phone user characteristics, that they also influence the CSF, Accessibility for customers in the technology domain of the STOF framework, a relationship represented in figure 6.17 above.

6.6.1 Value Proposition of Service Innovations

The genesis of both service innovations dictates the value elements that make up service design and subsequently dictates target group and value creation. MTrac’s service design began with supporting partners, such as Find Diagnostics, UNICEF and WHO. These later on introduced the service to the structural partners, Ministry of Health and the National Medical Stores. Its value elements include: (1) data collection and reporting, (2) medical and emergency alerts, (3) SMS polls and (4) an anonymous complaints hotline. However, data collection and reporting is the primary feature of the service. Case findings reveal that both end-users and partners do perceive value from mTrac. VHTs and health workers acknowledged that mTrac improves on timely reporting in the VHT-Nkozi and HF-2 interviews. In the SP-1 interviews with supporting partners, a respondent reveals that medical alerts have especially been beneficial to improved medical supplies to health facilities. The respondent also revealed that mTrac has also significantly reduced administrative costs incurred in manual reporting:

“Currently, the funding for reporting is coming from DFID. However, by rolling this out at national scale it gets significant reduction in cost. We are paying around Shs. 20 per message. Therefore, there is definitely a cost. Nevertheless, the previous system, the paper based system; there is a cost there as well. The cost of moving paper from facility to district, the cost of manually entering data. When we did the calculation, the cost of moving this information by SMS rather than physically was less expensive”

However, communication is one way that creates an information gap in mTrac’s structure. The primary mTrac value element, data collection and reporting is directed to partners and not end-users. Then, Data collected is accessed only at the district and national level leaving out end-users (health workers

and VHTs), a gap that however already existed within the healthcare system before mTrac was implemented. In the KI-1 discussions, one of the participants revealed that there is one-way communication within the health information system. While mTrac was being implemented a respondent in the HF-2 interview pointed out the need for access to mTrac's collected data when he stated, *"They are asking me for data, but I also need this information"*. This may have been the cause of poor reporting habits noticed especially among health workers and revealed in the SP-1 interview when the respondent stated:

"What we are seeing is a lack of appreciation for data. Part of that comes from people not properly utilizing the data. We have quite a range of reporting rates by districts. We have some districts that are consistent - 100%. Other districts are at 30, 40, and 50%. Some of it comes down to district capacity and leadership. With the splitting of districts, there are a number of districts that don't have biostatisticians or HMIS officers. Therefore, that translates down to facilities who are less likely to prioritize that. But we also have other districts that have very, very strong biostatisticians and strong leadership, but they are still struggling on maintaining good reporting rates. And again talking to them, one of the things that often comes up is that health centre staff don't always appreciate how important this data is, and don't utilize it themselves."

This gap may be a result of failure to include health workers in the design process of mTrac. In the KI-1 discussion, respondents revealed the necessity of including health workers and VHTs as design partners. However, mTrac designers were only able to include some health workers in the design process as the respondent in the SP-1 interview states:

"Definitely in the early stages we involved some facility staff... some district staff. With the role out, we've tried to make it participatory in a country where you have 5000 centres and 100,000 health workers it's a challenge. People will always feel... we can't consult everybody. We have to kind of sample the larger sizes."

On the other hand, FrontlineSMS started with end-users (health workers, VHTs and community members). The primary feature is data collection and reporting that was requested for by Nindye health facility in order to fill the information gap in mTrac. Remote monitoring, health education and inquiries were intended to fill information gaps between the health facility and community. Each of these value elements was requested for by end-users as discussed in the Service Design section (6.4) of this chapter. However, unlike mTrac, which is financially supported by structural and supporting partners, value elements in FrontlineSMS depend on end users' financial support. Data collection and reporting depends on the good will of VHTs who use their personal income to pay for standard SMS charges while sending monthly reports. Remote monitoring and health education SMS messages to community members depend on the facility's ability to load credit on the GPRS modem. Some of these features were initially funded by supporting partners (donor agencies) and were only functional when partners were still part of the project. However, at the end of the project the health facility failed to cover SMS charges. This limits the functionality of the application and therefore value creation.

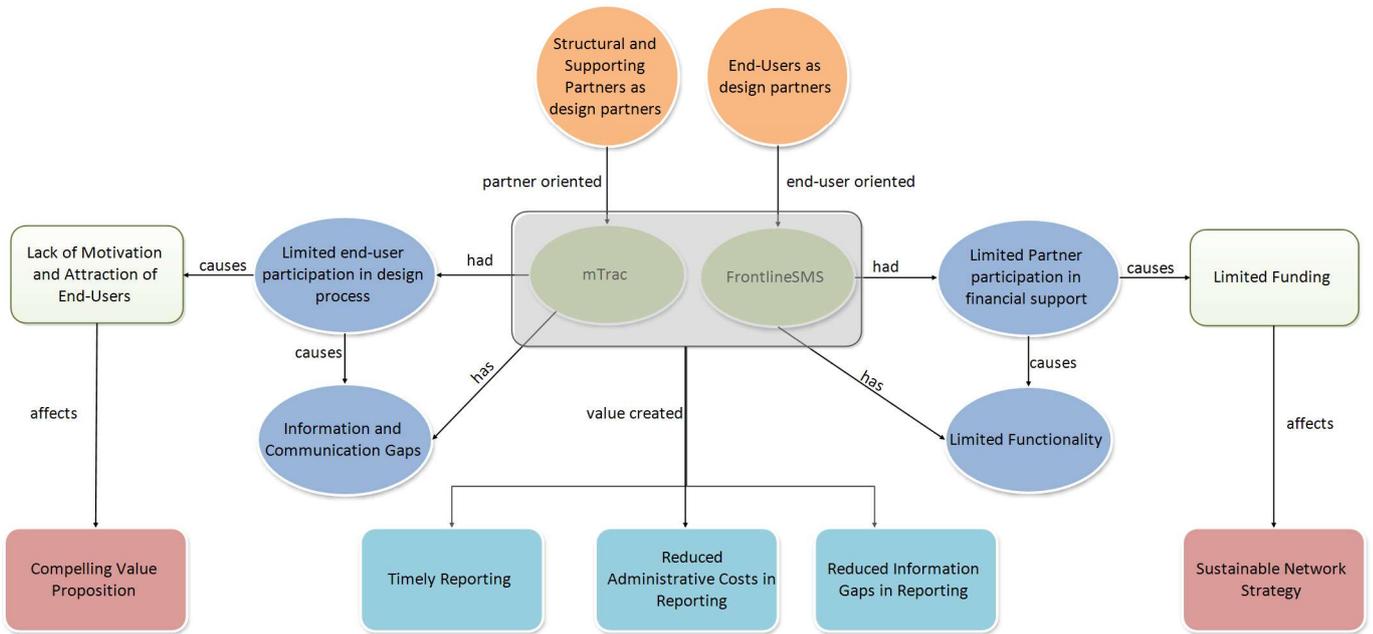


Figure 6.18: Service Design Evaluation (Source; Research)

Figure 6.18 above demonstrates that the observed effects context variables had service value creation and retention for both mTrac and FrontlineSMS and Table 6.4 below presents a summary of the same results and effects.

Table 6.4: Service Design Evaluation

| Service Domain | Design Strategy | Value Created | Design Gaps | STOF CSF affected |
|----------------|-------------------|--|--|------------------------------|
| mTrac | Partner-Oriented | <ul style="list-style-type: none"> Timely Reporting Reduced Administrative Costs | <ul style="list-style-type: none"> Limited end-user participation Information and Communication Gaps Lack of motivation and attraction of end-users | Compelling Value Proposition |
| FrontlineSMS | End-User-Oriented | <ul style="list-style-type: none"> Timely Reporting Reduced Administrative Costs Reduced Information Gaps | <ul style="list-style-type: none"> Limited Partner participation in financial support Limited Functionality Limited Funding | Sustainable Network Strategy |

6.6.2 Technology Architecture Evaluation

Both applications (mTrac and FrontlineSMS) use SMS as the platform for the service innovation as revealed in chapter 2, section 2.6.1, and literature reveals that there are both SMS based applications and applications with specialized software. However, specialized software require high end or smart phones, which are not accessible to low income earners in developing rural areas. The choice to use the SMS platform was to increase accessibility for end-users (health workers, VHTs and community members) and maintain an affordable application for supporting and structural partners. M-Health applications that use specialized software usually require structural and supporting partners to provide high end or smart mobile phones to end-users. By choosing to use SMS, end-users can use mobile phones available to them, thus reducing investment costs for partners. However, while opting to use SMS did reduce investment costs, both applications do require technical support, which creates an investment cost that must be borne by structural partners. As discussed in section 6.8.3, there was evidence of lack of supporting infrastructure and personnel to maintain both service innovations and this hinders value creation in the technology domain.

While we targeted accessibility for end-users by using SMS, low incomes and a disempowered community discussed in section 6.5, affect ownership and maintenance (charging and repair costs) of mobile phones for VHTs and community members, especially as end-users. In the VHT-Nindye and VHT-Nkozi surveys, 66% and 89% respectively of the respondents indicated that they spend more than Shs. 2000 a month on charging their phones. Literacy levels also create mobile literacy challenges, which affect accessibility for VHTs as discussed in section 6.5.3. End-users did however find the application easy to use in spite of mobile literacy challenges (93% from Nindye and 90% from Nkozi). SMS is a static platform that allows limited functionality. For instance, there is a discussion in section 6.4, the HF-1 discussion with Nkozi Hospital management team. Participants expressed the need for face-to-face contact with patients during diagnosis. On the other hand, community members expressed the need for services to be brought closer to them, for instance, diagnosis and treatment during the VHT-Nindye group discussion. During the women's presentation, it was stated:

“Women have asked me to explain this issue. If government could also provide the same service of treating children up to five years of age for the elderly. If they could also be given first treatment by the VHTs, and if the treatment fails, then they can be referred to the health centre.”

Men also expressed the same need:

“For our VHTs, they should be given medicine for adults, especially for us men. The way they have medicine for children and women, they should have medicine for men. You see, we men are the engines in the home. A child cannot survive if the father is not there.”

Although participants asked for VHTs to diagnose and treat adults as well as children at the village level, the underlying issue was that they need these services closer to them than what is currently provided. The FrontlineSMS application had initially been designed to support remote diagnosis and treatment. However, due to the conservative nature of the medical professional that requires face-to-face contact with patients, health workers discouraged this functionality.

Linking end-users to the SMS gateways (mTrac and FrontlineSMS) is the mobile network as the Literature in chapter 5 section 5.4.1 indicates that poor network coverage affects Quality of Service for mHealth applications. Case study findings that reveal that most respondents (63% and 55%) in the

VHT-Nindye and VHT-Nkozi surveys indicate that they had experienced up to one network failure while sending mTrac reports. In the HF-2 interviews, the records officer indicates that he sometimes experienced network failure while sending his weekly reports. He states:

“Sometimes the network is not available. But sometimes they fail to go, I don’t know why. Even if the network is available, they fail to be sent..... When you send a message on your phone, you have to get a feedback that your message has been sent. So this fails and sometimes I have to change to another network to send the message. If Warid fails, I try MTN or Airtel. And UTL.”

Both applications depend on networks from the telecom industry and support partners, especially in the case of mTrac as will be discussed in section 6.8.5 which experienced a lack of motivation from telecom providers during the design stages. In the case of the FrontlineSMS application, telecom providers contacted during the design phase were reluctant to join the value network because they did not respond to proposals sent to them. In the case of mTrac, telecom providers failed to give priority to emergency medical alerts and charged mTrac text messages premium rates. This lack of interest affects pricing for both partners and end-users as Figure 6.19 demonstrates observed effects of context variables on the technology architecture of mTrac and FrontlineSMS and Table 6.5 presents a summary of these effects.

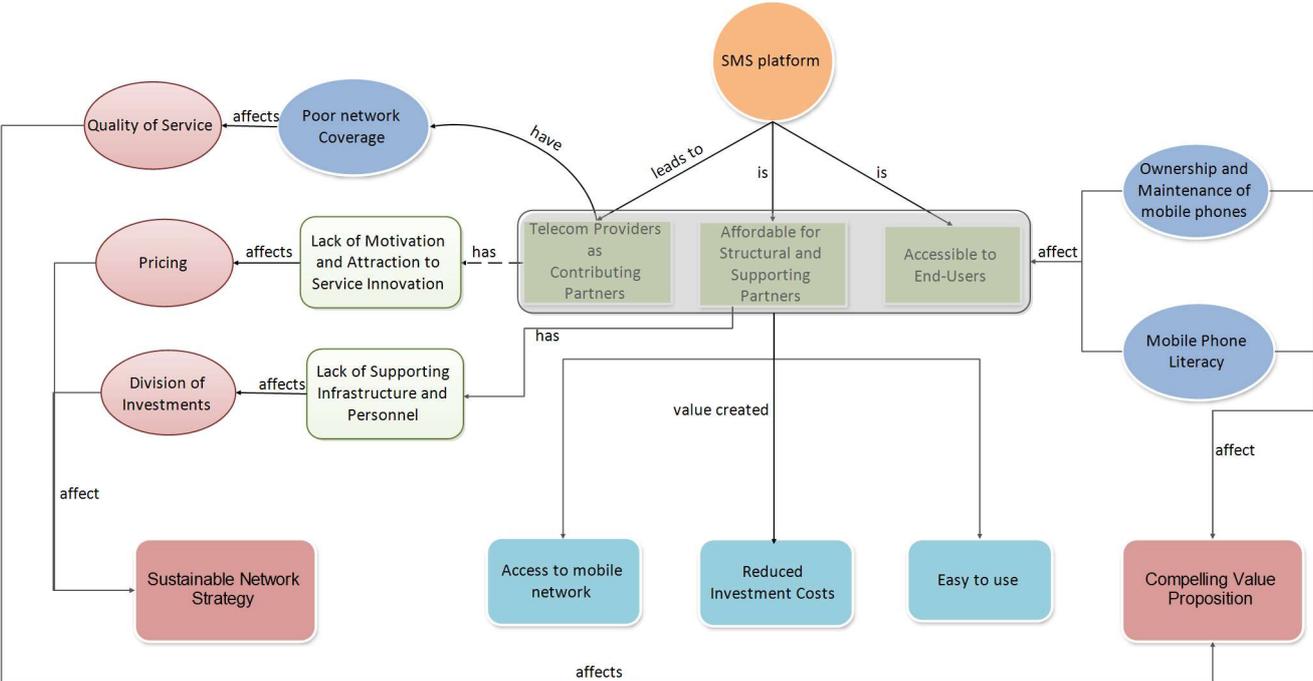


Figure 6.19 Technology Architecture Evaluation (Source; Research)

Table 6.5: Technology Architecture Evaluation

| Technology Domain | Design Strategy | Value Created | Design Gaps | STOF CSF affected |
|-------------------|---|--------------------------|--|------------------------------|
| SMS platform | Telecom Providers as Contributing Partners | Access to mobile network | Lack of Motivation and Attraction to Service Innovations | Sustainable Network Strategy |
| | | | Poor Network Coverage | Compelling Value Proposition |
| | Affordable for Structural and Supporting Partners | Reduced Investment Costs | Lack of Supporting Infrastructure and Personnel | Sustainable Network Strategy |
| | Accessible for end-users | Easy to use | Ownership, Maintenance and Mobile phone literacy | Compelling Value Proposition |

6.7 Livelihood Structures and Processes

Chapter 5, section 5.5 provides a description of rural healthcare structures that include International donor agencies and WHO, Ministry of Health and NGOs and Religious Associations. It also describes the processes, PHC and District Health System through which these structures operate, selected as the social value focused partners to represent the structural or core partners in a value network of an innovative mobile service. It was also proposed that telecommunications providers are included as contributing partners to the value network. They however have only a conflicting economic interest only.

From literature supplied, there are identified characteristics found within structures. For instance, limited funding from donors to support PHC and District Health System activities, lack of political will from government institutions, corruption and poor governance, characteristics later used to evaluate the ability to sustain the proposed network strategy. The case study identifies those characteristics highlighted in literature as well as others that were not discussed in literature. These characteristics are then used to evaluate the proposed mobile service innovation (FrontlineSMS and mTrac) and the underlying business model.

The two livelihood processes identified from literature are: Primary Health Care (PHC) and District Health System programs. Literature reveals that the District Health System is used to operationalize the PHC programs, though it does not describe how these processes function in the context described in the vulnerabilities and assets section while they are governed by the partners described in the Partner Characteristic section. In the case study, the research had an opportunity to study these processes and examine how they interact with the context, end-users and structural partners. The findings reveal both opportunities and threats for the two service innovations from the interaction the processes have with the context, end users and structural partners.

6.7.1 Organizational Arrangements

Case study findings reveal the presence and influence of all structures: International donors and WHO, Ministry of Health and Religious Associations, and it was discovered WHO (World Health Organisation)

right at the beginning of the research during the KI-1 group discussion with health workers and community health promoters when a participant pointed out the effort WHO has made to curb reporting gaps in the District Health System. As the director of member countries, WHO supports the health sector in establishing a reporting system for the PHC and District Health System. On the other hand ministry of Health as the governing institution, facilitates funding, staffing and resources for health facilities and VHTs. One of the Religious Associations in the case study, Uganda Catholic Medical Bureau (UCMB) facilitates and negotiates funding and resources from the Ministry, local and international donors for healthcare and ICT resources.

Funding for mTrac started with several international development agencies. According to the SP-1 interview with the Health Systems Strengthening Specialist in UNICEF, the platform mTrac uses RapidSMS that was largely developed by UNICEF, which was later on joined by International development-oriented NGOs, such as Earth Institute and The Village Project. The software development processes attracted Mobile and SMS software development companies such as dmagi and clock works, and growth from application to a data collection and reporting system started with the activities of a Swiss NGO (Find Diagnostics) in Uganda, which used it in a pilot project. This was later implemented and scaled up by UNICEF, DFID, WHO, Malaria Consortium and Ministry of Health Uganda as mTrac. To operationalize mTrac, national partners in the healthcare system include National Medical Stores, Medicines and Health Service Delivery monitoring unit as well as representatives from the ministry were involved.

It is important to note that the different phases of mTrac attract a different set of partners depending on their resources, capabilities and interests. For instance, the partners in the software development phase are not only software developers but also solution designers for social development. International partners in the implementation phase were predominately funders to the project while the national partners are those that will operationalize and utilize the data collected.

The genesis of the FrontlineSMS application started with three donor International Agency (Verizon Foundation, NUFFIC and University of Notre Dame), as agencies partnered with two local Institutions (Uganda Martyrs University (UMU) and Nindye Health Centre III) to implement and operationalize the service. The three donor agencies contributed to the initial funding of the project as well as providing technical expertise for equipment and software implementation. UMU departments include Outreach and Information Technology partnered to modify and implement the service. The health facility operationalizes the service.

6.7.2 Partner Selection, Network Openness, Network Governance and Network Complexity

The two services give a wider perspective on Structural partners who are also the Network Governors, as the Healthcare Institutions that own the two services. mTrac is owned by the Ministry supported by a number of national partners, that is to say, National Medical Stores, Medicines and Health Service Delivery monitoring unit. The system itself is located at the Ministry Head Quarters and as the owner, the Ministry is responsible for the maintenance of the system, which includes financial and technical support. The FrontlineSMS application is owned by Nindye Health Centre III where Financial and technical support is shared between a Supporting partner, Uganda Martyrs University and the end-users (VHTs). The application is dependent on the goodwill of VHTs who send monthly messages from their personal income while maintenance of the system will be supported by Uganda Martyrs

University. Initially the system (both hardware and software) is to be located at Nindye Health Centre. However, because of poor power supply and a lack of personnel for system and database administration, it was moved to Uganda Martyrs University. In this case, it is evident that social Entrepreneurship business model guidelines support a gap in the value chain. Uganda Martyrs University participated through its social corporate responsibility objective.

The findings also reveal more contributing partners than just the telecom providers that were identified from literature. Contributing partners are made up by private not for profit institutions, and private commercial companies with technical skills and resources to support the technology requirements of both services. MTrac's technology architecture introduces the regulator (Uganda Communication's Commission (UCC)) as another partner from the telecom sector. UCC provides short codes that are used when sending messages. Dmagi and clock works, software companies participated in the development of mTrac's platform, and RapidSMS. The Information Technology department in Uganda Martyrs University modified the FrontlineSMS application.

The view and perception of the supporting partners who are predominately donor and international development agencies has also evolved, and performed the role of initial funders of the service as discussed in the previous section. In the particular case of mTrac, donor and international agencies supported the initial funding and later on supported capacity building for the Ministry. One of the donor agencies has also continued to support the Ministry with the service costs after mTrac was handed over to the Ministry, as shall be discovered in the partner characteristics discussion. It has also been revealed that private not for profit institutions can support the service by providing Internet and support services for the technology architecture. This was evident with Uganda Martyrs University, which supports the FrontlineSMS application by hosting the system. The system is then accessed by the facility via the web through a wireless access point that links the facility to the University.

The discussion on organizational arrangements of the two services can be conceptualized in relation to two primary roles of the partners: (1) network governance and (2) facilitation and funding. Whereas the network governance has been assigned to the two institutions in the health sector, the roles of funding and facilitation have been taken on by supporting partners. This is a threat to the sustainability of the value network as the discussion in the partner characteristics section demonstrates. Figure 6.20 below presents the partners and their roles.

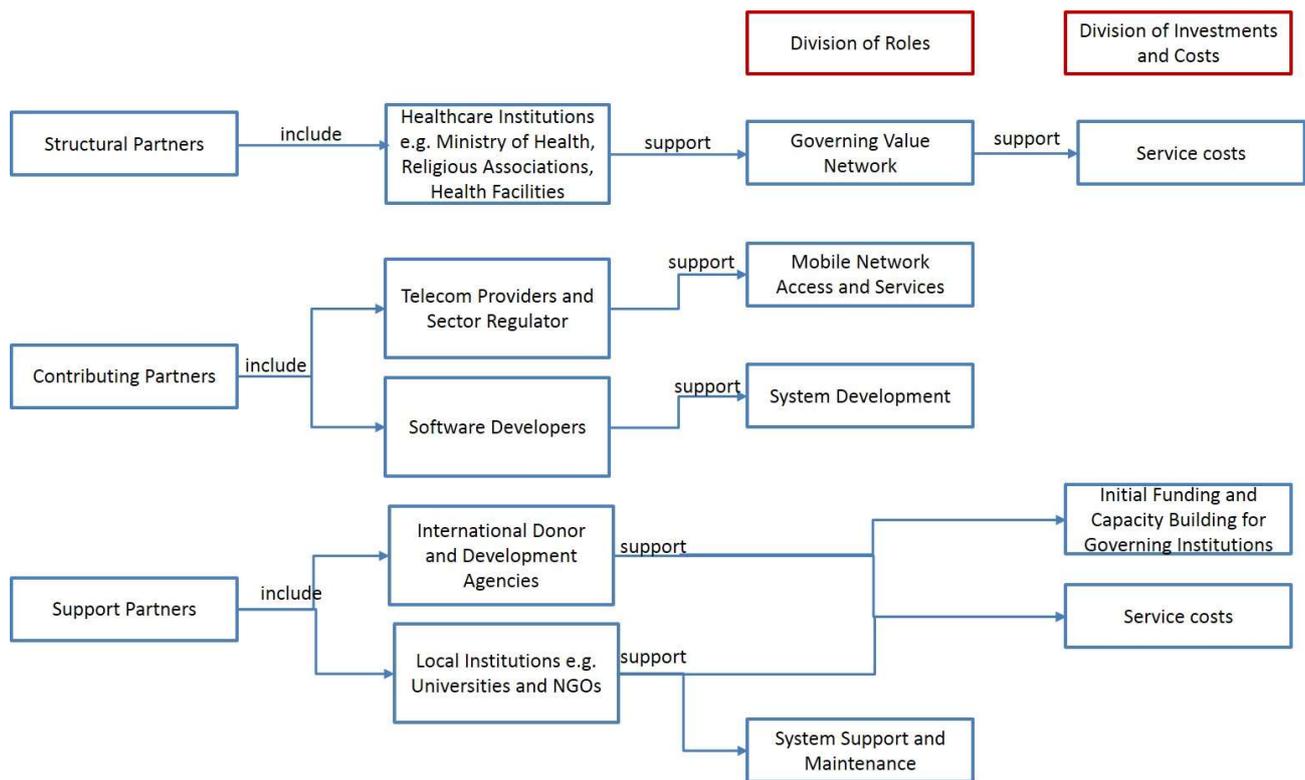


Figure 6.20: Social Value Partners in the Mobile Service Innovation (Source; Research)

6.8 Partners Characteristics

In section 5.5, chapter 5, there is a discussion on partner characteristics in the value network by examining their capabilities and capacities. The volatile nature of developing nation states was not a visible variable in our case study findings but identified: (1), limited funding, (2), poor governance, (3), fragmented Health Information Systems and (4), lack of a political will. In addition to these, the researcher identified four new variables, the first four are negative descriptions of the livelihood structures who in the business mode referred to as structural partners, and the fifth variable is a positive description of a developing context. This is sector growth. The findings in the case study indicate that while negative variables previously discussed from literature exist, there is positive growth especially in the form of increased facilitation and funding of local health facilities and improved governance from the Health Ministry. The sixth variable is a result of observing the contributing partners and the regulator of the telecom sector in the business model. The discussion in chapter 5 expressed concern on the conflicting interests between the contributing partners and the structural partners. From the case study, there is a discussion of the relationship between the telecom sector and m-Health applications as one that requires motivation and attraction. This is our sixth variable. The seventh and eighth variables are: Poor Working Conditions and the VHT strategy that describe and explain how health workers and VHTs who are the end-users interact with livelihood processes, as findings discussed in the next section, and summarized in figure 6.21.

6.8.1 Limited Funding

As discussed earlier in chapter 5, in the vulnerabilities and assets section, local health facilities receive limited funding and facilitation from governing institutions. There were indications of failure to carry out health promotion exercises because there was no facilitation for health workers to move into

villages, or failure to refund VHTs transportation costs as they convene for meetings with their immediate supervisors for report submissions. These indications of limited funds and facilitation experienced by facilities and VHTs indicate that the governing institutions also have limited funds. The end result at facility level is poor supervision, data collection and reporting. In the HF-2 interview with Nindye's health centre medical officer, he narrates that they as a facility are not able to monitor VHTs' performance because the facilitation that was originally given for meeting with VHTs had been stopped. He states:

"So we would gather all this information [household data] and compile into one report, and send to the district. So that used to be every month. But also we would have quarterly meetings with the VHTs. These were normally facilitated, in part by the district – of course by the Ministry of Health through the district, but would also take a portion of the money meant for VHTs – the recurring non-wage fund – a grant we normally get. We would use a portion of it to facilitate these meetings. The unfortunate bit is that somehow, that kind of arrangement died down, meaning we don't have that much interaction with VHTs at that level. So, that means we cannot effectively monitor their performance, their challenges and such things. Because when you call them here, they expect that you will give them their transport refund."

Reports from the lower levels to the district are also delayed and sometimes not even available. A participant in the KI-1 group discussion with health workers and community health promoter states:

"At the moment, the whole country is suffering from the problem of weekly reports. You will find from health centre to district, the weekly report is not in and yet it is a monitoring tool for all other activities. From the health facility to the district we have that problem. That is why when you check in the reports, there are some districts which do not have reports, meaning that there is a certain level of communication gap. And that communication gap, the WHO has been trying to curb."

The lack of facilitation does not only affect reporting and effective supervision of VHTs but also affects reporting and supervision between health facilities in the health system. A health Centre IV, for instance, supervises health Centre III facilities in the sub-county, a process that too requires facilitation. Nkozi Hospital which is responsible for all health Centre III facilities in Nkozi sub-county experiences the challenge of lack of facilitation to effectively supervise these centres.

Both mTrac and the FrontlineSMS application have used this challenge as an opportunity to create value for health facilities and the partners. SMS reports, for instance, are intended to reduce costs that are associated with paper based reporting. The Health Systems Strengthening Specialist in UNICEF in the SP-1 interview states:

"We are paying around Shs. 20 per message. But the previous system, the paper based system, there is a cost there as well. A cost from moving the paper from facility to district, a cost from manually entering the data. When we did the calculation, the cost of moving this information by SMS rather than physically was less expensive."

MTrac also introduced timely reporting. In the HF-1 interview with Nkozi Hospital's record's officer, states:

"It has improved the program, the way of reporting. Before the district people used to call us to compile the report. In other words, we first waited for their call and then we give them the results. But now we

compile the data and send it immediately. Apart from being bulky, because at first we used to send only a few things, but it is good."

On the other hand, FrontlineSMS was developed to report data to the facility. While mTrac reports data to the Ministry, it however does not give facilities access to the data which they too use to monitor and supervise VHTs. The problem with one way communication actually existed before mTrac with the Healthcare Information System as was pointed by a participant in the KI-1 group discussion with health workers and community health promoters when he states:

"Actually the biggest gap is that we always have one way communication. That is the VHTs send information to health Centre II, who may push it to three, four and five, like that, but no information is sent back to the VHTs. That is what is lacking. That is the point we could improve on."

However, while both services introduce timely reporting and reduce reporting costs associated with paper based reporting, there is still the question of whether the Ministry and facility funds can sustain both services. In both cases, donors played the role of initial funders but later transferred this responsibility to the governing institutions. With the specific case of the Ministry, after mTrac was transferred to the Ministry, responsibility for service costs at the time of field research was still in the hands of the DFID. It is yet to be seen if the Ministry will sustain payment of mTrac's service costs on its own. Nindye's application depends on the goodwill of VHTs to send SMS report messages from their personal incomes. However, service costs at the facility stalled after the donor pulled out. Limited funds for both institutions undermines their capacity to fulfill their role and responsibility as network governors and primary investors in the services which means that they influence the CDIs Network Governance and Division of Investments. These two CDIs in turn threaten the CSFs Acceptable Risks and Sustainable Network Strategy. In the next section we discuss the role of governance in detail.

6.8.2 Poor Governance

Case study findings do not reveal corruption in rural healthcare, but there is evidence of poor governance. The poor state of the public health facilities was blamed on weak leadership from the governing body, Ministry of Health. The responsibility for setting up and supporting public health facilities lies with the Ministry. Indications of failure to properly implement or administer processes are evident in comments made during the VHTs-Nindye group discussion. A participant comments about the slow implementation of changes made by the Ministry to the local health facility:

"You know very well that in as much as this health centre's status was raised and that we should provide certain services, we are still working on the old budget that we had previously. They have been promising for seven months now. Remember we do not ask for the drugs. The drugs are given. So if and when they start to give us the drugs for a health Centre III, then drugs will increase in number and variety. We shall then find that people will be more satisfied."

Poor governance at district and national level is evident in poor resource and facility distribution, and Local health facilities suffer from persistent lack of sufficient supply of drugs. Although this challenge was pointed out in the vulnerabilities and assets section, it however points to the governing body, Ministry of Health and its governing capabilities. An inefficient drug supply and distribution strategy adopted by the Ministry and referred to as the "push" method was blamed for drug shortages at the health facility. Health facilities do not request for drugs but are supplied by the Ministry periodically. In the HF-2, group discussion with VHTs, Nindye's in-Charge states:

“Remember we do not ask for the drugs. The drugs are given. So if and when they start to give us the drugs for a health centre III, then drugs will increase in number and variety. We shall then find that people will be more satisfied.”

Supply of drugs is also related to the limited number of health facilities in the locality. An area of service that has a health centre III should also include a health centre II to support both service and drug distribution. However, the case study area only had Nindye Health Centre III as the only source for public healthcare. The allocated drugs therefore fail to meet the demand in the locality.

Reporting and medical alerts within mTrac were perceived, as a possible solution to drug shortages as resolved with mTrac. Weekly reports by VHTs and health workers were used to keep track of not only disease prevalence but also drug stock outs. VHTs perceived that this would ensure timely drug supply for the community. During the VHT-Nkozi interviews with an Nkozi Hospital VHT, respondent states:

“I think it is good because they are going to supply us with drugs much faster than before. Before we would run out of drugs and we would go to the health centre and find there are no drugs. We had to wait until they bring a fresh supply. I think now they will be able to supply drugs to us much faster and this will help our children, because they fall sick and need treatment immediately.”

Health workers also suggest medical alerts for the Frontline service innovation so that VHTs could first report to the facility which would then carry out an investigation before reporting to the District Headquarters. In the HF -1 interviews, the Out Patient Department nurse, she suggests:

“:....the VHT can inform the hospital that there is a problem in the community. Because if they say there is an outbreak, then the hospital has to go there and see. If they go there, they can carry out investigations...how many people have been infected by this problem and decide how we going to tackle this problem. So if they know that there is an outbreak of measles, for example, they can call the district and inform them that there is an outbreak in such and such an area. Then the district will have to act.”

MTrac supports some of these needs. The Health Systems Strengthening Specialist in the SP-1 interview affirmed this when he states:

“So the main driving force behind mTrac was data utilization and response. Specifically around bottlenecks such as medicine stock. So, with the facilities that are now reporting one of the things that we’ve been trying to focus strongly on is ensuring that the districts use that data to better forecast medicines to ensure that overstocked facilities’ medicines are shifted to understocked facilities... that disease outbreaks are followed up on quickly. I think we’ve seen big successes with the response time for disease outbreaks. We’ve had cases of cholera for example reported in the North in West Nile responded to within a few hours of the report coming in where previously it would take weeks.”

The designers of mTrac also realized that beyond reporting, communication between VHTs and health workers for the sake of supervision is necessary. In the same SP-1 interview, the respondent states:

“One of the things that we are going to be adding in the next couple of months is closed SMS messaging so that health workers and VHTs can communicate amongst themselves within the system. That was based on requests that we got from both the VHTs and health centres.”

While poor governance creates opportunity for the both services, it also presents threats to the viability of the service. If the Ministry as network governor does not have the necessary resources and capabilities to support a service innovation, then viability is threatened, especially the CSF Sustainable Network Strategy. The Ministry is essentially the custodian of social value in healthcare, and it is explicit, building the capacity of the Ministry is key in creating sustainability for the service innovation.

6.8.3 Supporting Infrastructure and Personnel

There is evidence from both institutions of a lack of supporting infrastructure and personnel for both service innovations. The Ministry as the governor and owner of mTrac lacks key resources and capabilities to maintain mTrac. It was revealed during the design process of mTrac that key policy and strategy frameworks to support mTrac were non-existent. This was revealed during the SP-1 interview with the Health Systems Strengthening Specialist in UNICEF where the respondent states:

“..as we were starting to roll out mTrac we recognized the fact that the government did not have a national e-health strategy or vision and a company policy framework. That in itself was a major risk in the long term for the government to fully take this on and sustain it. And so around the same time we also, as part of the larger support to the Ministry and support for mTrac working with WHO, we seconded people to the Ministry to develop a national e-health strategy, that is to assist the Ministry develop a national e-health strategy.”

He further revealed that, the Ministry lacked key personnel, including a system or database administrator to support mTrac. Gaps such as these undermine the Ministry’s ability to effectively govern mTrac’s value network. It is however important to note the strategy taken by donor partners, together with the Ministry while developing the e-health strategy, also developed a set of recommendations to include the positions of a database and system’s administrators. He states:

“One of the things we did with the e-health strategy was that we looked at the HR organigram of the resource centre and the current HR structure is based on the days of paper system. So they are no formal systems in the Ministry for database administrators, systems administrators, and yet the Ministry policy says that they want to be managing many of these systems and many of these tools. And so there is a big discrepancy between the two. And so working with USAID, with CDC, with WHO and Ministry of Health, we developed a new set of recommendations, a new organigram for not the resource centre anymore. They are looking at rebranding it to Department of Health and Information. That organigram will have a technical team in place to manage and support these various tools.”

Nindye’s Health Centre was found lacking in critical resources and capabilities to maintain the FrontlineSMS application. The facility depends on a weak solar system which we observed fails to store sufficient power during the rainy season. This hindered system installation which was later installed at Uganda Martyrs University and accessed via the web at Nindye. The facility already understaffed for healthcare activities does not employ a system or database administrator to support the service. The strategic choice to shift the service to the University not only avails a more reliable power supply, but ensures technical personnel to maintain the service.

Coupled with poor governance, lack of resources and capabilities affects the CSF Acceptable Division of Roles among partners. However, in both cases, support strategies were applied to support the lack of resources. Supporting partners developed an e-health strategy for the Ministry and recommended

support staff for mTrac. The FrontlineSMS application's location was changed from Nindye's facility to Uganda Martyrs University, the local support partner.

6.8.3 Fragmented Health Information Systems

Chapter 2 and chapter 5, reveal the presence of fragmented health systems in rural healthcare. The result of this was poor record management and information flow and Findings in the case study reveal the existence of the same. Related to heavy workloads experienced by VHTs and health workers, fragmented reporting in the District Health System was reported by respondents in the two facilities. In the HF- 2 interview with Nindye's health Centre in-Charge the respondent states:

“But above all, we believe that this reporting system, should be more of an integrated reporting system. Of late we have parallel programs going on in the community. And these things are really exhausting our VHTs so much. For example we have the NTD program, the Neglected Tropical Disease program. Those [NTD program] have their own registers. We have the general household registers, the green ones you see there, they are supposed also to be reported as independent tools. Now they have to report on the ICCM thing. This is also an independent tool. And you find World Vision will also introduce - many times, it introduces forms and many other things in the community that are supposed to be used by the VHTs.”

While defining the target group, it was revealed that some VHTs participating in the Nindye and Nkozi surveys were participating in up to four (4) programs and that each program requires them to collect data. Within health facilities, it was also revealed that both Nkozi Hospital and Nindye Health Centre had fragmented record management systems with duplicated data entries that are paper based in form of registers, where health workers make daily entries. These have caused challenges, such as increased workload and an inability to manage data especially patient data. This was revealed first in the SP-3 interview with the Project Coordinator Uganda Catholic Medical Bureau and second in a HF-1 group discussion with the facility staff during a presentation of the FrontlineSMS application. It is not possible in both facilities to trace a patient in the system. The current systems are not able, for instance, to determine if a patient is new or a follow-up in the system. Each patient that visits the facility is entered as a new patient even when it is a follow up visit. This, the Medical Superintendent stated was their immediate need with regard to information needs before a mobile service innovation. During evaluation of mTrac, it was observed that these parallel and paper based systems increased effort in data collection for the service in the facility. In the HF-1 interviews with Nkozi Hospital's records officer, he describes the different departments and registers he used to compile the data required for mTrac as follows:

“Malaria tests, those I get from the labs, that's where they test for malaria. Then others like measles, dysentery I get those from OPD which is in the computer. Then the drugs like coartem, I go to the pharmacy, about treatment I get that from the OPD register. Deaths I get from general ward and private ward. Then maternal deaths from maternity. Then quinine is also from pharmacy. Then attendance is from the dental department, OPD and then from the private ward. In fact for attendance I get those from OPD, private, dental and HIV clinic”

He further revealed that the data he collects from these registers is duplicated, which therefore compromises the integrity of mTrac reports. The HF-2 interview with Nindye's record's officer revealed the same challenge. While at the national level, the Ministry insists that all national data collected must be integrated into the national database branch DHS2, yet, this cannot be achieved if at the lower

levels (facility and VHTs) fragmented systems still exist. MTrac designers aligned the service to the DHS2 system, though the data coming from the lower levels is at the moment inaccurate and therefore compromises Quality of Service and System Integration. In turn, these two CDIs affect the CSF Acceptable Quality of Service.

6.8.4 Political Will

The Literature reveals that lack of a political will poses a challenge to healthcare in developing countries. This is not an obvious variable from the governing institutions, but it is visible in the local political leadership, particularly in the PHC and District Health System that are supposed to supervise and support VHTs in the community activities. However, findings in the case study indicate that these local leaders are a hindrance rather than a support system. VHTs and health workers reported that local political leaders were mistrustful of VHTs. During the HF-2 interview with Nindye's Medical Officer, he states:

"There is a weak leadership at the community level. We used to have the LC system functioning some time back. I remember what it entails you going to community to work with LC. LC are the people who of late are so splitty. They are not helping us. Under the government arrangement when the VHT system was being put in place, it was meant to be that the LC leadership were supposed to be the immediate supervisors to the VHTs. And they is no way an LC will be a supervisor to a VHT when the LC himself does not know what the VHT should be doing. And that is one weakness I saw right from the start. Many times I call LCs here for sensitization. Because during these meetings we normally call the LC I chairmen to come along. From all the 12 villages. Quite often you find 3, 4, 5 coming out of 12. And when these VHTs go back, once they start mobilizing masses, the LC chairmen feel as if they are competing with the VHTs for popularity, for recognition."

VHTs also revealed the same view about their local leaders, as a participant in the VHTs – Nindye training session narrates:

"Once we had a training session here, when we went back and we informed our LC chairman that we wanted to pass on what we had been trained on, up to now they have not mobilized the community."

What was observed at the local level is that lack of political will frustrates the activities of VHTs and therefore their moral and motivation as discussions on the moral and motivation of VHTs already reveal. However, there will be further discussion on motivation of VHT under the VHT strategy and how it affects the business model and therefore viability of the services.

6.8.5 Motivation and attraction of Telecom Industry

In chapter 5, the conflict of interest the contributing partners (telecom providers) may introduce into the value network was highlighted. From the case study findings, it was discovered that they (telecom providers) and others in the industry, specifically the regulator may need to be motivated to participate in the value network. Also, during the design process, there was a perceived indifference towards the FrontlineSMS service from telecommunication providers. For instance, proposals sent to them seeking partnership in the value network were sometimes left unanswered. In the SP-1 interview with the Health Systems Strengthening Specialist in UNICEF, when asked about the role of telecoms in mTrac he states:

“Other than us using their physical infrastructure they have not played a very strong role. We haven’t partnered with them on anything.”

High service costs both from the service providers and the regulator were a hindrance to mTrac, though Medical alert messages are given the same priority as commercial messages in network traffic. Similarly, Health information and reports are charged the same premium rates as commercial information. In addition, Uganda Communications Commission (UCC) the sector regulator charges mTrac \$2000 every two years for short codes used by end-users to submit reports and complaints. This prompted mTrac partners to lobby UCC to reduce this cost and telecom SMS traffic costs. The Health Systems Strengthening Specialist in UNICEF states:

“We have been trying to work with UCC to put into place a new category of messaging services for government humanitarian usage. So right now it’s quite costly to get short codes and to get set up in Uganda. It’s also, the messaging costs and the priority are the same as commercial messages. So your love tips, your jokes, your sports scores. So this can be a big deal if for example a case of Ebola is reported and delayed because this critical government data is given the same priority as love tips. One of the things we would like to see from the telecoms is jointly an acceptance of these government services, of lowering of rates. Again we don’t need them to provide these for free. But they shouldn’t be charging premium rates or high rates offers and to provide priority access to the pipeline so that we don’t see any delays for the in-going and outgoing messages.”

These service costs are supposed to be borne by institutions that we have already seen struggling with limited funding. One participant in the KI-1 discussion points out that the lack of interest perceived from telecom providers towards rural areas is probably because of the high operational costs they experience in rural areas. He states:

“For the private sectors they consume more in rural areas than in the city. There is electricity and in the rural areas they have to have generators all the time. Meaning it is more expensive compared to the urban areas. So perhaps this may be one of the reasons why people do not want to invest in the rural areas.”

Hence, it is significant to note that high service costs influence the CDIs Pricing and Accessibility for Customers, which in turn affects end-users with limited income and partners with limited funds. These two CDIs similarly influence the CSFs Compelling Value Proposition and Acceptable Profitability.

The discussion on partner characteristics presents a part of the context that describes the partners and their influence on rural healthcare as well as the service innovations applied to the context. These are summarized in figure 6.16. In the next section, there is a discussion on sector growth as observed in the context.

6.8.6 Sector Growth

The Literature supplied in chapter 5 does not indicate growth patterns in rural healthcare. However, it must be noted that despite the negative characteristics observed, there is evidence of improved service delivery and an increase in resource provisions and this ultimately points to growth and development in the sector. It was also observed, for instance, that there was an increase in services and equipment as reported by the Centre in-Charge during the VHT-Nindye training sessions. During the period of implementation, it was also observed that staffing was increased with the addition of a

records officer to the Nindye Health Team. These improvements were attributed to Ministry of Health and NGO projects and activities.

In addition, there was also growth in governance and administration observed within the Ministry. During the SP-1 interview with the Health Systems Strengthening Specialist in UNICEF, he noted that while the Ministry did have gaps in personnel to support mTrac, they were however in the process of restructuring their information system approach, as he states:

“Architecturally there has been fairly interesting updates in the last year. The Ministry is shifting to a more enterprise architecture approach, where they are in the process of establishing stand-alone registries for things like HR, health facilities, patients, patient records.”

Such an observation therefore indicates that while there may be challenges in the rural healthcare and the governing institutions, there are improvements and positive developments along the way that can support a service innovation

6.8.7 VHT Strategy

PHC and District Health System programs described in literature, chapter 5 depends on VHTs who are volunteers and part of the local community. While the literature does not provide a description of these community members as participants of rural healthcare, the case study findings reveal that these are an essential component of the health system whose challenges present both opportunity and threat to both service innovations. VHTs are selected from the community described in the vulnerabilities and assets section. This means that they experience the same challenges and characteristics as the poor communities they serve. That is disempowerment, illiteracy and low incomes as also reflected by a member of Nindye Health Centre board in the HF -2 Nindye interviews who states:

“These people..., because they were elected by their communities, they did not consider education. Someone might be hard working but is illiterate. But they will say “That person is very sympathetic. That person is very social”. They bring such a person. But the person fails to write a report. And you cannot change that person, because he was chosen by the community. So what we have been doing, since I have been chairperson of the VHTs for the last two years, is to include someone on the team that can read and write. But this is a general weakness [report writing] in the community, not only the VHTs.”

Notably, VHTs are responsible for carrying out some of the PHC and District Health System activities at the community level, for instance ,making home visits to follow up on new born babies or patients, health promotion and education at household level and treatment of children five years and below. However, there were indications that some VHTs find some of these duties a challenge. Report writing in particular was mentioned. The chairperson of the Nindye Parish VHTs raises this as one of the challenges they experience with VHTs during the VHTs-Nindye group discussion:

“Report writing is difficult for many. It is a big issue, writing reports from the village level upwards. This is a big problem.”

In the VHT-Nindye survey, VHTs were asked to evaluate themselves. One of the questions in the survey was to determine if participating VHTs had ever been told by their supervisor that they filled in the register wrong. Although most of the participants (16), claimed that this had never happened five

(20%) of these participants admitted that they had made errors in register updates. This problem was also observed during the mTrac implementation process. In the SP-1 interview with the Health Systems Strengthening Specialist in UNICEF, the respondent states:

“During the trainings one of the things that we found was a challenge wasn’t training the people how to send the data by SMS. The biggest challenge in many cases was actually having to retrain them on how to fill out the HMIS forms. And so we had to restructure our trainings after phase one, to focus less on the SMS sending and more again to retrain them on where to find the data with the source documents, how to add up everything properly. So data quality continues to be a major issue. The difference is that it is now easier to see problems with the data quality because it is digitized and we get it in immediately.”

The statement of the respondent as noted above confirms what was earlier discussed, that is to say, disempowered VHTs may affect the quality and relevance of the service. Their capabilities are further challenged by age. The voluntary status of the VHT position attracts mainly mature members of the community. The VHT-Nindye survey reveals that most of the participants were between the age groups 30-40 (40%) and 40-50 (32%). Although these statistics are not representative of all VHTs in Uganda, they do however reveal that volunteerism may attract mature individuals. The age of the VHTs affects their ability to grasp some skills, tasks expected of them in PHC programs, and activities, for instance some VHTs reported that they experience failing eyesight and cannot fill in their registers. As earlier discussed, this has an effect on their mobile phone literacy skills. Disempowered VHTs may fail to use the service due to limited abilities and therefore threatens the CDIs Accessibility for Customers, Acceptable Customer Base and Quality of Service which in turn affects the CSFs Acceptable Profitability (i.e. social development) and Acceptable Quality of Service.

It is significant to note that the activities VHTs carry out also interfere with their personal income generating and household activities and yet, as earlier pointed out, they are not facilitated or funded as they carry out these activities. This demotivates VHTs and sometimes affects their activities, including data collection and reporting. In addition to government healthcare workload, NGOs that come into the community also depend on the VHTs to execute their program activities as was evident in the fragmented health information system section. This increases their workload and further demotivates them as revealed in the HF- 2 interview with Nindye Health Centre III. The in-Charge states:

“Of late we have parallel programs going on in the community. And these things are really exhausting our VHTs so much.”

Further, the in-charge later on reports that due to the heavy workload, some VHTs opt out of the programs. If it is a challenge to retain VHTs in the community programs, then it is also going to be a challenge to retain them as end-users of both services. During the SP-1 interview with the Health Systems Strengthening Specialist in UNICEF, he reports an incident when VHT reporting dropped because of what he believed was demotivation on the side of VHTs. He states:

“One of the things that we saw during the last eight months was that there was a decrease in the VHT reporting rate and at the same time there was a growth and spike in stock out of ACTS and amoxicillin. My assumption is that VHTs that were reporting initially, they were reporting their stock of medicines,

week after week after week, eventually lost some faith in the information they were sending because they weren't actually seeing any response based on their reports."

It is noted that the VHTs operate basing on whether they are motivated or not as they carry out their duties unlike paid health workers. In the above reported incident, the VHTs stopped using the service when they perceived that their activity was not yielding value and this in turn affects the CDI Customer Retention which subsequently affects the CSF Acceptable Profitability.

There is also an opportunity for value creation, which was identified from the VHTs strategy challenges, specifically in the need to improve the capacity of disempowered VHTs through continuous training. The designers of mTrac already had this in mind, to use the service as a communication tool in determining training needs among health workers. In the SP-1 interview with the Health Systems Strengthening Specialist in UNICEF, the respondent states:

"What we've been able to do for example .., we run some class surveys and identified hundreds of facilities that had for example stock outs of gas cylinders, or had not received their training for PCB vaccine. We've been able to use that as a way to identify these fairly critical bottlenecks that were preventing facilities from doing their jobs."

It has also been realised that among VHTs, the VHTs themselves and their supervisors raised the need for continuous training. During the HF- 2 interview, the respondent states:

"We normally think about building capacity among VHTs to be able to implement the things we think they should be implementing in the community. Whether this is health promotion and education or treatment, sanitation and other things. The first thing we look at is building capacity among them to be able to put such things in place."

Notably, in the VHTs-Nindye interview with a VHT, when asked what he believed were the challenges of the VHTs, he states:

"Our VHTs also need to get a stimulus. Because other VHTs are old. They can't remember things all the time. So they need refresher courses."

Hence, it is without doubt that there is a need for training as VHTs continuously brought this out during group discussions, with a claim that they forget the details of their work, for instance, prescription of drugs or how to update their registers. It was argued earlier that VHTs fail to grasp healthcare skills, which compromises their quality of work. Training improves the capabilities of both VHTs and health workers, which gradually improves the CDIs Quality of Service and similarly influence the CSF Acceptable Quality of Service.

6.8.8 Poor Working Conditions

From the Literature read, it reveals that health workers experience poor working conditions characterized by poor pay and heavy workloads. So far, the findings also revealing that these conditions exist in the case study and extend to VHTs as well, with the result that poor work conditions affect the quality of service delivery in health facilities, as discussed, both in the vulnerabilities and assets section and the partner characteristics. The discussions further reveal that due to poor facilitation and funding, healthcare activities fail to be executed and limited resources and services challenge access to healthcare. As for heavy workloads, these create poor attitude, and poor work

ethics among health workers and VHTs. In chapter 5, in the discussion and evaluation, it was thought that these conditions would affect adoption of a service innovation. The Designers of mTrac experienced poor reporting habits from some health facilities which they believed was a result of lack of appreciation for data, as a result of poor work ethics and professionalism that was visible among health workers, as the respondent in the SP-1 interview (Health Systems Strengthening Specialist in UNICEF) states:

“What we are seeing is a lack of appreciation for data. Part of that comes from people not properly utilizing the data. We have quite a range of reporting rates by districts. We have some districts that are consistent 100%; other districts are at 30, 40, and 50%. Some of it comes down to district capacity and leadership. With the splitting of districts, there are a number of districts that don’t have biostatisticians or HMIS officers. And so that also translates down to facilities who are less likely to prioritize that. But we also have other districts that have very, very strong biostatisticians and strong leadership, but they are still struggling on maintaining good reporting rates. And again talking to them, one of the things that often comes up is that health centre staff don’t always appreciate how important this data is, and don’t utilize it themselves. And so this also distils over to our VHT program.”

Whereas health workers are qualified personnel, unlike VHTs they demonstrate poor work ethics which may be a result of poor working conditions and therefore influence Quality of Service, not only in healthcare delivery, but also in using mTrac, a challenge that threatens the CDIs Customer Retention and Quality of Service, which in turn affects the CSF Acceptable Profitability and Acceptable Quality of Service.

partners from the Telecom sector including telecom providers and regulator, these threaten the CDI Pricing with high service costs and disinterest in the development-oriented services.

The issue of the variables Limited Funding and Poor Governance that describe the structural partners will especially the ability for the partners to sustain the value network and therefore the CSF Sustainable Network Strategy. It is noted that financial investment, starts with donor agencies who assume the responsibility of initial investment and the governing institutions are responsible for the long-term service costs. However, due to limited funds, it is also noted that the Division of Investments does not favour the governing institutions that have limited funds. Thus, this arrangement does not favour the governing institutions whose resources and capacity are inadequate hence, it affects the CSF Acceptable Risks to social development.

As earlier discussed, fragmented Health Information systems that prevent System Integration directly influence Quality of Service that the two services need to offer and therefore compromises the CSF Acceptable Quality of Service. Poor Working Conditions, VHT Strategy and Lack of Political Will also affect end-users (VHTs and health workers), and jointly threaten two CSFs: (1) Acceptable Quality of Service and (2) Acceptable Profitability. These three variables can hinder potential end-users from accessing the services or fail to attract an end-user to the services. The variable Motivation of Telecom Industry describes the relationship between contributing partners of the services and the value network. It is evident that the lack of interest and motivation perceived from these partners in the value network raises the service costs, which correspondingly affects the price and customer base. In turn, these factors affect social profit as well as the value proposition for both partners and end-users.

On the other hand, there is a positive side; the variables limited funding, poor governance and poor working conditions benefit from the service innovations and m-Health reporting reduced reporting costs that governing institutions experienced with paper based reporting and improved supervision. Then, both VHTs and health workers expressed perceived value in the timely reporting from the services. Also, additional functionality to support training needs of both VHTs and health workers was identified, which would supported demotivation experienced by both end-users (health workers and VHTs). Indeed, the positive sector growth and development directly supports the CSFs Sustainable Network Strategy and Acceptable Risks, because this variable benefits the two negative variables Limited Funding and Poor Governance. Figure 6.22 below is a summary of the effect these variables have on the CDIs and CSFs.

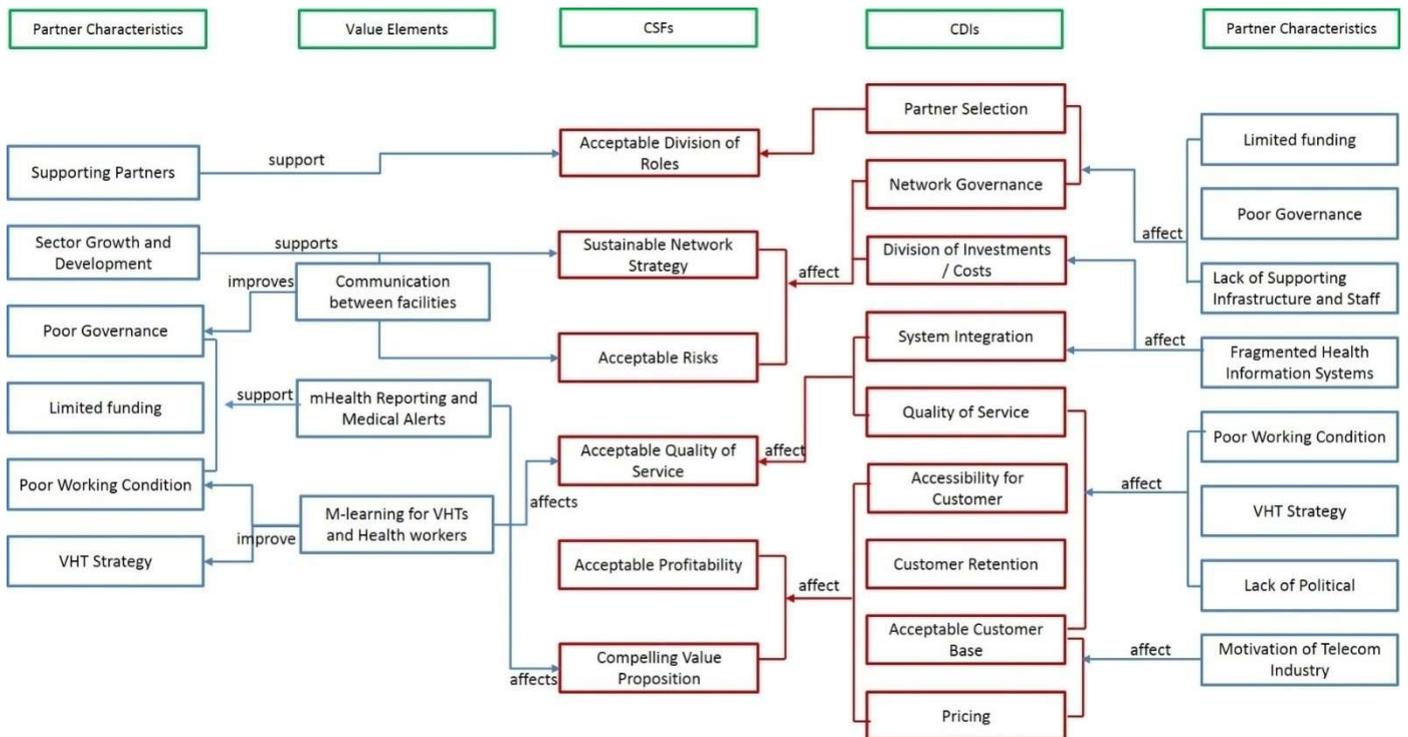


Figure 6.22: Evaluation of Business Model Partners (Source; Research)

6.10 Towards a Context-Aware Design Model: Contribution of the Empirical Research

Chapter 5 section 5.7, presents the first version of the context aware model, which contains the first set of identified design principles of a rural mHealth service innovation and its underlying business model. These design principles include value elements and actors in the value network. First, is presented the refined design principles and the relationships they create in value creation and sustainability, which is done by defining sources of value creation or healthcare needs. From these value elements are defined. From the value elements, the target group is identified (end-users) and partners in the value network (structural and contributing). A model is built with socio-economic structures and characteristics in the context that influence the ability for value elements to generate value and for the actors in the value network to sustain value. Included in the model, are identified strategies that counteract the effect of some of the socio-economic structures and characteristics.

The presentation of the model in chapter 5, summarized in figure 5.11 begun with sources for value creation in the rural areas and service partners. Then, value sources were identified from health care needs, which include: (1) long distances between poor communities and public or PNFP facilities due to limited numbers of health facilities and (2) limited drug supply and absenteeism of health workers. A conclusion was drawn that, providing remote healthcare services to remote areas could provide much needed services to remote patients while providing information services to community members on availability of drugs and health workers might improve quality of services. The first two sources of value creation were therefore termed as: (1) Access and Delivery of healthcare services and (2) Access to healthcare information. The literature also reveals that rural community members lack healthcare knowledge to prevent communicable diseases and reliance on cultural and traditional practices for healthcare. The third source of value creation was formulated and termed as: (3) Health Education on

health risks and disease prevention. The case study findings refined the first source of value from Access and Delivery of healthcare services to **Remote Monitoring**, due to the static nature of the SMS platform that does not allow face-to-face diagnosis and treatment of patients that is necessary in the medical profession and healthcare. Furthermore, the findings affirmed the need for the second and third sources of value **Health Education** and **Health Information**. The Literature review also reveals that due to fragmented programs and information systems in the healthcare system, there is need for, (4), improved management and decision-making, this defined as the fourth source of value. Using our experience from case study findings that revealed the static nature of SMS, this was refined to **Reporting and Medical Alerts**. As regards health facilities, these have a wide range of information system challenges and needs. However, because of the limitations of SMS, the value element were limited to Reporting and Medical Alerts. The fifth and sixth sources of value were revealed during implementation and evaluation of mTrac. These include: (5), **Communication Groups** and (6), **m-Learning**. Communication Groups emerged as a value element after health workers and VHTs expressed the need for easy communication between facilities and VHTs, as part of information and communication gaps existing in the healthcare system and also discussed in section 6.6.1 of this chapter. m-Learning has also been revealed as a need especially among health workers to support improved quality of services in the sector. It is from these design principles that we formulated some of the value elements were formulated that make up our two service innovations. The value elements appeal to different groups of people in the rural healthcare context, for instance, the first four (Remote Monitoring, Health Education, Health Information and Communication Groups) appeal to the community and health facilities, whereas the last two (Reporting and Medical Alerts and m-Learning) appeal primarily to partners, and to some extent to health facilities and VHTs. This stage leads us to the next set of design principles, which describe our target groups, as a set of design principles that demonstrate characteristics of the target groups that consequently influence value creation.

In a profit-oriented service innovation, the target group would include customers, whereas in a development oriented service innovation, the target group includes end-users and structural partners who must perceive value from the value elements. This is why the model categorizes value elements according to community and health facility values elements and partner value elements. The first design principle in this category identifies **end-users** and includes the same set of end-users that was identified in chapter 5. These include: (1) **Health workers** (2) **VHTs** and (3) **Community members**. The second design principle presents **structural and supporting partners**. These include: (1) **Ministry of Health**, (2) **NGOs and Religious Associations**, (3) **Donor Agencies** and (4) **Local Institutions and NGOs**. Notable is the fact that this set of partners has increased from those identified in chapter 5. From case findings, were Local Institutions and NGOs identified as supporting partners, from the FrontlineSMS project where local institutions and NGOs played supporting roles in funding and technical support.

Case study findings further increased the value of sources and target groups in the service design. As Literature gave the research its first view of a rural community and rural healthcare, case study findings have provided an in-depth view of end-users in the community and service partners. The findings also give the research an opportunity to conceptualize the value elements into generic strategic choices for rural healthcare and SMS based m-Health applications. The discussion leads to the refined core strategic choices as represented in figure 6.23.

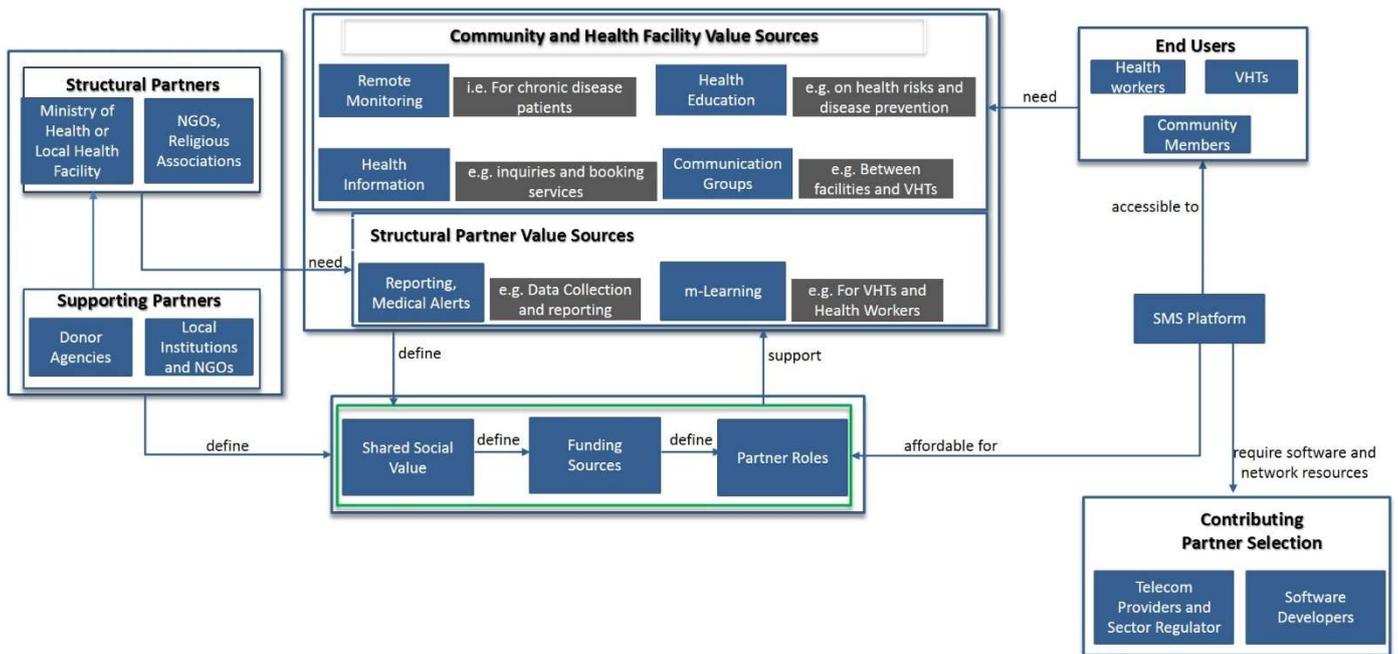


Figure 6.23: Core Service and Organizational Strategic Variables (Source; Research)

As observed, the model in chapter 5 includes socio-economic structures and characteristics that describe our target groups and might influence the ability for value elements to generate value end-user and for partners to sustain value. These are also the third set of design principles that begin with end-users, chapter 5 explores: (1) limited finances and number phones among community members and VHTs, (2) poorly facilitated health facilities, (3) demotivated health workers and (4) preference for unregulated healthcare providers among community members. Basing on case study findings and how the poor define their financial status, it was possible to refine the description of the financial assets of the poor from limited finances and number of phones to **Low Incomes and Earnings**. Community members also refined the description of the poorly facilitated health facilities to **inaccessible healthcare services**. Demotivated healthcare workers were bundled together with inaccessible healthcare services, a decision based on the perceptions of community members who presented this problem together with challenges that hinder their access to healthcare. Preference for unregulated healthcare providers was split into two new characteristics; the first indicates the presence of **Unqualified Healthcare Providers** who may influence healthcare access, and the second is that this is a **Traditional and Information Isolated Society**. Findings also revealed that the poor perceive themselves as a **Disempowered Community** especially because of their low incomes and traditional and information isolated status. From the study of VHTs, community members and health workers as end-users, it was able to formulate design principles that describe them as mobile phone and mHealth users. It was also observed that there is need to **Motivate and Attract End Users**. The value of mHealth services is intangible and must be demonstrated to the poor and health workers. Initially in chapter 5, limited finances had been aligned with number of phones. However, our case observations reveal that low incomes not only affect mobile phone ownership but also affects maintenance of phones for those with phones. Thus, a new design principle was formulated; **Ownership and Maintenance of phones**. Significantly, Mobile **phone Literacy** was observed among end users as a characteristic and design principle that affects value creation. In addition to these characteristics, case findings reveal end-user adoption strategies to overcome some of the challenges they face as mobile phone users. These

include: “**Mobile phone Sharing**” for those without phones and need to access mHealth services and “**Seeking Assistance**” from family and friends for those with mobile literacy challenges.

The fourth set of design principles are socio-economic structures and characteristics that describe and influence the ability for structural and supporting partners to sustain value as Chapter 5 identifies: (1) limited donor funding, (2) lack of political will from governing institutions to support healthcare programs, (3) poor governance and corruption in health system, (4) volatile nature of developing nations and states, (5) fragmented and overlapping governance and management in national health systems and (6) weak ICT infrastructure in health facilities. While literature reveals Limited Donor Funding, case findings revealed that structural partners also experience limited funding, and this was rephrased to **Limited Funding**. Also, observed were the effects of lack of **Political Will** and **Poor Governance**. Corruption was only visible at the community level and confirmed the presence and negative effects of **Fragmented Health Information Systems**. These cause poor record management and increase workload for health workers and VHTs. It was discovered that, weak infrastructure exists not only at facility level but also for the governing partner. Findings also reveal that in addition to weak infrastructure supporting personnel was also non-existent for both the governing partners and health facility. We therefore rephrased this design principle to **Supporting Infrastructure and Personnel**. However, it is also from this characteristic that the need for data collection and reporting comes from. There was a discovery of new design principles, for instance, the **VHT Strategy** that relies on the goodwill of VHTs and produces both positive and negative effects. On one hand, VHTs provide much needed healthcare services at the village level, on the other hand, lack of funding and facilitation for their activities caused demotivation and absenteeism among VHTs. Also identified, are **Poor Working Conditions** that are a consequence of **Poor Governance** and **Limited Funding**. This design principle causes demotivation among health workers.

What follows is the last set of design principles that describe the contributing partners who were separated from structural and supporting partners because their goals in the value network differs. Contributing partners are profit-oriented whereas structural and supporting partners are development-oriented. Chapter 5 identifies: (1) weak wireless security protocols, (2) Electronic storage and transmission of personal health information and (3) Poor competition and regulation in telecommunication sector. Regarding case findings, they were not able to ascertain **Poor Competition and Regulation in the Telecommunication Sector**, but it was possible to observe poor **Motivation and Attraction of the Telecommunication Sector** towards mHealth projects, a sector that plays a passive role in the value network with very limited responsibilities, costs and investment while receiving revenue from partners and end-users. Transmission of personal health information was not an issue since because no information transmitted included individual’s personal information. However, it was established that **Poor Network Coverage** did affect Quality of Service. Although findings do not reveal the last two design principles, they remain valid to the context-model. Next, is Figure 6.24 that presents all the design principles discussed and also demonstrates the effect each design principle has on value creation and sustaining value in the value network.

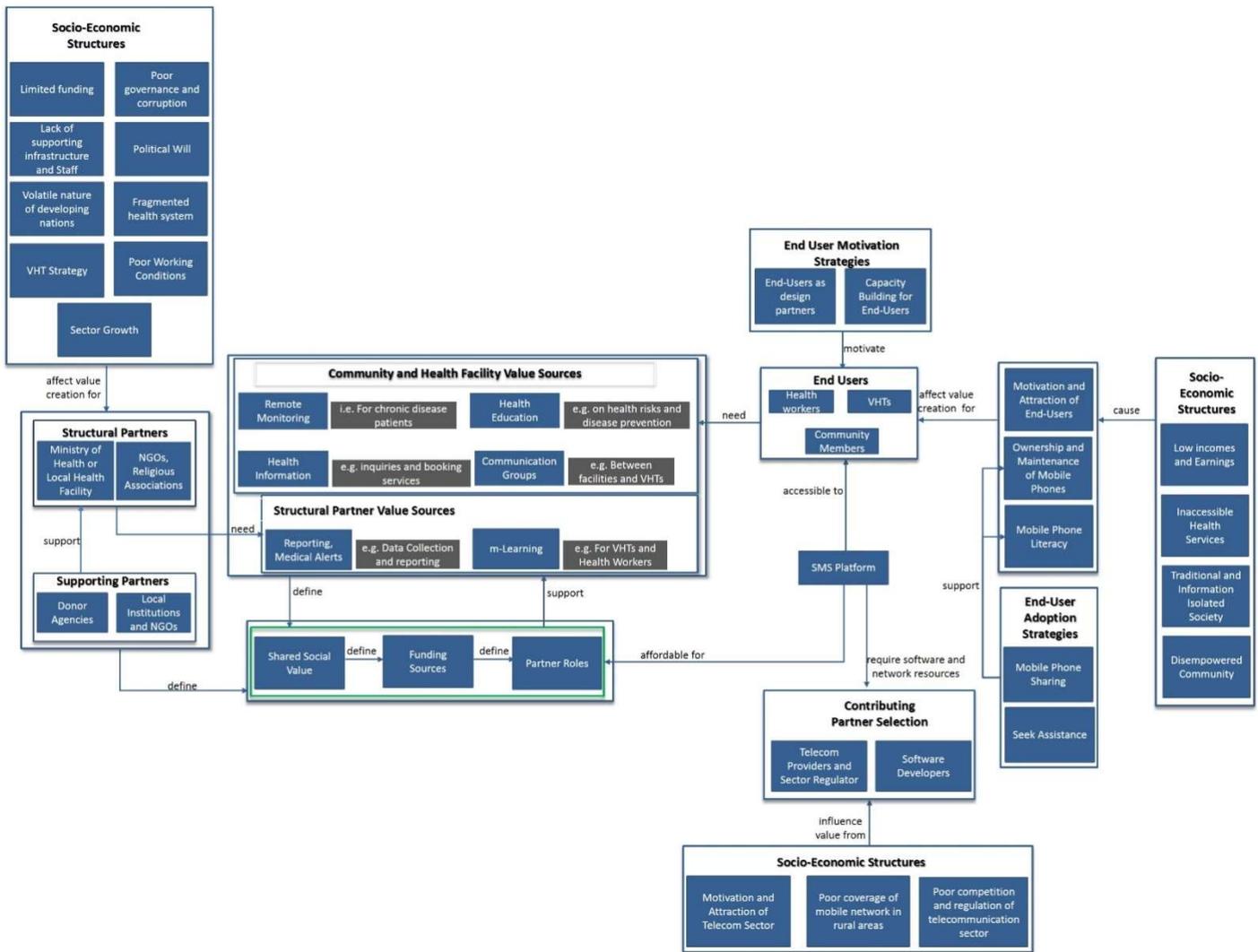


Figure 6.24: Context-Aware Model (Source; Research)

6.11 Conclusion

This chapter presents the findings from the case study. As observed, Literature in chapter 5 gives the research the first view of a rural context and the variables in the context that generate or influence value of a mobile service innovation. The findings have enabled the study to affirm and refine these variables as well as their influence on the business model of the service. It is important to note that the chapter refined these variables using the livelihood and STOF frameworks.

The result of this evaluation is the context-aware model, which is built upon the first version that the research developed from literature analysis. In this model, are two components; the first includes service, technology and organizational strategic choices, which guide the design process of an SMS-based m-Health service and its underlying business model. The second component includes variables that describe the socio-economic structures that influence the value creating ability of the strategic choices. Unlike, the first version of the context model in chapter 5, this model differs as it includes a third component, strategies that counter-act negative effects of socio-economic structures that particularly affect end-users.

In the next chapter, is a conclusion of this report given with a summary of the research that discusses research questions, theoretical framework and research methods. This discussion also highlights the limitations in the research that stem from the theoretical framework and research methods. Basing on the limitations made for future research.

7. Chapter 7 Conclusion

7.1 Introduction

This chapter concludes the main research thesis. Its purpose is to give an overview of the thesis with the intention of answering the final question and to assess if the objective of the research has been achieved. To fulfil this purpose, this chapter will start by providing an overview of each chapter and how each chapter contributes to the overall objective. Then, a discussion on each research question shall be given and the contribution made to the research. These two sections of the chapter should be able to fulfil the purpose of demonstrating the contribution of the research. Lastly, there will be a discussion on the limitations and recommendations for further research.

7.2 Overview of the Research

Chapter 1 introduced the research area and question. Because the research is exploratory, Chapter 2 provides a description of the domain the research explored. Chapter 3 presents and describes the theory that was used to explore the domain of the research and chapter 4 describes the methods deemed appropriate to collect data for the case study. Chapter 5 and 6 explore the domain by giving a livelihood perspective in more detail. It is noted that Chapter 5 begins the process of exploration using the initial domain description whereas Chapter 6 validates and refines the results of the initial exploration process analysed in chapter 5, from qualitative and quantitative case study findings.

As observed, Chapter 1 begins by introducing the subject area, which is ICT4D, sustainability and the lack of empirical based design research in the field of ICT4D to determine what works and what does not work. Since the research is exploratory in nature, the scope of study was narrowed down to m-Health service innovations in rural areas. Also, drawing on the call for a development perspective and business model implementation in the design of ICT4D, the chapter highlights two theories; Livelihood approach and Business Models, to explore a developing context and evaluate its viability in sustaining service innovations and supporting business models. Hence, the objective of the research is to *design a context-aware model that supports design and evaluation of an m-Health service innovation's viability in a developing rural context*. Its research question is therefore: *What social, political and economic characteristics in a developing rural healthcare context should designers, development practitioners and policy makers consider when designing a sustainable m-Health innovation for developing rural areas?*

The process of exploring a rural developing context begins Chapter 2 and further undertakes this task by describing the context which includes rural areas, their communities and a healthcare system. However, the added dimension of poverty creates characteristics and challenges to the three components in the context. In describing the context, the chapter undertook to describe the three components in relation to poverty, thus highlighting the unique characteristics and challenges that arise from experiencing poverty. However, the context components must be seen in relation to ICT4D and specifically mobile phones. The discussion further highlights the effect these unique characteristics and challenges had on ICT4D in developing contexts. A profile of m-Health applications that exist and the relationship they have with identified characteristics and challenges in the developing context is also presented. Relating the context to ICT4D artifacts begins the process of identifying opportunities and challenges to sustainability and value creation in the context. A description of rural areas and the

community presented a socio-economic profile that included education and literacy levels, a rural economy and the state of health of poor communities. From this analysis, the following factors were highlighted: (1), education and literacy levels, (2), low incomes, (3), rural infrastructure and (4), a high disease burden. Education, literacy levels and low incomes are indicators of the kind of ICT4D and mobile end-users one should expect in a poor community. The rural infrastructure points to the e-readiness of rural areas for ICT4D. Indeed, the high disease burden was indicative for mobile service innovation opportunities the research could take advantage of, especially the lack of healthcare knowledge among poor communities should be taken into account. In describing a rural health system, institutions were identified, structures, processes and programs that make up the system. In doing so, potential partners were identified to support the service innovation. Notably, were also highlighted challenges the system experiences. For instance, poor quality of service delivery and poor healthcare reporting systems which also reveal an opportunity for service innovation. It was also taken note to profile developing rural areas in general and related them to Uganda, where the case study area is located. This set the scene for the research to relate findings from the case study area (Nindye Parish and its health system) to similar developing rural areas.

In introducing the technology dimension to the discussion, there was ushering in of a description on the telecommunication sector. At this point, it is evident that this sector is separate from the context – a developing rural healthcare context, owing to the fact that the context is focused on social development whereas the communication sector is focused on economic development. This immediately raised the question on compatibility of the two sectors in one context.

Regarding the theoretical framework the research used to address the research problem, this was presented in Chapter 3. The framework emerges from Rural Development and Business Model fields. Then, development approaches are presented: (Poverty Reduction Strategy Papers, capabilities approach, actor-oriented approach, Participatory Rural Appraisal approach and Livelihood approach), that have been adopted in Rural Development and argue that the Livelihood Approach best reflects the bottom-up approach required to explain and predicting a developing rural area from the perspective of the poor in comparison to Poverty Reduction Strategy Papers and capabilities approach which are top-down kind of approaches. The actor-oriented approach and Participatory Rural Appraisal approaches that are bottom-up were considered inappropriate because: (1) the actor-oriented approach is best suited for evaluation and (2) the ambiguity of the Participatory Appraisal approach that focuses on description rather than on explanation and prediction. The livelihood analysis determines the needs, challenges and impediments of the poor. Needs are then translated into requirements, assumptions and specifications. Then, challenges and impediments were used to evaluate the viability of the service innovation. To translate requirements, assumptions and specifications into a service innovation with an underlying business model, Business Model tooling. Business Model tooling was adopted to provide methods to design and evaluate business models that include; CANVAS, E3-Value, CSOFT, BEAM, Allee's Value Network and STOF. CANVAS supports design, evaluation and analysis of services; however, focuses on single firms. Allee's Value Network examines exchanges in the value network in a single organization. Multiple partners operate our service innovation. E3-Value analyses value networks basing on economic value exchanges in the network. However, the service generates social and not economic value. CSOFT was created to operationalize Business Models. The research is limited to the design and evaluation. BEAM is a high-level design and evaluation tool that examines Business Model ecosystems and models. The perspective of this research is on a lower level that requires identification of variables that make up the context, which

leads to the business model that supports service innovation. STOF designs, evaluates and analyses mobile service innovations operated by multiple actors. STOF also starts with the end-users, developing the service and the business model through four interrelated domains (Service, Technology, Organizations and Finance). This approach is believed to be best suited to bottom-up approach in translating the requirements, assumptions and specifications into a service innovation with an underlying business model. STOF however was developed for profit-oriented service innovations and not development-oriented service innovations. There is also Social Entrepreneurship (SE) literature, which presents guidelines on strategic choices, value networks, value creation and value capture in development-oriented business models. SE together with STOF were used to identify design variables which underlie social, cultural and political structures (challenges and impediments) identified from the livelihood analysis and are used to evaluate viability of the business model. The end-result highlights requirements, assumptions and specifications as strategic choices for a rural m-Health service while the challenges and impediments are variables that influence viability of the service.

Next, is Chapter 4 which presents methodology the research used in an endeavour to understand a rural healthcare context, design and evaluate its service and business model. The methods selected respond to the theoretical framework used. To support the livelihood framework explain and predict a developing rural context, the research used Ethnography to study groups of people in their natural setting, and attempts to understand a way of life from the perspective of the people. The STOF framework designs and evaluates a mobile service innovation and its underlying business model using output from the Livelihood framework as input. The research employed Action Design Research (ADR), a research method that recognizes that an artefact emerges from interaction with the context, and combines the problem solving and reflection approach with the build and evaluation approach from Design Science. With these two approaches, ADR uses the output from Ethnography and Livelihood analysis as input to build, refine and evaluate the service innovation and its business model. The four stages: (1) problem formulation, (2) building, intervention and evaluation, (3) reflection and learning and (4) formalization of learning in Action Design Research were used to apply methods from both methodologies. Further, Ethnography methods (group discussions, observation during training sessions, interviews and participatory observation sessions during the implementation of the service innovation with end-users) were applied in the first two stages. To operationalize ADR, the STOF method was applied and used by ADR to design and evaluate the service innovation basing on the needs, challenges, impediments and characteristics identified using Ethnography methods, and analysed using the livelihood framework. STOF like ADR follows four steps; the first is the Quick Scan that developed a rough draft of the service innovation and its business model based on the livelihood analysis. The rough draft is applied and through evaluation is refined. The second step is Evaluation of Critical Success Factors, which starts with evaluation of the Quick Scan on paper and later after implementation. Specification of Critical Design Issues is the third stage that is done alongside the second stage and involves determining those variables that are crucial for service innovations. Evaluation is the final stage, which checks for robustness and the innovations ability to involve overtime. As for methods used, they include: (1), Meetings and discussions with stakeholders ,(2), participatory observation of training sessions ,(3), survey questionnaires ,(4), participatory observation of computer and mobile literacy classes and (5), mobile literacy tests.

Chapter 5 captures the Domain and Theory Application. It develops and evaluates the rough draft of the service innovation and its underlying business model and uses the domain description as input for

the livelihood framework. The output from this analysis is then used by the STOF method to design the service innovation on paper (Quick Scan). Literature is then used to describe poor communities and their assets according to livelihood framework criteria; as human capital, their financial status, natural resources available to them, social political / cultural assets available to them and healthcare facilities and services in their communities. From these descriptions, are identified characteristics, which are categorized as needs, challenges and impediments. Needs were defined as social value and therefore translated into value elements that make up value proposition of our service innovation. The community and health facilities, beneficiaries of the value proposition were defined as the target group. Challenges and impediments are classified as the description of our target and were used to evaluate the value proposition, which constituted our service design and evaluation. The service design together with domain data were then used to develop a technology architecture and literature was used to evaluate the quality of service the architecture is able to provide for the service. The architecture is made up of end-users that include community members and health workers, an SMS gateway (such as, FrontlineSMS) application on a computer, a GPRS modem and a mobile network. Community members access the service using personal mobile phones while health workers use the SMS application. Livelihood structures and processes revealed possible partners to own and support the service and these include: (1), Donor agencies such as, WHO, (2), Ministry of Health as the governing institution, (3) ,Religious Associations and NGOs and (4), Telecom providers. Using Organizational domain directions used in STOF, roles and responsibilities were assigned to the partners basing on the description provided by the livelihood analysis. Analysis of the Literature however revealed negative factors that affect the efficiency of these partners, which might affect value creation (social development), network sustainability and division of roles among partners, then used these to evaluate their ability to sustain the value network of the service innovation. Just as the technical architecture was developed from the service design, the financial model was developed from organizational arrangements. Also, partners with shared social objective (donor agencies, Ministry of Health and Religious Associations / NGOs) were assigned the roles of governance, funding and facilitation. It is also to note that service charges levied on community end-users reduces dependency on the partners. However, the partner characteristics listed previously also negatively influence the financial model especially in generating acceptable profitability (service maintenance costs). Further, analysis of livelihood strategies and outcomes reveals that there is a need to motivate the community to use recommended health facilities and dissuade them from using unqualified health providers through the Health education value element. However, personal preference for unqualified health providers may negatively affect the value proposition. Finally, the result of this analysis was a model that comprised of Strategic choices in m-Health service and business model design as well as variables that negatively influence value creation.

Chapter 6 presents case study findings. As noted above, the previous Chapter 5 identifies strategic choices that were used to design the service innovation and its underlying business model, and variables (characteristics) that were used to evaluate the viability of the service innovation and business model. In this chapter, knowledge of these strategic choices and variables was refined from case study findings. The chapter first presents the case study design of the research by a description of the case study area, which is the unit of analysis, presented in chapter 2. The units of observation in the case study design were discussed: Community members, VHTs, health workers and health facilities in and used by Nindye community (Nindye Parish Health Centre III and Nkozi Hospital that is a Health Centre IV and a referral hospital). The findings were compared with the same units of observation in

Nkozi area, which also used two service innovations in the case study area (mTrac and FrontlineSMS). The reason for this arrangement was because of a ban that had been placed by Ministry of Health on e-Health applications at the time. Both services are similar in architecture and functionality. MTrac is based on RapidSMS, a web-based SMS gateway that uses a GPRS modem to send and receive messages, whereas FrontlineSMS is a standalone application that also uses a GPRS modem to send and receive messages. Thus, field data collection was began with FrontlineSMS for the Problem Formulation, but used mTrac in its implementation stage to add knowledge to the FrontlineSMS building, intervention and evaluation stage. Findings from both applications were then used in the reflection, learning and formalization of learning stages.

Following the same structure as used in Chapter 5, analysis of findings first started with identifying vulnerabilities and assets in the case study. While literature was used to identify vulnerabilities in healthcare, the poor were asked what they believed were their healthcare needs through group discussions and interviews. The result refined our definition of needs, which was also recognized as social value and each of the needs then translated into value elements that make up the value proposition. These value elements refine the service design and the context-aware model highlights these as design principles to generate social value for a community. The Literature was also used to describe assets (human, natural, physical, social cultural, social political and financial). This time, the poor define their assets, their description refines variables that were used to evaluate the service innovation (FrontlineSMS). These variables are included in the context-aware model as socio-cultural structures that influence the viability of a service innovation. Case study findings did not only refine the context variables identified from literature, but also revealed variables not visible in literature. These were characteristics defining community members as mobile phone users. While ICT4D literature does describe the computer literacy abilities of community members, their abilities as mobile phone users was not clear. Findings also reveal adoption strategies the poor use to overcome their inability to use or access mobile service innovations.

Furthermore, Livelihood structures and processes identified in the case study were used to refine our organizational arrangements from chapter 5. The two service innovations revealed two levels from which a service innovation can be supported: National and local. MTrac is managed at the national level and therefore reflects partners identified from literature. FrontlineSMS managed at health facility level reveals that support from local institutions is possible in sustaining a service innovation and in both cases, it was evident that donor agencies were the driving force at the initial stages since they provided funds and facilitation for both innovations. There were also contributing partners from the private sector who also expanded to include telecom providers and software development companies. The refined organizational arrangements were then included in the model as organizational strategies to support the value network. However, concerns on the conflicting interests between the private sector and the public sector raised in chapter 2 and chapter 5 were affirmed in case study findings where telecom providers were seen to be disinterested in the service innovations. Regarding, structural and supporting partners' (including national, local, NGO and donor agencies), characteristics were also refined and expanded and these were then used to evaluate organizational arrangement and their ability to sustain a value network, then included these in the context-aware model as socio-economic structures that influence viability.

7.3 Research Questions

The overall objective of the research was to design a context-aware model that would support knowledge generation, design and evaluation of an m-Health service innovation. To achieve this, five research questions were formulated that all together generated the design model to be applied in service innovations in developing countries. In this section, all five research questions are discussed and how they contributed to the objective, by starting with the first question that was answered by chapter 2.

7.3.1 Composition of a Rural Healthcare Context

It was necessary to describe the context and use this to identify characteristics / variables that would make up our context-aware model. The first research question used literature to describe a developing rural healthcare context. The question states:

RQ 1: What makes up a developing rural healthcare context in which a mobile service innovation and its supporting business model is designed?

In response to this question, the research identified: (1) the major components that make up a developing rural healthcare context and (2) the generic characteristics that describe a developing rural healthcare context. The major components of the context include: (1) poverty and rural areas, (2) health, (3) a rural healthcare system and (4) a telecommunication industry in a developing country. It was in describing the state of each of these components that characteristics of the context were identified. Literature also reveals the influence these characteristics might have on individuals as ICT4D users and ICT4D artifacts.

The Literature examined described *Poverty and Rural Areas* as co-dependent. The three primary characteristics of rural areas: (1) remote locations, (2) sparse populations and (3) limited natural resources including land and water as catalysts of poverty. Remote locations of rural households and communities isolate them from basic socio-economic services and infrastructure. Of concern, is the fact that these remote and sparse populations do not attract service and infrastructure development in comparison to urban populations with active trade activities. On the other hand, rural populations are dependent on natural resources like land and water sustenance with low incomes, a state that does not attract services such as banks, markets, schools, health centres, roads, electricity or communication services. The result is low levels of education, literacy and incomes with poor infrastructure.

In the Literature that describes the status of *health* in developing rural areas; it reveals that the predominant characteristic is a high disease burden made up of primarily preventable and communicable diseases such as malaria, HIV/AIDS, tuberculosis and diarrhoea. Sources of the high disease burden are traced to the environment (the tropical climate is catalyst for malaria and diarrhoea), low income levels that fail to support healthcare needs and costs, behaviour caused by poor healthcare knowledge and a poor healthcare system.

Significantly, Literature does not only describe the composition of the *rural healthcare system*, but also highlights its characteristics which include: (1) the population the system serves, (2) the building blocks that include service delivery, health workforce, information, medical products, financing and leadership / governance, and (3) incorporated programs and processes. The population served by the system is described using the context components: (1) poverty and rural areas and (2) health. The

Literature further describes the healthcare system as governed and facilitated by Ministry of Health and healthcare services are delivered through public and private health institutions. Private institutions include Private Not for Profit (PNFPs) institutions and private profit-oriented institutions. PNFPs are governed by Religious Associations and NGOs but in collaboration with the Ministry. It is noted that private facilities are autonomous. In addition, there are two major programs through which healthcare services are accessed and delivered: Primary Healthcare and the District Healthcare System. The Primary Health Care Approach was adopted from WHO and is operationalized by the District Health System. These two programs use a hierarchical structure starting at the village level where VHTs who are volunteers are the first contact for individuals and households providing basic healthcare information and targeted treatment. The second and third levels are found at the parish level and may have a nurse, midwife and clinical officer, also providing targeted and specific treatment and information. The fourth level is a more specialized general hospital at the sub-county or district level. There are also regional and national hospitals that act as points of referral for the lower level health centres. Lastly, supervision and reporting in the sector use this structure with all reports sent to the district, which forwards them to the Ministry.

In the examined literature, several challenges are revealed within the system. The first is quality of services provided to a rural population. The poor facilitation and governance of health facilities compromises quality of services provided by particularly public health facilities. Poor pay and understaffing creates poor attitudes from health workers and perceived high costs in the private health sector prevent poor households from accessing healthcare. The second challenge is poor reporting due to a lack of facilitation and fragmented health information systems, a result of multiple governing bodies (for instance, the Ministry governs public facilities but also governs PNFPs which also is governed by Religious Associations or NGOs), vertical programs such as HIV/AIDS, maternal health and vaccination supported by donor agencies which report separately to these agencies, the Ministry and Religious Associations. Discussions on all context components reveals that opportunities for m-Health service innovations arise from the challenges experienced in the rural healthcare context: (1), behavioral change applications especially on HIV/AIDS health education, (2), health promotion application on disease prevention, (3), drug adherence reminders for example, for TB patients, (4), disease surveillance applications for instance tracking malaria infections and treatment and (5), drug supply and stock outs in health facilities. Existing m-Health innovations reflect these with applications that focus on, (1), education and awareness, (2), remote data collection, (3), remote monitoring, (4), disease and epidemic outbreak and tracking, (5), communication and training for health workers and, (6), diagnostics and treatment support.

After describing a rural healthcare context, attention then focused on *The Telecommunication Industry*, a sector which gives m-Health innovations access to mobile networks and therefore is a determinant in the success or failure of the service. Literature further reveals that the sector in Uganda, like most developing countries has a vertically integrated operator industry. This means that the backbone infrastructure is privately owned by private investors who predominately use expensive satellite connections, and as the backbone operators, charge profit-oriented fees for access to their gateways. This in turn creates expensive services for low-income earners. Coupled with poor regulation, the industry provides expensive services that favor urban users over rural users. The mobile phone is the most widely available technology in the market because mobile phone infrastructure is cheaper and easier to set up than fixed line infrastructure. Internet technologies have borrowed a leaf from the mobile sector and use Wi-Fi technologies to achieve last mile connectivity for end-users.

Significantly, market demand demonstrates end-user preferences, and although service costs are high, mobile phone services have a high demand from the market among the poor. Also, internet subscription is however low and mostly limited to urban users.

The domain description has made two major contributions to the research and therefore to the objective. The first is that it revealed generic characteristics that might create opportunities and challenges for a service innovation. It therefore highlights areas the research needed to focus on during the design and evaluation process. Major concerns especially on the compatibility of the private sector (telecom sector) with the public sector (health sector) became visible from the domain description. The second contribution is that the description provided a generic profile of a developing rural healthcare context, which guided the research in selecting an appropriate case study area (Nindye Parish healthcare system) and the accompanying service innovations. This profile was later used to select appropriate units of observation based on the generic description in chapter 2 provided. These include: (1), the community (population served), (2), the health facilities, resources, health workers and (3), healthcare programs (Primary Health Care and the District Health System) currently in progress in the health system.

7.3.2 Theory Selection

In response to the first research question, those challenges that m-Health services can and has attempted to improve are identified and referred to as opportunities to include: (1), behavioral change applications especially on HIV/AIDs health education, (2), health promotion application on disease prevention, (3), drug adherence reminders such as, for TB patients, (4), disease surveillance applications, for instance, tracking malaria infections and treatment and (5), drug supply and stock outs in health facilities. Also identified, are those challenges and characteristics that might influence the viability of an m-Health service that include: (1), illiteracy and functional illiteracy, (2), low incomes and earnings and (3), poor infrastructure, (4), limited knowledge on healthcare practices, (5), poor quality of healthcare services, (6), poor reporting systems, (7), high telecom service costs and (8), poor sector regulation. However, this profile describes poverty, but not how poverty is caused so as to develop strategies for development. Development gives direction on how to improve the state of the poor. There is therefore a need to select an appropriate development theory to introduce a development perspective to the description of poverty. A theory presents points of reference to define research material. In applying development theory whereas the research would define the variables discovered in the literature from the perspective of development. On the other hand, the description also suggests possible influences, challenges and characteristics that arise from poverty might have on a service innovation. There is also a need for Business Model tooling to determine the effect these variables might have on service innovation and Business Models demonstrate the viability of a service innovation. Thus, in addition to selecting appropriate development theory, there is need to select appropriate Business Model tooling that will use the variables identified to design and evaluate a mobile service innovation and its underlying business model. It is noted that this question was answered by the second part in the research that is discussed in the next section.

RQ 2: What Rural Development Theory and Business Model tooling is appropriate to support the design and evaluation of a mobile service innovation in a developing rural healthcare context?

In answering this question, the research outlined theories and methods from Rural Development and Business Model tooling. Secondly, in selecting the appropriate theory and method from Rural

Development paradigm, the study sought for a theory that could define social value from the perspective of the poor (a bottom up approach). The research further discussed prevailing Rural Development theory including: (1) Capabilities Approach, (2) Poverty Reduction Strategy Papers, (3) Actor-Oriented Approach, (4) Participatory Rural Appraisal and (5) Livelihood Approach. Capabilities approach focuses on the grassroots in poverty measurements (individuals and households). Poverty measurements and strategy development starts with the capabilities of individuals or households, measuring the abilities of individuals, for instance, literacy, health or emotional state. Strategies are then developed depending on these inabilities. While the approach can be applied at the grass roots, it however does not give the research the opportunity to define poverty from the perspective of the poor, which does not also enable the research to determine what is of value to the poor. The poverty reduction strategy papers are macro-level methods used to describe a country's macro-economic structure, social policies and programs for a given period in order to create strategies for broad-based development that takes into account sectors, for instance, agriculture, public infrastructure at the national level and target development programs for priority areas. However, this is a top-down approach, which defines poverty from the perspective of development agencies and government institutions, but not the poor. Of concern, is a danger of defining social value from the perspective of the elite, and failing to provide value to end-users of the service innovation. The actor approach defines all stakeholder in a poor context (the poor, key institutions and individuals) as actors, and participants and attempts to solicit the perspective of each actor by mapping information flow and analysing those linkages. While this approach presented the research with a bottom up approach, it was however developed to be applied after a poverty alleviation strategy has been applied and not before. Therefore, it measures value afterwards.

Therefore, there was need for a research approach and method that would guide the design and evaluation process, by defining value before application and therefore guide the design of the application and its business model. Participatory Rural Appraisal is a family of approaches and methods that transfers all powers of poverty definition and alleviation from the "outsider" to the poor, a method that involves mapping and modelling of important resources in the locality, transact within the village to observe, listen and map, matrix scoring, well-being and wealth ranking. The locals together with the researcher did all this. This was however, the first attempt by researchers to define poverty from the perspective of the poor and therefore is focused more on general description but fails to identify specific variables that can be translated into a strategic poverty alleviation plan, hence this approach was perceived as more descriptive, and neither analytical nor providing the research with a concrete solution to our design and evaluation needs. This led to turning to the last approach; the livelihood approach which is a by-product of bottom-up, Participatory Rural Appraisal approaches and the Environmental Sustainability concept. It attempts to understand poverty from the perspective of the poor by mapping out means by which people sustain livelihoods. The approach further identifies causes of poverty in the context referred to as vulnerabilities in the context, assets the poor have at their disposal to overcome those vulnerabilities and institutions, programs and policies that influence how the poor use these assets as they attempt to overcome their vulnerabilities. Actions and decisions taken by the poor to overcome their vulnerabilities are referred to as livelihood strategies whose to sustain a livelihood is measured from the livelihood outcomes. The research selected this approach as the most appropriate because: (1) poverty is defined from the perspective of the poor and (2) it provides a mature method to identify and analyse poverty variables (vulnerabilities, assets, livelihood

structures, livelihood strategies and livelihood outcomes). From these findings, the research identified needs, challenges and impediments that were later on translated into design and evaluation variables.

It is of concern to note that, after selecting the livelihood framework, the study shifted focus to Business Model tooling. Here, the research needed to identify a tooling that could use the opportunities, challenges and characteristics as input to design and evaluate a mobile service innovation and its business model. The tooling must take into consideration the ecosystem of a mobile service innovation in designing the business model and considered the following Business Model toolings: (1) CANVAS, (2) Ballon's Approach, (3) E3-Value Methodology, (4) CSOFT, (5) BEAM, (6) Value Network Analysis and (7) The STOF Framework. The first, CANVAS uses nine building blocks to design and evaluate single firm service innovations, however, this was not appropriate for our research that intended to design a mobile service innovation that depends on multiple partners to operate. The second, Ballon's Approach focuses on categorizing Business Models whereas this research requires design and evaluation. And as for E3-Value Methodology is used to evaluate economic value of value chains, and whereas this answers the need for evaluation, it does not answer the need for design. This tooling also focuses on economic value, yet this research needed to evaluate not only economic value but also social value in the value chain of our business model. CSOFT uses five components, customer, service, finance and technology to understand and describe a service innovation. However, CSOFT is used to operationalize a business model, which deviates from our research objective. BEAM is used to analyse business model ecosystems and modelling. This also deviated from the research objective. Value Network Analysis examines the inter-organizational exchanges that create value in value chain. It is vivid that the model also focuses on single firm innovations like CANVAS and was therefore not appropriate for a research objective. Thus, the STOF framework was the most appropriate for the design and evaluation of a mobile service innovation. It uses four interrelated domains, service, technology, organization and finance, each with design and evaluation variables that indicate the influence they have in the domain and to other domains. It was important to note that while the STOF was appropriate for our design and evaluation needs, it was developed for a profit-oriented context. Therefore, to adopt the design process to a developing context, Social Entrepreneurship gave the research guidelines on strategic choices (a clear social objective, incorporating social responsibility and public institutions), the value network (using the resource needs an opportunity to expand the value network) and creating and capturing value (integrate "customers" or target group into the social value network). The research at this point had two theories to guide analysis, design and evaluation; the livelihood framework identify needs, challenges and impediments, and STOF to design and evaluate the service innovation and underlying business model.

It is also evident that apart from selecting appropriate theories, the discussion also demonstrates how the theoretical framework contributes to the four Design science principles: (1) Rigorous design processes, (2) Design Evaluation, (3) Research contributions and (4) Communication of Research. The first two principles contributed to by the primary functions of the theoretical framework, that is to say, identification and analysis by the livelihood framework, design and evaluation by STOF. The livelihood analysis contributes to rigour by "explaining and predicting" what is of value and what breaks the value chain in rural healthcare. The STOF framework uses these as inputs to design and evaluate the initial service innovation and business model, which contributes the first principle; rigorous design process. The livelihood framework also defines the desired end result (social value) for all stakeholders to the problem / opportunities and challenges in a rural context. In addition, the STOF framework is used to evaluate the service innovation, and this contributes to the second principles; design evaluation. By

relating the opportunities, challenges and characteristics to demonstrate value creation / value capture and negative effects to this value, the research developed a context-aware model. Notably, this is the research contribution that is communicated.

7.3.3 Research Design

While theory presents references from which research material can be defined, methodology presents steps to systematically solve a problem. Thus, in the third research question, there is a discussion of the methodology used by the research to systematically understand a rural developing context and also use the knowledge attained to design and evaluate a service innovation, as discussed in the next following section.

RQ 3: What methods can the research use to understand a developing rural healthcare context while evaluating the viability of a mobile service innovation in the context?

The previous research question identified development theory to describe poverty and a rural healthcare context and Business Model tooling to design and evaluate a service innovation and its underlying business model. The Methodology selected complimented the function of each theory and its method of application and Ethnography tries to understand and describe and explain a way of life from the perspective of the native (Eisenhart, 1988) and further compliments the livelihood framework. Hence, the research used this methodology to understand and describe poverty and rural healthcare from the perspective of the poor, thereby used: (1) community group discussions, (2) observation of VHT training sessions, (3) interviews with health workers and community members, (4) participation in community health outreach exercises, (5) supervisor reports on VHTs, and (6) participatory observation of m-Health and mobile literacy training sessions.

It is significant to note that Action Design Research (ADR) was used for the purpose of design and evaluation of the service innovation and its business model. ADR is a combination of Action Research and Design Science and ADR recognizes that the design of an artefact is shaped by the context it is designed for, an aspect that reflects the bottom-up approach recommended by Sutinen and Tedre (2010) for ICT4D designs, scholars who argue that, it fosters ownership of the artifact since it has been designed basing on inputs from the context. ADR uses four stages to do design artefacts: (1) problem formulation, (2) build, intervention and evaluation, (3) reflection and learning and (4) formalization of learning. In the problem formulation stage, the theoretical framework was applied, followed by analysis of the domain using the livelihood framework and then identified the first needs and stakeholder characteristics. Needs were then translated into design variables that makes up a service innovation and its business model, and stakeholder characteristics were translated into socio-economic structures that were used to evaluate the service innovation and business model. In the building, intervention and evaluation stage, the service innovation was implemented into the context. This is modified and based on the reactions of stakeholders in the context. Of paramount importance is to note that this stage used Ethnography methods outlined previously to determine perceptions of stakeholders. We then used the livelihood framework to refine definition of stakeholder needs and characteristics and STOF to modify our service innovation and business model. The third and fourth stages, reflection, learning, and formalization of learning used the Critical Success Factors (CSFs) and Critical Design Issues (CDIs) in the STOF framework to evaluate opportunities, challenges and characteristics identified from the social, political and economic structures in a rural healthcare context. Significantly, the context-aware model was culminated of the stages discussed above.

There was also the STOF method, which was used in ADR and for the design and evaluation process. The STOF method has four steps: (1) the quick scan, (2) evaluation with CSFs, (3) specification of CDIs and (4) evaluation. In the quick scan, a rough draft of a business model for the service innovation is developed. This stage used output from the domain analysis in the problem formulation stage to develop the four domains of the business model. Evaluation of CSFs and specification of CDIs is done during the building, intervention and evaluation stage and the first service design from the quick scan was implemented in the context. Using reactions from the building, intervention and evaluation stage, the service innovation and business model are evaluated, processes that result in refined opportunities, challenges and characteristics from social, political and economic factors in rural healthcare. Finally, in the evaluation stage, was presented the context-aware, demonstrating the effect identified opportunities, challenges and characteristics to value generation.

7.3.4 Theory to Design

Whereas the first three research questions laid the foundation for designing the context-aware model, the last two are responsible for developing it. There was need to identify those social, economic and political factors which are termed as opportunities, challenges and characteristics in a developing rural healthcare context that influence social value generation. This led to the fourth research question that began this process as discussed in the next section.

RQ 4: What social, economic and political characteristics in a generic developing rural healthcare context might influence the viability of a mobile service innovation?

An attempt to answer this question began by applying the theoretical framework developed from Research Question two to the domain description developed from Research Question one, the analysis was started with the livelihood framework, which, as earlier discussed, is divided into four sections; (vulnerabilities, assets, livelihood structures, livelihood strategies and livelihood outcomes). Analysis in this framework starts with vulnerabilities and assets (Duncombe, 2006).

Then, relationships between assets and vulnerabilities were used in the rural healthcare to determine the healthcare needs. These include: (1) access and deliver healthcare in remote areas, (2) access to healthcare information, (3) deliver health education on health risks and disease prevention, and (4) management and decision making in health system. Healthcare needs were translated into social objectives / value as the social objectives that Social Entrepreneurship (SE) recommended must be clearly defined. Then, applied the STOF framework, by translating the social objectives to value elements that include: (1) Remote service delivery, (2) information inquiries, (3) health education services, and (4) data collection and reporting. Value elements are the first set of design principles that make up our context-aware model. Then, the value elements were used to identify target groups or end-users that can be found in a developing rural healthcare context. Target groups include: (1) community members, (2) health workers, and (3) VHTs. The STOF framework requires that a target groups be described. A developing context creates a unique environment that determines how end-users will respond to a service innovation. Thus, the process of describing end-users was began in relation to the unique developing context using data from chapter 2 and asset descriptions. The community was then described as having: (1) manual labourers, (2) subsistence farmers, and (3), low income earners. For Health workers, they were described as: (1) demotivated, overworked and underpaid, and (2) working in poorly facilitated health facilities. Literature was silent on VHTs hence the research used these descriptions to determine the effect VHTs may have on the ability to sustain

value creation for the target groups, specifically on the CDIs, Accessibility for Customers, Pricing and the CSF A Compelling Value Proposition. The first set of design principles are summarized in table 7.1 below together with design guidelines.

Table 7.1: Service and Technology Design Principles

| Service | | | | | Technology | |
|--------------------------------------|---|----------------------------------|--|--------------------------------|---|--|
| Design Guidelines | Design Principles | | | | Design Guidelines | Design Principles |
| Social Entrepreneurship Social Value | Access and deliver healthcare | Access to healthcare information | Deliver health education on health risks and disease prevention | Management and Decision Making | Accessible & Affordable | SMS platform |
| Value Elements | Remote Service Delivery | Information inquiries | Health education services | Data Collection and Reporting | Applications in the mHealth market | SMS gateways |
| Target Group | Community Members | | Health Workers | Health Workers and VHTs | Access Network and Backbone Infrastructure | Mobile Network |
| Target Group Definition | 1) Manual labourers 2) Subsistence farmers 3) Low incomes | | 1) Poorly facilitated health facilities 2) Demotivated health workers that are overworked and underpaid | | Access Network and Backbone Infrastructure Definition | 1) Poor network coverage in rural areas 2) Weak security protocols 3) Storage and transmission of personal information |

From the above table, it is vivid that the technology architecture was developed based on: (1) technologies and services available in the telecommunication sector, (2) m-Health applications readily available in the market and (3) the requirements of the value elements identified in the service design. The architecture was based on the SMS application because it is widely available to all mobile phone users. M-Health designers have also developed SMS platforms (FrontlineSMS and RapidSMS) that enable sending and receiving messages from a computer using a GPRS modem. Using this platform, health facilities can communicate to community end-users and set automated responses to inquiries sent to the facilities by community end-users. The technology domain is also uniquely affected by a developing context just as domain and literature was used to determine the unique characteristics that were identified as potential influencing factors in delivering value to end-users (community members

and health workers). These include: (1) poor network coverage in rural areas, (2) weak security and transmission and (3) storage and transmission of personal information. These are also summarized in table 7.1 together with the design guidelines that was used in the technology domain.

After the design and evaluation of the service and technology domains, focus was shifted to livelihood structures and processes, which were developed to the second set of design principles that make up the context aware model. Structures are public, private and non-governmental organizations that set and deliver policy, while the processes are the political, economic, social, legal and cultural mechanisms that govern how structures interact with groups and individuals (Duncombe, 2006). From this section, were identified partners that would support the service innovation. Then, social Entrepreneurship guidelines were used to select structural, supporting partners. It is vivid that these guidelines require that selected partners have the same social objective as the service innovation intends to achieve, and these were referred to as structural and supporting partners: (1) Ministry of Health who are assigned the role of network governor, and (2) Religious Associations / NGOs who govern private not for profit health facilities. Supporting partners include donor agencies who are assigned the role of initial funders and investors. Also, contributing partners were selected based on the technology domain requirements. Significantly, Literature revealed characteristics that define these partners in a developing context and these were used to evaluate their ability to sustain value creation in the value network. There were also structural partners who were described as: (1) lacking in political will, (2) poorly governed, (3) existing in volatile states, (4) operate fragmented healthcare information systems, and (5) with weak ICT infrastructures at their health facilities. Supporting partners, these were described as limited in funding. Contributing partners that include telecom providers were described as poorly regulated with poor competition. Finally, these characteristics were used to determine the effect they might have on the CSFs Sustainable Network Strategy and Acceptable Division of Roles. These are summarized in table 7.2.

It is essential to note that Design principles formulated in the financial model depend on the design principles that were formulated from service, technology and organizational domains, as summarized in table 7.2. Sources of funding were defined. CDIs like Pricing, Division of Costs and Revenues are crucial to determine financial sustainability, especially for a development-oriented service innovation. The challenge is, depending on community end-users that can barely sustain basic healthcare costs, health facilities that are poorly facilitated and governing institutions with limited funds and capabilities to govern the value network. It should be taken into account that Donor funding is short term and cannot be depended on for long-term sustainability. However, there can be a Division of Costs between end-users and partners. Equipment and installation costs can be assigned to donor agencies (supporting partners). Recurring maintenance and service costs can be assigned to governing institutions (structural partners) and service access costs can be assigned to community end-users. The second challenge arises from sharing of revenues in the Division of Costs and Revenues. While all the costs are shared among partners (structural and supporting) and end-users, contributing partners (telecom providers) who do not contribute to costs affect the CDI Valuation of contributions and benefits. This creates an imbalance in a business model that is already challenged by social, political and economic impediments experienced by end-users, structural and supporting partners. In turn, these social, political and economic challenges affect CSFs a sustainable network strategy, acceptable division of roles and responsibilities, acceptable risks and acceptable profitability.

Table 7.2: Organization and Financial Design Principles

| Organizations | | | | Finance | |
|--|---|--------------------------------|---------------------|---|--------------------------------------|
| Design Guidelines | Design Principles | | | Design Guidelines | Design Principles |
| Social Entrepreneurship Shared Social Objectives | Structural Partners | | Supporting Partners | Source of Investment | Structural and Supporting Partners |
| | Ministry of Health | Religious Associations / NGOs | Donor Agencies | | |
| Access to Mobile Network | Contributing Partner | | | Source of Cost and Risk | Governing Institutions and End-Users |
| | Telecom Providers | | | | |
| Partner Roles and Responsibilities | Structural | Supporting | Contributing | End-users, Structural and Supporting Partners | Governing Institutions and End-users |
| | Network Governor | Initial Funding and Investment | Network Traffic | | |
| Partner Description | <ol style="list-style-type: none"> 1) lack of political 2) poor governance and volatile nature of developing nations 3) fragmented health systems 4) weak ICT infrastructure in health facilities 5) limited donor funding 6) Poor competition and regulation of telecommunication sector 7) Low incomes among end-users | | | | |

The first analysis gives the research the first opportunity to observe how appropriate the theoretical framework is to this area of study. The livelihood framework was supposed to describe the context, which includes: (1) poverty and rural areas, (2) health, (3) the rural healthcare system and (4) the telecommunication industry. However, the livelihood framework and approach primarily describes the way the poor live their lives (Ashley and Carney, 1999; Brocklesby and Fisher, 2003). There are four components of the framework: (1) vulnerabilities and assets, (2) structures and processes, (3) livelihood strategies and (4) livelihood outcomes are designed to understand and describe poverty for individuals and households in a specific context. It should be noted that the livelihood analysis is representative of poverty for poor communities in rural healthcare, but is not representative of institutional and organizational contexts where end-users structural, supporting and contributing partners are found. While the livelihood analysis did identify these institutional stakeholders, evaluation of these stakeholders depends on literature description, which does not give an accurate description and understanding of their role and contribution to the value network, and this therefore affects the Business Model analysis of the partners.

It can be seen that the design and evaluation process was affected by the gap in the livelihood analysis. As argued, service design depends on identifying “value” (Bouwman, De Vos and Haaker 2008). Identifying the needs of the poor assists in identifying social needs and therefore the social value from

which the service was designed. The service domain requirements were used to develop the technical architecture. Although there was guidance by Social Entrepreneurship in partner selection, apparently there is a need to determine partner resources and capabilities. Secondly, because partners are not part of rural poverty, the social value identified by the livelihood analysis may not be considered value to the partners.

7.3.5 Refining Context Variables

In the first analysis, the first stage was fulfilled in Action Design Research, problem formulation and the first stage in the STOF method and the Quick Scan. To complete the design processes, the service innovation was applied in a case study developing rural healthcare context. Design activities included stakeholder participation in description of social needs and objectives, implementation of service and evaluation of service. The results of these design activities are discussed in the next section where there is an outline of those social, economic and political factors that were discovered in the context that did have an influence on viability of the service innovation.

RQ 5: What social, economic and political characteristics in a case study developing rural healthcare context influence the viability of a mobile service innovation?

The purpose of this research question was to determine if the social, political and economic characteristics identified in literature exist in a natural setting (context) where a service innovation is implemented. The initial design was applied in case study rural healthcare context (Nindye Parish and Nkozi Hospital), a process that started in 2010 and ended in 2013. During this time, identified stakeholders were involved; community, health workers and health facilities, a Religious Association (Uganda Catholic Medical Board), Ministry of Health and two donor agencies (UNICEF and Malaria Consortium). Group discussions were used, observation sessions, participatory observation sessions, interviews, supervisor documentation and surveys to study the service innovation and the context. Two objectives were to be fulfilled; the first was to determine if the social value identified from literature exists in the case study and the second was if the characteristics identified from literature do exist and if they affect viability of the service innovation. Two service innovations were examined; mTrac, which is operated by Ministry of Health together with national medical and pharmaceutical agencies and supported by donor agencies and international development partners, and FrontlineSMS which is operated by Nindye Health Centre III, supported by international development partners (Ford Family Program) and local institutions, such as, Uganda Martyrs University.

Analysis of the domain identified the first context-aware model made up of the first identified design principles for a rural m-Health service innovation. Further, case findings were used to affirm or refine these design principles. Within the service design, one social objective was refined and introduced two new social objectives. Access to and delivery of healthcare to remote areas was refined to remote monitoring. When the limitations SMS and the conservative nature of healthcare were realised, it was advisable to narrow down this social objective to remote monitoring of chronic diseases, such as HIV/AIDs and tuberculosis. We realized that there were communication gaps existing within the healthcare system, especially between health workers and VHTs hence suggested that communication groups could be of value to the health system. It was also realized that on-going training of VHTs and health workers could be supported by m-Learning services, hence adjusted our context-aware model value sources to include: (1), remote monitoring of chronic diseases ,(2), health education, (3), health information ,(4), communication groups ,(5), reporting and medical alerts and (6), m-Learning. The

target groups (end-users) remain the same as those identified in the first analysis. These include the community, health facilities and the governing institutions. However, it must be noted that value elements target different stakeholders in the rural healthcare implying that, value proposition differs, consequently creating a challenge in an attempt to gain end-user and institutional support for a service innovation.

The list of partners also increased but structural partners (governing institutions, Ministry of Health and Religious Associations) remained constant. However, findings reveal that supporting partners may include local institutions, as revealed in the design of FrontlineSMS, which was applied at a health facility level in the healthcare system. The contribution a local university made to the development and maintenance of the system as part of corporate social responsibility was observed and this filled in a gap in the value chain of FrontlineSMS, whose owner, Nindye Health Centre III does not have the resources and capabilities to develop and maintain an m-Health service. Contributing partners also increased. Significantly, in the design of mTrac, mobile and software development companies participated in the development of the service.

Further, the target group characteristics identified from literature were refined and in some cases, new dimensions were observed that influence viability of a service innovation. The financial asset was refined to low incomes and earnings while physical assets (healthcare facilities) were refined to inaccessible healthcare services. As for the social cultural asset, it refined to a traditional and information isolated society whereby community members defined themselves as disempowered due to the low incomes and earnings and isolation from information. This therefore came up as a new definition of human capital, though the social political asset remained the same. Summarily, asset description was used to define our target groups.

It is also essential to note that the findings did not only refine the asset description, but also revealed dimensions to the target groups as mobile phone and m-Health end-users that are a consequence to poverty. The first dimension was that end-users (community members, VHTs and health workers) had to be motivated to use the service though it was clear that the poor had access to unqualified providers that they perceive affordable and more accessible than public and PNFP services. It is vital to motivate them, not only to use qualified health services but a service innovation that is associated to the same facilities and requires that they incur a cost in using the service. The existing heavy workloads demotivate health workers and VHTs and by introducing the service innovation, it adds to their daily activities. There was also evidence that they perceived the data collection and reporting as increased workload for which they are not paid for, hence, of necessity for m-Health designers to develop strategies that motivate end-users in adopting the service. The second dimension was ownership and maintenance of a mobile phone. Whereas literature indicates that mobile phone ownership is minimal due to limited incomes, findings reveal that this extends to maintenance and those who own phones also find it a challenge to maintain them. Challenges include: charging phones, purchasing credit to use mobile phone services and repairing phones when they break down. The third dimension observed is mobile phone illiteracy, which affects accessibility and adoption, particularly the mature members of a poor community, and is related to illiteracy and functional illiteracy among end-users. However, another set of dimensions were also realised from these challenges such as, adoption strategies that emerged from end-users to counteract end-user challenges. Mobile phone sharing was used by end-users where phones were scarce. Those with limited mobile phone literacy skills sought assistance

from younger members of their households to use the service. The new set of design principles are summarized in table 7.3. To note is, the technology domain remains the same.

Table 7.3: Refined Service Design Principles

| Service | | | | | | |
|-------------------------|--|----------------------------------|---|-------------------------------|-----------------------------|------------|
| Design Guidelines | Design Principles | | | | | |
| Social Value | Access to Healthcare Services | Access to healthcare information | Deliver health education on health risks and disease prevention | Reporting and Medical Alerts | Communication Groups | m-Learning |
| Value Element | Remote Monitoring of chronic diseases | Information inquiries | Health education services | Data Collection and Reporting | For Health workers and VHTs | |
| Target Group | Community Members | | Health Workers | Health Workers and VHTs | | |
| Target Group Definition | 1) Low incomes and earnings 2) Inaccessible healthcare services 3) Traditional and information isolated society 4) Disempowered community 5) Motivation and Attraction of End-users 6) Ownership and maintenance of mobile phones 7) Mobile phone literacy | | | | | |
| Adoption Strategies | Mobile phone sharing Seeking Assistance | | | | | |

As for structural partner characteristics (dimensions), they revealed new dimensions in addition to those identified from literature. The first is a lack of supporting infrastructure and staff for service innovations. Findings further revealed that structural partners were not prepared to maintain the hardware and software for the service innovations. In one case (mTrac), the governing partner did not have technical staff to maintain the system. In another case (FrontlineSMS), a weak solar system was not able to power the computer where the system was installed. The second dimension was the VHT strategy, which depends on volunteers voted in by the community, hence depends on the goodwill of these people without pay. However, other findings reveal that there are ever increasing duties, a lack of facilitation and poor funding that demotivates them. In addition, the VHT position attracts mature members of the community, and for some, age constrains their abilities, especially SMS literacy. The discussion based on the literature analysis had raised concerns about involving a profit-oriented partner in the value network. The existing poor working conditions, which are a result of poor funding, facilitation and governance cause demotivation and poor work ethics among health workers, as reflected in the poor reporting habits among health workers.

The contributing partners, specifically telecom providers, need to be motivated so as to participate in the value network, however, they failed to fully participate in both service innovations because they charge premium prices for development-oriented service innovation and give the same priority to emergency text messages as commercial messages. Moreover, the regulator charges a high service fee (\$2000 per year) for the short code used for sending mTrac’s reports, probably because contributing partners’ are profit-oriented whereas structural partners are development-oriented. This led in a culmination of a new set of design principles as summarized in table 7.4.

Table 7.4: Refined Organization and Financial Design Principles

| Organizations | | | | Finance | |
|------------------------------------|--|---|-----------------|-------------------------|---|
| Design Guidelines | Design Principles | | | Design Guidelines | Design Principles |
| Shared Social Objectives | Structural Partners | Supporting Partners | | Source of Investment | Structural and Supporting Partners |
| | Ministry of Health Religious Associations / NGOs, Health facility | Donor Agencies Local Institutions and NGOs | | | |
| Access to Mobile Network | Contributing Partner | | | Source of Cost and Risk | Structural and Contributing Partners |
| | Telecom Providers Software Developers | | | | |
| Partner Roles and Responsibilities | Structural | Supporting | Contributing | Source of Revenue | End-users, Structural and Supporting Partners |
| | Network Governor | Initial Funding and Investment | Network Traffic | | |
| Partner Definition | <ol style="list-style-type: none"> 1) Limited funding 2) poor governance and Corruptions 3) Volatile nature of developing nations 4) Fragmented health information systems 5) Poor working conditions 6) Lack of supporting infrastructure and personnel 7) VHT strategy 8) Sector growth 9) Poor competition and regulation of Telecom Sector 10) Motivation and Attraction of Telecom Sector | | | | |

This, as the last stage of the design and evaluation process refined the description of the developing context. However, the gaps (livelihood analysis gaps) identified from research question four were even more vivid in the case study analysis. When the output were examined, the context-aware model, and the sections defined, variables that describe the rural community and end-users were well defined. However, variables related to partners (structural, supporting and contributing) are yet to be clearly defined. Supporting partners in particular were categorized with structural partners, but they in particular are not visible in the context and therefore were not observable.

Notably, this stage also highlighted the significance of the design approach to ICT4D. In chapter 3, the four principles of design science were highlighted: (1) rigorous design process, (2) design evaluation, (3) research contribution and (4) communication of research. It was particularly significant for an ICT4D artefact to be subjected to such a rigorous process primarily because ICT4D designers have been accused of: (1) neglecting empirical research in their design process and (2) a lack of knowledge on development and the developing context (Heeks, 2002; Tongia and Subrahmanian, 2006; Dada, 2006; Best and Kumar, 2008; Lucas, 2008; Prakash and Rahul De', 2007; Schuppan, 2009). Thus, application of the design process using Action Design Research revealed the nature and characteristics of end-users in a developing context unknown to literature. For instance, while illiteracy is a known fact among the poor, mobile phone literacy was not known. It was believed that mobile phone ownership was a challenge due to low incomes, but it was not known that maintaining a mobile phone is also a challenge due to the same low incomes. ICT4D and m-Health research does not reveal the attitude of health workers towards these service innovations in relation to their poor working condition, all these findings were possible because of the design approach. While it is possible to predict an organizational context for ICT or IS artifact due to extensive empirical research in these contexts, this is not case for developing contexts. The context-aware model and the variables identified hence present an initial framework from which the behavior of a developing context towards an m-Health service can be predicted.

Sutinen and Tedre (2010), as cited in Chapter 3 propose a bottom-up approach to ICT4D design, which, they argue enriches and artefact as opposed to the top-down approach which strips down an artefact and emphasizes access rather than ownership. They advance that the bottom-up approaches uses inputs from the context to create and enrich an artefact which promotes ownership of the artefact. The two artefacts were evaluated; mTrac and FrontlineSMS. MTrac was a solution developed by donor agencies and governing institutions in the health sector. Evidence of health workers' poor attitude towards adoption of the service was reported in the findings. On the other hand, the FrontlineSMS application was developed basing on requirements the community and health workers identified. Overall, the model presents a wider array of value elements because all stakeholder needs and requirements were taken into consideration. This highlights opportunity for ICT4D designers to move away from single-solution which might be barrier to value creation (Mechael et al, 2010), to multiple-solutions applications that offer more value to all stakeholders (end-users and partners) and therefore have a greater chance of survival.

Summarily, the discussion on each of the research question highlighted: (1), how the research objective was achieved, (2), rigorous nature of the methodology applied and (3), how appropriate the theoretical framework was to the research. In the next section, is a discussion of the research contribution made to ICT4D designers, policy makers and ICT4D partners.

7.4 Research Contributions

The context-aware model is a summary of the findings from this research. To the three stakeholders in the field of ICT4D, this model presents opportunities for growth and development. In the next paragraphs is a discussion of the implications the model has for each group of stakeholders.

7.4.1 Implications for ICT4D designers

The context-aware model is the first attempt at *predicting the behavior and characteristics of a developing rural healthcare context* towards an m-Health service innovation, and attempts to predict

social value creation. The model does this by highlighting social needs of stakeholders in a developing context, particularly significant for ICT4D designers who have been accused of a lack of awareness and knowledge of a developing context and development in general. The value elements are derived from development needs of the poor, health facilities and structural partners. Also, categorizing the value elements guides the ICT4D designers on targeting during the design process, hence contributes to knowledge generation of the context. There is targeting which requires a designer to describe the target group and therefore evaluate the sustainability of the service innovation. Generic characteristics of the target group that are a result of poverty (low incomes and earnings, inaccessible healthcare services, traditional and information isolated society and a disempowered community) should guide the designer in understanding the end-users and the challenges they experience in general, and in particular as users of m-Health service innovations. During the design process, the challenges end-users experience were discovered as a result of poverty, strategies were developed to counteract those challenges. For instance, mobile phone illiteracy was counteracted with mobile literacy classes with community end-users and computer literacy classes for health workers. For value elements, they not only categorize end-users, but service partners as well. Partner selection leads to role allocation which also leads to determining resource and capabilities partners need to support the service. Partner characteristics and challenges indicate to a designer areas where strategies may have to be developed to ensure value creation in the value network. For instance, in the case of a lack of infrastructure and staff, mTrac donor agencies supported Ministry of Health to boost its human and ICT resources. The lack of a reliable power supply at Nindye's health facility prompted us to approach a local institution (Uganda Martyrs University) so as to accommodate and support maintenance of the FrontlineSMS application.

7.4.2 Recommendations for ICT4D Designers

Multiple-solution applications are inclusive of all stakeholders in a developing context and ultimately increase value creation. Application design can be driven by structural and supporting partners (governing institutions and donor agencies) or they can be driven by end-users (health workers and community members). When they are driven by partners, institutional and political support is guaranteed but may not be accepted and adopted by end-users. On the other hand, a solution driven by end-users may be perceived as valuable by health workers and by the community, but without partner support, long term costs and maintenance needs may not be supported.

Further, *Adoption and support strategies* are necessary to ensure a compelling value proposition and a sustainable value network. A disempowered community experiences capability challenges that include low income, illiteracy and isolation. It is possible to exclude some community members from accessing a service innovation unless strategies are developed to include all, especially the vulnerable. This can be done by including all community stakeholders in the design process to: (1) identify the vulnerable and (2) identify strategies already used, for instance, mobile phone sharing and community support groups. Such pre-existing strategies can be used to increase access and adoption as support strategies target partners. The nature of ICT4D is that initial funding comes from donor agencies who are short term partners. However, findings and the model indicate that structural partners lack resources and capabilities to maintain service costs and expenditures as well as human resources to support technical maintenance needs of the service innovation. It is therefore necessary that designers include support strategies for structural partners. For instance, in the case of mTrac, donor agency partners supported human resource development and e-health strategy formulation for the structural

partner, whereas in the case of the FrontlineSMS application, a local institution supports the structural partner by accommodating and maintaining the application.

7.4.3 Implications for Policy Makers and Development Partners.

The model highlights socio-economic factors in the context that are in need of attention from policy makers and development partners. Other scholars advance that the survival of an ICT4D depends on institutional and political support (Fillip and Foote, 2007; Ali and Bailur, 2007). However, the model demonstrates to policy makers at national and international level areas in the healthcare system and telecommunication sector that need address to support sector development. The gaps are recognized from challenges and characteristics experienced by partners (structural, supporting and contributing) though they demonstrate a lack of resources and capabilities, especially with structural partners, poor regulation in the telecommunication sector and divergent development goals between structural and supporting partners (governing institutions and donor agencies) and end-users (community members and health workers). Here, the model guides policy makers at national and institutional level on where action plans need to be implemented to lay a foundation for ICT4D institutional and political support. The model also highlights where regulation of the telecommunication sector needs to be improved to support not only ICT, ICT4D growth and development. Finally, the model demonstrates the divergent development goals, specifically evident in the value elements. Structural and supporting partners' interest in data collection and reporting differs from the need to access and deliver healthcare services among community members and health workers. Of concern are these parallel interests which do not only affect support and adoption among end-users and partners for service innovations, but on the whole affect development programs. Finally, it is of significance to note that the model serves to emphasize the differences in development agendas and the need to re-align interests to achieve development.

7.4.4 Recommendations for Policy Makers

The need to *develop structural partners' resources and capabilities* is vital as a foundation for sustaining the value network. Development-oriented service innovations, in particular social development depends primarily on structural partners for survival. Of concern are the low incomes and earnings of the target group that cannot be depended on to generate sufficient revenues to support costs and expenditures. Implying that, strengthening the resources and capabilities of structural partners not only benefits organizational efficiency but greatly increases the chances of institutional support for ICT4D. Although there are cases of corruption and a lack of a political will, there are cases where there is a will to support service innovations, but because of a lack of resources, structural partners fail to fulfill their role as governors and owners of the service innovation. For instance, Nindye's health facility specifically asked for the FrontlineSMS application, but because of a weak power source, the facility was not able to operate the application at the facility. Thus, policy makers at national and institutional level can support the growth of organizational and institutional resources and capabilities, especially those that directly affect the ICT infrastructure.

There is a need for *improved regulation of the telecommunication sector to include development-oriented service innovations*. While the industry is profit-oriented, it is recognized that inclusion in information and communication access is a right. Universal access that is already part of sector regulation should be redefined to include ICT4D applications. It is not only enough to have infrastructure and services, but also necessary that these services are affordable for both the end-users and partners. It is important that ICT4D service innovations are categorized as development-

oriented services by telecom providers thereby giving them priority in service charges on mobile network traffic.

7.4.5 Recommendations for Partners

An *inclusive development agenda* that represents the needs of all stakeholders is key not only for development in general, but particularly for mobile service innovations. A service innovation whose value elements only represent the needs of structural and supporting partners, this excludes end-users and by this exclusion, development cannot be attained. Development paradigms present both top-down and bottom-up approaches. So far service innovations driven and supported by partners are single-solutions with value elements that reflect a top-down design approach. It is therefore necessary to include a bottom-up approach to the design process so as to enrich the development agenda of the service innovations. Lastly, it is important that structural and supporting partners include stakeholders from health facilities and the community in identifying development needs during the design process of service innovations.

7.4.6 Recommendations for Social Entrepreneurship Business Models

It is explicit that *the role of partners in a development-oriented Business Model* differs from for-profit Business Models. Whereas structural partners in a for-profit Business Model are the source of funding, supporting partners contribute the bulk of the funds for the service innovation. However, funding is not limited to the service innovation but must include developing resources and capabilities of the structural partners who may lack the resources and capabilities (personnel or infrastructure) to sustain a service innovation. This means that supporting partners may therefore be required to support the development of resources.

7.5 Limitations of the Research

The above discussion highlights the research contribution and recommendations. It is however important that limitations the research encountered are highlighted from the theoretical framework, methodology and case study as discussed in the next section.

7.5.1 Theoretical framework

The research selected the livelihood framework from rural development paradigm to define poverty in a developing rural healthcare context. In addition, the framework was selected from an array of rural development approaches because of its: (1) bottom-up approach in poverty and context definition and (2) maturity as an analytical tool in rural poverty. As an analytical tool, the framework requires that the poor and poverty are defined basing on five assets (human, financial, physical, social and natural). By basing the poverty definition on these five assets; this description can be related to other domains of poverty up to a certain extent. For instance, our focus was rural healthcare, but the definition of the five assets (human, financial, social and natural) are generic descriptions of poverty and are therefore applicable to other domains of poverty. Physical asset description focuses mainly on healthcare and therefore may not be applicable in other domains. This means that value elements (opportunities), challenges and characteristics related to four generic descriptions may be applicable to other domains.

Further research is therefore necessary in other domains of poverty. Combining these descriptions will refine our context-aware model and increase knowledge of developing context in relation to mobile

service innovations. Significantly, this research was the first of its kind in the field ICT4D and m-Health. Also to note is that this was an exploratory research, discovering the developing context from the perspective of m-Health hence, a starting point from which researchers can build a body of knowledge to guide ICT4D designers while developing viable service innovations.

While the framework was designed for analysis of poverty and the poor, it was not meant to analyze livelihood structures. However, it was from the structures that we selected partners (structural, supporting and contributing). The framework used the assets as a point of reference to description and evaluation. However, there is no structure to describe and evaluate the partners within the framework, hence only able to identify characteristics of these partners in relation to the poor. Thus, it was not possible to present a generic description and analysis of the partners as organizational entities whose descriptions can relate to structures in other domains.

It is therefore evident that further research is necessary to treat these stakeholders independent of the poor. Although poverty does influence the description of these stakeholders, it is necessary to examine them using appropriate organizational theory. A generic description and analysis is necessary for a more rigorous evaluation of the partners and therefore the value network. The work of Tongia and Subrahmanian (2006) developed a design model that based on identified stakeholders and metrics in the ecosystem, however, it does not provide a description of the stakeholders, and therefore still poses a gap in knowledge of partners as stakeholders in relation to a developing context. Just as value elements were derived, challenges and characteristics from the description of assets of the poor, it is also necessary to refine our understanding of partner variables from a rigorous analysis and evaluation of partners in a developing context.

7.5.2 Research Methodology

The research design adopted a qualitative approach, considering that this was an exploratory research on a topic that is relatively unknown to ICT4D designers. To ensure internal validity, the research adopted three strategies: (1) extended field work – it took 3 years to collect field data, (2) data triangulation – we used literature and field data to analyse the context, design and evaluation the service innovation and (3) method triangulation –mixed methods were used to cross check our causal effects. However, the limitations of the livelihood framework analysis on value network partners cannot be ignored, and the definition of value partners cannot be verified because they are not clearly defined using the livelihood framework. Therefore, the research cannot conclusively determine the causal effect partner characteristics might have on the viability of a service innovation. In addition, Ethnography focuses on groups of people in a cultural context. While this was appropriate for a community, this was not the case with health facilities, governing institutions, donor agencies and telecommunication providers. Specifically, these partners were not visible in the rural context and therefore were not observable as was the case with the community, health workers and health facilities.

In addition, there is need for further research using organizational methodology to describe partners as institutions and organizations in a developing context is recommended. While such partners may be considered to be modern constructs as opposed to traditional communities, they do however possess unique characteristics and challenges based in their relationship with a poor context. Hence, it is necessary to identify those generic characteristics for a valid evaluation of their ability to sustain a value network in a business model.

7.5.3 Single case study strategy

The phenomena of viability and sustainability were observed in a rural developing context. The case study area selected possessed similar characteristics to most rural developing contexts. To ensure external validity, the research process began the identification of rural variables from literature. A generic description of a rural developing context and poverty was first presented in chapter 2. The first livelihood analysis used this generic description to identify rural healthcare variables which were used to design the initial service innovation and its underlying business model. Therefore when data collection was begun in the case study, there was an endeavor to identify and refine the variables identified from literature. This enabled relating findings to contexts similar to the case study (Seawright and Gerring, 2008). However, it is acknowledged that while the context may be similar to most poor contexts, circumstances, individuals and cultures differ. For instance, there may have been a description of the community as traditional, but cultures determine behavior of individuals.

Further Research using a multiple case study strategy is necessary to determine validity of variables identified. It is necessary to examine these variables in contexts with differing levels of cultural and poverty. A multiple case study strategy may affirm variables and causal relationships while disregarding others. This would ultimately refine our context-aware model.

7.6 Conclusion

This chapter serves the purpose of presenting a summary of the research and demonstrating how the research objective was achieved by answering the research questions. Also demonstrated, is the unique contribution the research has made to stakeholders in the field of ICT4D. Of concern are the limitations that pave the way for future research and growth of the context-aware model proposed by the research. The field of study is relatively new which requires a body of knowledge to guide ICT4D design and application. Moreover, just like its counterpart ICT, ICT4D is a vital component in the developing context. It must, however, represent development strategies and goals for end-users and partners made to recognize its value.

Theory and methodology in the ICT4D field is also relatively new. The research has had to merge profit-oriented design and evaluation tooling with Social Entrepreneurship, development-oriented theory with business model concepts to design and evaluate a development-oriented service innovation. It is of no doubt that gaps exist in methodology and theory that challenge the research process. However, the growing interest in the field is also evident from literature. Finally, it is important to state that empirical research is central to the body of knowledge.

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Appendices

Appendix A: Quick Scan Presentation to Hospital Management Team and Healthcare workers – Power point outline

- 1) Why the project?
 - Background to the development of the project
 - Purpose of the study
 - Situational on rural healthcare
 - Discussion on Mobile and Wireless Dominance
 - Theoretical development of the project
- 2) What is being proposed?
 - A mobile and wireless service solution
 - Service Design
 - Technology Design
 - Organizational Arrangements
 - Financial Model
- 3) How will this be done?
 - Methodology
- 4) Discussion, Question and Answer Session

Appendix B: Meeting with Nindye's Health Centre III Medical Officer in-Charge.

1. What are the Health facility needs in delivery of healthcare services?
2. What are VHTs needs in delivery of healthcare services?

Appendix C: Group Discussion with Nindye Community Members (Men and Women) and VHTs

The women's' group was guided by the following question:

1. What healthcare challenges do you experience as women in your villages and homes?

The Men's group was guides by the following question:

2. What healthcare challenges do you and your children experience in your villages and homes?

The VHT group was guided by the following question:

3. What healthcare challenges do you and community members experience in your villages and homes?

Appendix D: Interview questions for Nindye and Nkozi community members

1. What is your name and occupation?
2. What healthcare challenges do community members experience in the villages?
3. What would you say is the biggest challenge community members experience in healthcare access?
4. What do you think can help improve health care in your villages?
5. If you or a family member is sick where would you first go to seek for healthcare services?
6. Where do you seek healthcare if you fail to access healthcare services at the public health facility?
7. Who are the preferred healthcare providers of the community?
8. What challenges do you experience in accessing healthcare at the PNFP, Nkozi Hospital?
9. What do you think about an SMS inquiry service at the health facility that informs you on whether drugs or a health worker is available at the public health facility?
10. We were thinking about using the mobile phone, in case you need information from the Nindye health Centre, by using SMS. What kind of information would you need?

Appendix E: Interview questions for VHT.

1. What challenges do you VHTs experience?
2. How many times do have meetings that require you to come to the centre?
3. How many times in a week do you fill out your registers?
4. How many times do you make home visits to find out if a home has all these essentials?
5. Do VHTs have phones?
6. What is your experience in using a mobile phone?
7. What in your opinion is the community's experience in using mobile phones?
8. What is the general opinion of community members about healthcare?
9. What influence do traditional healers and traditional birth attendants have on healthcare in Nindye?
10. What do you think about an SMS inquiry service at the health facility that informs you on whether drugs or a health worker is available at the public health facility?

Appendix F: Interview with Nkozi Hospital health workers

1. What is your name and position?
2. What challenges do you experiences in delivery of healthcare?
3. What is your opinion of private clinics in the Nkozi area and the treatment they give to patients?

4. What information services can we include in the mobile service to support the health facility?
5. What in your opinion is the experience of the VHTs with mobile phones?
6. What information services can we include in the mobile service to support the VHTs and their work?
7. What information services can we include in the mobile service to support community healthcare needs?

Appendix G: Interview Questions Health Workers After mTrac Implementation

1. What is your position in this institution?
2. What are your duties?
3. Explain to me more about your reporting duties? What reports do you have to compile at the health centre / hospital
 - a. Internal
 - b. For the national health system
 - c. For donors and sponsors
4. What kind of support do you get to carry out these reporting duties?
 - a. Tools e.g. registers forms.
 - b. Material e.g. Training material
 - c. Financial e.g. Facilitation, appreciation
5. What challenges do you face when carrying out these reporting duties?
 - a. Tasks performed
 - b. Time spent
 - c. Facilitation given or not
 - d. Information compilation
 - e. Feedback from the healthcare system
6. Did you participate in the mTrac organized for your health unit?
7. What functions were you trained on in mTrac?
What was your experience of using mTrac to send the information?

- a. The task of sending information
- b. Time spent typing and sending the information
- c. Facilitation
- d. Information
- e. Feedback
8. What was your experience of mTrac training?
 - a. The SMS / USSD application
 - b. The interpretation of data from the HMIS 033B form into the weekly report
 - c. The material given to you during the training session
9. What was your experience of using mTrac?
 - a. Do you find it easy to translate the data from the form into the SMS report format?
 - b. Using the SMS / USSD application
 - c. Do you get error in reports when sending the SMS reports? If so, what kind of errors?
 - d. Is the mobile network you use to send mTrac reports always available? Which network is this and what is your opinion of its efficiency?
10. What is your experience of mTrac workload
 - a. Are you ready on Friday to send reports
 - b. Is your phone fully charged
11. How do you feel about mTrac
 - a. Does it increase or decrease your workload

- b. Do you find it easy to use
- c. Would you like more training?
- d. Would you like it to add more functionality?

Appendix H: Interview Questions for mTrac Partners

1. How and when did UNICEF and its partners begin to develop mTrac?
2. What are the organizational arrangements for mTrac?
3. Where did the initial financing come from and who takes it on after?
4. Who bears the traffic charges for mTrac’s reporting?
5. Explain to me the technical architecture of mTrac. DMark is mTrac’s aggregator.
6. What is your opinion on the Ministry’s capabilities to maintain mTrac?
7. What is the vision for mTrac, to make it a little bit more relevant the health facility in terms of functionality?
8. What has been your experience with weekly reports from health workers and VHTs?
9. What new functionalities do you think should be included in mTrac for added value to end-users?

Appendix I: Questionnaire for VHTs after mTrac implementation

Dear Respondent,

My name is Sheba Nyakaisiki, a research student from Uganda Martyrs University, in Uganda and Delft University of Technology, the Netherlands, focusing on **Value Generation in Mobile Health Solutions in Rural Areas**. Since October 2012, in addition to your VHT duties, you have been introduced to and used mTrac. The purpose of this questionnaire is to solicit your opinion about and experience with mTrac.

Please note that your identity will not be required and you can therefore rest assured that your responses will remain anonymous.

1. What is your gender?

| | | | |
|------|--------------------------|--------|--------------------------|
| Male | <input type="checkbox"/> | Female | <input type="checkbox"/> |
|------|--------------------------|--------|--------------------------|

2. How old are you?

| | | | | | | | |
|---------|--------------------------|---------|--------------------------|---------|--------------------------|------------|--------------------------|
| 20 - 30 | <input type="checkbox"/> | 30 – 40 | <input type="checkbox"/> | 40 – 50 | <input type="checkbox"/> | 50 - Above | <input type="checkbox"/> |
|---------|--------------------------|---------|--------------------------|---------|--------------------------|------------|--------------------------|

3. Please indicate with a tick which of the following programs you are currently involved in.

| | |
|---|--------------------------|
| General Household Registers | <input type="checkbox"/> |
| Integrated Community Case Management | <input type="checkbox"/> |
| Neglected Tropical Disease Program | <input type="checkbox"/> |
| Community Health Promotion Exercises | <input type="checkbox"/> |
| World Vision’s Citizen Voice and Action (CVA) | <input type="checkbox"/> |

4. For any of the above programs that you are engaged in indicate with a tick the activities you carry out under the program.

| General Household Registers | | Integrated Community Case Management (ICCM) | | Community Health Promotion Exercises (eg Immunization, deworming) | | Neglected Tropical Diseases | | World Vision’s CVA | |
|-----------------------------|--------------------------|---|--------------------------|---|--------------------------|-----------------------------|--------------------------|--------------------|--------------------------|
| Household visits | <input type="checkbox"/> | Household visits/ Patient Visits | <input type="checkbox"/> | Household visits | <input type="checkbox"/> | Household visits | <input type="checkbox"/> | Household visits | <input type="checkbox"/> |
| Update Registers | <input type="checkbox"/> | Update Patient and Drug Stock Registers | <input type="checkbox"/> | Update Registers | <input type="checkbox"/> | Update Registers | <input type="checkbox"/> | Update Registers | <input type="checkbox"/> |
| Submit Registers | <input type="checkbox"/> | Submit Patient and Drug Stock Registers | <input type="checkbox"/> | Submit Registers | <input type="checkbox"/> | Submit Register | <input type="checkbox"/> | Submit Registers | <input type="checkbox"/> |

5. For each of these activities indicate with a tick the type of facilitation given to you.

| Program/Activity | Household visits / Patient visits / Community promotion exercises | | Register / Report Submission | |
|---|--|--------------------------|-------------------------------------|--------------------------|
| General Household Registers | Bicycle | <input type="checkbox"/> | Bicycle | <input type="checkbox"/> |
| | Transport Refund | <input type="checkbox"/> | Transport Refund | <input type="checkbox"/> |
| | NON | <input type="checkbox"/> | NON | <input type="checkbox"/> |
| Integrated Community Case Management (ICCM) | Bicycle | <input type="checkbox"/> | Bicycle | <input type="checkbox"/> |
| | Transport Refund | <input type="checkbox"/> | Transport Refund | <input type="checkbox"/> |
| | NON | <input type="checkbox"/> | NON | <input type="checkbox"/> |
| Neglected Tropical Diseases | Bicycle | <input type="checkbox"/> | Bicycle | <input type="checkbox"/> |
| | Transport Refund | <input type="checkbox"/> | Transport Refund | <input type="checkbox"/> |
| | NON | <input type="checkbox"/> | NON | <input type="checkbox"/> |
| World Vision's CVA | Bicycle | <input type="checkbox"/> | Bicycle | <input type="checkbox"/> |
| | Transport Refund | <input type="checkbox"/> | Transport Refund | <input type="checkbox"/> |
| | NON | <input type="checkbox"/> | NON | <input type="checkbox"/> |

6. When you are carrying out these activities, how much time do they consume in a day?

| Activity / Hours | In a Day | |
|---|-----------------|--|
| Household visits | Less than 1 hr | |
| | 1-2 hrs | |
| | 2-3 hrs | |
| | 4-5 hrs | |
| | More than 5 hrs | |
| Patient visits | Less than 1 hr | |
| | 1-2 hrs | |
| | 2-3 hrs | |
| | 4-5 hrs | |
| | More than 5 hrs | |
| Community promotion exercises (eg Immunization, de-worming exercises) | Less than 1 hr | |
| | 1-2 hrs | |
| | 2-3 hrs | |
| | 4-5 hrs | |
| | More than 5 hrs | |
| Register / Report updates | Less than 1 hr | |
| | 1-2 hrs | |
| | 2-3 hrs | |
| | 4-5 hrs | |
| | More than 5 hrs | |
| Register / Report Submission | Less than 1 hr | |
| | 1-2 hrs | |
| | 2-3 hrs | |
| | 4-5 hrs | |

7. Do you think you need more training on how to fill in your ICCM and Drug Stock registers? For each statement below, please select the option that best describes how you feel about the training you have had on how to fill in your ICCM and Drug Stock Registers.

| | | | | | |
|---|---|--------------------------------|----------------------------------|-----------------------------------|--|
| The training I have had on how to fill in the ICCM Patient and Drug Stock registers correctly was good. | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I do not find it difficult to fill in my ICCM and Drug Stock registers after treating a patient | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| The ICCM and Drug Stock registers are easy to understand. | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I have enough material and support to assist me fill in the ICCM and Drug Stock registers correctly | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I do not need re-training on how to fill in my ICCM and Drug Stock registers | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |

8. Do you always fill in and submit your ICCM and Drug Stock Registers correctly and on time? For each statement below, select with a tick the option that best describes your performance in filling in and submitting ICCM and Drug Stock Registers.

| | | | | | |
|---|---|--------------------------------|----------------------------------|-----------------------------------|--|
| I have never been told by my supervisor that I have filled in the ICCM and Drug Stock registers wrong | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| When it is time to hand in my ICCM and Drug Stock registers it is always up to date. | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I have never been late in handing in my ICCM and Drug Stock registers to my supervisor | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |

| | | | | | |
|---|---|--------------------------------|----------------------------------|-----------------------------------|--|
| I always have time to take my ICCM and Drug Stock registers to my supervisor | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I always have transport to take my ICCM and Drug Stock registers to my supervisor | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |

9. Have you been trained on how to use mTrac? Use a tick to indicate if you have received training and when.

| | |
|---|--------------------------|
| I took part in the official training that was done at the health facility on the 18 th and 19 th October 2012 | <input type="checkbox"/> |
| I missed the official training, but a fellow VHT or health worker showed me how to register and use mTrac | <input type="checkbox"/> |
| I have not been trained on how to use mTrac and I am not using it | <input type="checkbox"/> |

If you have NOT received training on mTrac and therefore are not using it, please DO NOT answer the following questions.

10. How do you feel about the training you had on how to use mTrac? For each statement below select the option that best describes how you feel about the training you had on mTrac.

| | | | | | |
|---|---|--------------------------------|----------------------------------|-----------------------------------|--|
| I clearly understand what mTrac is about. | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I clearly understand how to get information from the ICCM and Drug Stock registers and send it as a report with mTrac | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| The training material given to me is enough to guide me when I am sending my report | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I know how to use mTrac | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |

11. Do you have a phone to send your mTrac reports? Use a tick to indicate whether you have a phone to send mTrac reports or not.

| | |
|--|--------------------------|
| I have a personal mobile phone that I use to send my weekly reports | <input type="checkbox"/> |
| I use a mobile phone for someone in my household to send my weekly reports | <input type="checkbox"/> |
| I use a friend or neighbor's phone to send my weekly reports | <input type="checkbox"/> |
| I do not have a phone to send my mTrac reports | <input type="checkbox"/> |

If you are not sending your reports because you do not have a phone to use, DO NOT answer the following questions.

12. Which mobile network provider do you use to send your weekly mTrac reports?

| | | | | | | | | | |
|-----|--------------------------|-----|--------------------------|-------|--------------------------|--------|--------------------------|--------|--------------------------|
| MTN | <input type="checkbox"/> | UTL | <input type="checkbox"/> | Warid | <input type="checkbox"/> | Airtel | <input type="checkbox"/> | Orange | <input type="checkbox"/> |
|-----|--------------------------|-----|--------------------------|-------|--------------------------|--------|--------------------------|--------|--------------------------|

13. How well does the mobile network you are using to send your mTrac reports work when you are sending reports? For each question below, indicate the number of times you have had a good or bad experience with the provider.

| | 0-1 | 1-2 | 2-3 | 3-4 | More than 4 times |
|--|--------------------------|--------------------------|--------------------------|--------------------------|--------------------------|
| Since you started using mTrac, how many times has the mobile network been unavailable when you wanted to send your weekly report? | <input type="checkbox"/> |
| When you are able to send your report, how many times did they NOT send you a message that your report had been received? | <input type="checkbox"/> |
| Since you started using mTrac, how many times have you called the mTrac helpline for help when the network failed to send your report? | <input type="checkbox"/> |

14. Had you ever used a phone to send or receive messages before using mTrac?

| | |
|---|--------------------------|
| Send a message | <input type="checkbox"/> |
| Read a message | <input type="checkbox"/> |
| I have never used my phone to send or read a message before using mTrac | <input type="checkbox"/> |

15. Do you send your mTrac report yourself?

| | | | |
|---------------------------|--------------------------|--|--------------------------|
| I send the reports myself | <input type="checkbox"/> | I ask a member of my household or community to send the reports for me | <input type="checkbox"/> |
|---------------------------|--------------------------|--|--------------------------|

If you are not sending your mTrac reports yourself, please DO NOT answer the following questions.

16. Do you know how to use mTrac? For each step you take when using mTrac, select the option that best describes how you feel about it as a user starting from Strongly Agree to Strongly Disagree.

| | | | | | |
|---|--|--------------------------------|----------------------------------|-----------------------------------|---|
| I know where to go on a mobile phone to start typing my report | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |
| I know how to type out the report before sending it | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |
| I know the number to send my report to. | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |
| If I get a problem with the network when sending the report, I know the number to call for help | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |
| I do not need more training on how to send | Strongly <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> |

| | | | | | |
|------------------|-------|--|--|--|----------|
| my weekly report | Agree | | | | Disagree |
|------------------|-------|--|--|--|----------|

17. How do you feel about using mTrac to send reports? For each statement below, please select the option that best describes how you feel about mTrac and if you think it is good for you for sending reports.

| | | | | | |
|--|--|--------------------------------|----------------------------------|-----------------------------------|---|
| mTrac is easy to use | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |
| Writing a message is getting easier | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |
| mTrac makes my reporting work easier | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |
| Sending my reports as messages is getting easier | Strongly <input type="checkbox"/> Agree | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly <input type="checkbox"/> Disagree |

18. In the last five weeks, how many reports have you sent?

| | | | | | | | | | |
|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|
| 0 - 1 | <input type="checkbox"/> | 1 - 2 | <input type="checkbox"/> | 2 - 3 | <input type="checkbox"/> | 3 - 4 | <input type="checkbox"/> | 3 - 4 | <input type="checkbox"/> |
|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|-------|--------------------------|

19. If you missed sending any report, what was the reason for it? Please select with a tick the reason you were not able to send your report / reports or specify if your reason is not among those given.

| | |
|--|--------------------------|
| The network was not available | <input type="checkbox"/> |
| The network was available but when I sent the report it failed to go | <input type="checkbox"/> |
| My phone was not charged | <input type="checkbox"/> |

| | |
|-----------------------------|--------------------------|
| My phone was not working | <input type="checkbox"/> |
| I was busy | <input type="checkbox"/> |
| I forgot to send the report | <input type="checkbox"/> |
| Other (Please specify) | |
| | |

20. How much time does it take to type and send your mTrac reports?

| | | | | | | | |
|-----------------|--------------------------|--------------|--------------------------|--------------|--------------------------|----------------|--------------------------|
| Less than 30min | <input type="checkbox"/> | 30min – 1 hr | <input type="checkbox"/> | 1 hr – 2 hrs | <input type="checkbox"/> | More than 2hrs | <input type="checkbox"/> |
|-----------------|--------------------------|--------------|--------------------------|--------------|--------------------------|----------------|--------------------------|

21. How often were you charging your phone before using mTrac in a month?

| | | | | | | | |
|-----|--------------------------|-----|--------------------------|-----|--------------------------|-------------------|--------------------------|
| 1-2 | <input type="checkbox"/> | 2-3 | <input type="checkbox"/> | 3-4 | <input type="checkbox"/> | More than 4 times | <input type="checkbox"/> |
|-----|--------------------------|-----|--------------------------|-----|--------------------------|-------------------|--------------------------|

22. How often do you charge your phone now with mTrac in a month?

| | | | | | | | |
|-----|--------------------------|-----|--------------------------|-----|--------------------------|-------------------|--------------------------|
| 1-2 | <input type="checkbox"/> | 2-3 | <input type="checkbox"/> | 3-4 | <input type="checkbox"/> | More than 4 times | <input type="checkbox"/> |
|-----|--------------------------|-----|--------------------------|-----|--------------------------|-------------------|--------------------------|

23. What is the cost of charging your phone in a month?

| | | | | | | | |
|--------------------|--------------------------|--------------------|--------------------------|--------------------|--------------------------|--------------------|--------------------------|
| Shs 500 – Shs 1000 | <input type="checkbox"/> | Shs 1000- Shs 1500 | <input type="checkbox"/> | Shs 1500- Shs 2000 | <input type="checkbox"/> | More than Shs 2000 | <input type="checkbox"/> |
|--------------------|--------------------------|--------------------|--------------------------|--------------------|--------------------------|--------------------|--------------------------|

24. Do you feel that mTrac takes a lot of effort to use? For each statement below, select the option that best describes how you feel about the effort you put in to use mTrac starting from Strongly Agree to Strongly Disagree.

| | | | | | |
|--|---|--------------------------------|----------------------------------|-----------------------------------|--|
| Getting the information from the ICCM and drug stock registers to send as reports is easy. | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
|--|---|--------------------------------|----------------------------------|-----------------------------------|--|

| | | | | | |
|---|---|--------------------------------|----------------------------------|-----------------------------------|--|
| It takes me very little time to get all information from the ICCM and Drug Stock registers correctly to send as a report every week | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I do not think that sending mTrac reports takes up too much of my time from other household and income generating duties. | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I think that the task of sending mTrac reports is a very small addition to my VHT duties | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |
| I do not think that sending the weekly reports uses up too much of phone's battery | Strongly Agree <input type="checkbox"/> | Agree <input type="checkbox"/> | Neutral <input type="checkbox"/> | Disagree <input type="checkbox"/> | Strongly Disagree <input type="checkbox"/> |

Thank you for taking the time to answer these questions.

Summary

Background: The term ICT4D refers to Information and Communication Technology that is applied in a developing context with the intention of supporting development goals, for instance, improving healthcare service delivery in poor communities. Healthcare in developing countries is challenged by a high disease burden and poor healthcare systems. Governments in developing nations and international development agencies are therefore tasked with improving healthcare access for the poor and many times remote communities with poorly facilitated healthcare facilities. Noted is the increasing use and penetration of mobile phones in poor and remote communities that has encouraged ICT4D designers to use this technology in designing ICT4D solutions. In healthcare, this has given rise to m-Health service innovations. M-Health solutions use technologies such as Bluetooth, GSM, Wi-Fi, and WiMAX, and devices such as mobile phones or smart phones, and Personal Digital Assistants (PDAs) to provide various healthcare services. In developing countries m-Health has used SMS or specialized software for remote monitoring of chronic diseases, data collection and reporting, education and awareness campaigns, communication and training for health workers and for diagnostic and treatment support for health workers.

It has however been noted that sustainability of ICT4D and m-Health solutions is a challenge. Sustainability of ICT4D solutions requires that these solutions are able to generate adequate revenue to cover their costs and expenditures over time, deliver value to the targeted users, and users' must be seen to accept, adopt and adapt them into their social setting, and finally they must have institutional and political support in the social and economic environment. Literature points to two major gaps that contribute to continued sustainability challenges: The first is, ICT4D designers lack knowledge and understanding of a developing context. Literature points out that most ICT4D solutions may not match the expectations of the users, or may fail to incorporate cultural and political influences in organizational processes and / or may be implemented in a country context that differs from the context in which the solution originated. The second gap is a lack of evaluation and research method application to activities in the life cycle of ICT4D applications. Most ICT4D literature focuses on impact assessment, but fails to indicate what works and what does not work. The result is that most ICT4D and m-Health solutions survive only as long as donor funding is available, failing to generate adequate revenues to cover their costs, deliver value to end-users, or gain institutional support.

Notably, the first gap requires understanding a developing context, which is to define and describe any information that characterizes the situation of an m-Health application and is considered relevant to the interaction between the application and end-users. This information describes all stakeholders that will use an m-Health service innovation and social, political and economic factors in a rural healthcare context. Further, describing a developing context requires a development perspective. Development is a response to poverty, which is a state of ill-being of a person or community that lacks basic needs for a minimum standard of well-being and life, for instance, income, food, shelter, healthcare, education and information. Given that 70% of the world's poor live in rural areas (Wiggin and Proctor, 2001; Willis, 2005; Dercon, 2009; IFAD, 2011), attention was given to a rural context, and therefore turned to the Rural Development Paradigm to identify a rural development theory that would in turn enable to describe a rural context. A theory was needed that would differentiate poverty and healthcare needs from the perspective of the poor. This would ensure that what is of value is established basing on the perspective of end-users and therefore fulfill the first requirement of sustainability; deliver value to end-users. The livelihood approach was thus used, which first identifies

vulnerabilities (healthcare needs), describes assets (resources available to the end-users), identifies structures and processes that influence how assets are used, and finally describes strategies used by the poor to overcome vulnerabilities. Healthcare needs are translated into social objectives / value, asset description and strategies are similarly translated into characteristics that influences end-users and m-Health application. Then, structures and processes are used to identify partners that support the m-Health application.

The second gap requires to determine what works and what does not work in a developing context using evaluation and research method. Evaluation identifies what actually creates and what does not create value for all stakeholders in a developing context, this, was done by looking to Business Models. A Business Model represents the core logic and strategic choices that create and capture value within a value network. Business Model tooling that can support the design and evaluation of an m-Health application for a rural context were considered. Selected was the STOF framework, a Business Model tooling that was developed to cater for specifically the ecosystem of mobile and wireless service innovations. The STOF framework uses the STOF method to design a mobile service innovation and its underlying business model. Then, using four domains (Service, Technology, Organizations and Finance) the STOF model demonstrates the ability for the service innovation to generate value for all stakeholders in its given context. However, it was observed that STOF was developed for profit-oriented service innovations, and the m-Health application is development-oriented. Therefore, the research looked to Social Entrepreneurship, which is the innovative combination of resources to pursue social change. Social Entrepreneurship literature demonstrates how to create and capture social value, then, used these guidelines were used in the business model design to create a development-oriented business model. Variables were identified from the livelihood framework as input for the STOF method and framework to design and evaluate the service innovation and its business model. Variables that create and capture social value are referred to as strategic choices and context characteristics that influence value creation are referred to as underlying social, political and economic factors.

Research Objective: The objective of this research is to understand a developing context from which strategic choices ICT4D designers can use are identified so as to design a mobile service innovation in a rural healthcare context. There was also need to identify social, political and economic factors in a rural context that might influence the viability of the service innovation. These variables are then used to design a context-aware model that will support designers to design and evaluate an m-Health service innovation. The structure of this model is demonstrated in the following figure 1.

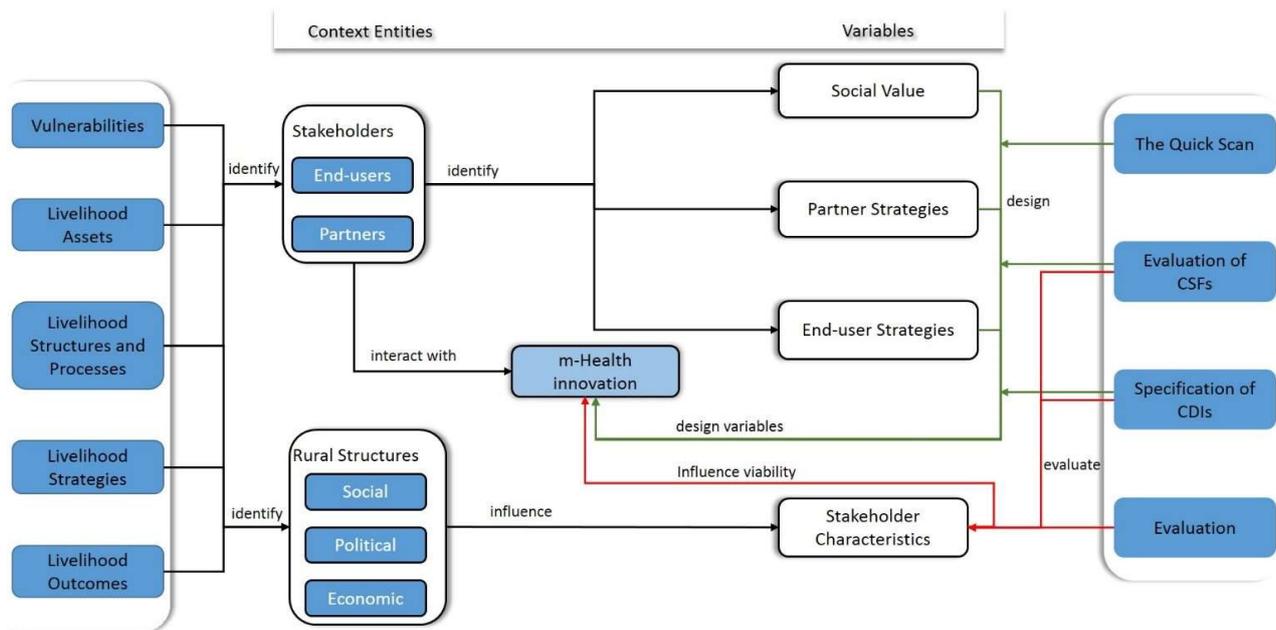


Figure 1: Context-Aware Model Structure (Source; Research)

Research Approach: Using a design-oriented approach, variables were identified (design principles) that make up our context-aware model. Action Design Research (ADR) strategy used the STOF method which uses four stages to design and evaluate a service innovation. The first stage, the Quick Scan, was used to design and evaluated a service innovation from literature. Finally, the first set of design principles through this process were identified.

The Quick Scan analysis identified strategic choices and context characteristics for the service domain. These include social objectives and their value elements that make up the service design. These were derived from healthcare needs and were perceived as value creators for end-users in the rural context.

Value elements: The findings from literature reveal that; (1), access and deliver healthcare in remote areas, (2), access to healthcare information, (3), deliver health education on health risks and disease prevention, and (4), management and decision making in health system are healthcare needs existing in rural healthcare. From these were formulated value elements that include: (1), Remote service delivery, (2), information inquiries, (3), health education services, and (4), data collection and reporting.

Target Groups: From the value elements, our end-users were identified and categorized into target groups. As pertains remote service delivery, information inquiries and health education target; (1), community members and (2), health workers. Data collection and reporting targets health workers and introduces our last group, (3), the village Health Teams (VHTs).

Target Group Definition: Characteristics of these target groups were used to determine their effect on value elements and their ability to create value. Community member characteristics include: (1), manual labourers, (2), subsistence farmers, and (3), low income earners. Health workers were described as: (1), demotivated, overworked and underpaid, and (2), working in poorly facilitated health facilities. VHTs were not visible in literature and were therefore not defined at the Quick Scan level.

Strategic choices in the technology domain made up the technology architecture, which can support the value elements identified. These include devices, platform and applications the service operates uses. Also, were identified context characteristics that might influence this architecture and its ability to provide value to end-users.

Technology Architecture: Technology architecture was developed based on ; (1), technologies and services available in the telecommunication sector ,(2), m-Health applications readily available in the market and (3), the requirements of the value elements identified in the service design. There was therefore selection of mobile phones as the devices to access the service, and SMS as the platform for the service. The SMS gateway application was selected from open source software (FrontlineSMS) available on the market, and used to manage sending and receiving text messages.

Access Network and Backbone Infrastructure Definition: The technological architecture introduced the research to mobile networks in developing countries. The following characteristics that might influence quality of service for the service innovation were identified: (1), poor network coverage in rural areas, (2), weak security and transmission and (3), storage and transmission of personal information.

Analysis of livelihood structures and processes led to identification of partners to support m-Health applications in a rural context. These partners are assigned roles, support and sustain the value network. Descriptions of these partners were then used to determine their ability to sustain the value network.

Partners: Partners were selected basing on shared social objectives and the current roles they perform in rural healthcare. These were categorized into structural and supporting partners. Structural partners include: (1), Ministry of Health, (2), Religious Associations / NGOs as structural partners. These govern the value network and are responsible for long-term support of the value network and m-Health application. Donor agencies are supporting partners responsible for initial funding and investment in the value network. The technology architecture also introduced telecom providers as contributing partners that give the application access to mobile networks.

Partner definition: Literature reveals characteristics that might affect the ability for these partners to sustain the value network of the service innovation. Structural partners were described as: (1), lacking in political will, (2), poorly governed, (3), existing in volatile states, (4), have fragmented healthcare information systems and (5), weak ICT infrastructures at their health facilities. The Donor agencies were described as having limited funding for ICT4D projects.

Case findings were the result of implementation stage in ADR. Further, on, Ethnography was used in this stage to observe stakeholders in a rural healthcare case – Nindye Parish in Uganda and two service innovations (mTrac and FrontlineSMS). While context variables were identified and defined in the Quick Scan, this stage gave the research the opportunity to affirm and / or refine these design principles identified according to how stakeholders in the context defined them. This provided the researcher with opportunity to discover new design principles for the context-aware model. Starting with the service design, social objectives and value elements were not only refined but also increased in number.

Value elements: The first value element, access and deliver healthcare to remote areas was refined to remote monitoring of chronic diseases. Health education and information remain the same while reporting and data collection was refined to reporting and medical alerts. Two new value elements were discovered and these include; (1), communication groups and (2), m-Learning. Case findings which emphasized that value elements target different stakeholders in the rural healthcare. Some value elements are target end-users, others support partners. It is important that designers take note that each stakeholder has different roles to play in the value network. End-users ensure adoption and adaptation; partners ensure institution and political support. It is therefore necessary that all stakeholders are catered for in m-Health applications to ensure sustainability.

Target Group definition: While the target groups remain the same, their descriptions were affirmed and refined as low incomes and earnings, but refined poorly facilitated healthcare facilities to inaccessible healthcare services. While literature reveals that poor community members rely on cultural practises and knowledge to overcome healthcare challenges, case findings affirmed this definition to traditional and information isolated society. Overall community members defined themselves as disempowered due to their low incomes and limited resources. Finally, literature did reveal the presence of unqualified healthcare providers as affirmed by case findings that enabled us to observe our target groups as mobile phone users, which rather revealed a second dimension to the description of the target groups. The first is that end-users need to be motivated and attracted to m-Health services. Ownership and maintenance of mobile phones was revealed as a challenge especially for VHTs and community members. Lastly, mobile phone literacy was challenge for some community members and VHTs. Case findings also reveal adoption strategies that end-users, especially VHTs devised to overcome mobile phone ownership and literacy challenges. The first was mobile phone sharing and the second was to seek assistance from friends and family in case of limited literacy skills.

Partners: The number of identified partners did increase, although the categories remained the same. In the FrontlineSMS case, health facilities were included to our list of structural partners while Local institutions and NGOs participated as supporting partners in the FrontlineSMS application. Software developers participated as contributing partners in the mTrac application.

Partner definition: In addition to characteristics identified from literature (limited funding, poor governance and corruption, volatile nature of developing nations, fragmented health information systems, poor working conditions, poor competition and regulation of telecom sector), new characteristics were discovered from case findings that affect the value network. The first was a lack of supporting infrastructure and personnel with regard to structural partners. The second were poor working conditions that had a negative effect on end-users. The third was the VHT strategy, which was found, had both a negative and positive effect on the value network and the fourth was sector growth. While most characteristics are negative, this was a positive characteristic. The last was a characteristic evident with contributing partners, specifically telecom providers. It was discovered that telecom providers need to be motivated to join the value network. This was primarily because m-Health services are development-oriented while telecom providers are profit-oriented.

These refined context-variables are what is proposed as design principles that an ICT4D designer can use to design viable m-Health applications in a rural context. They make up the context-aware model that is represented in figure 2.

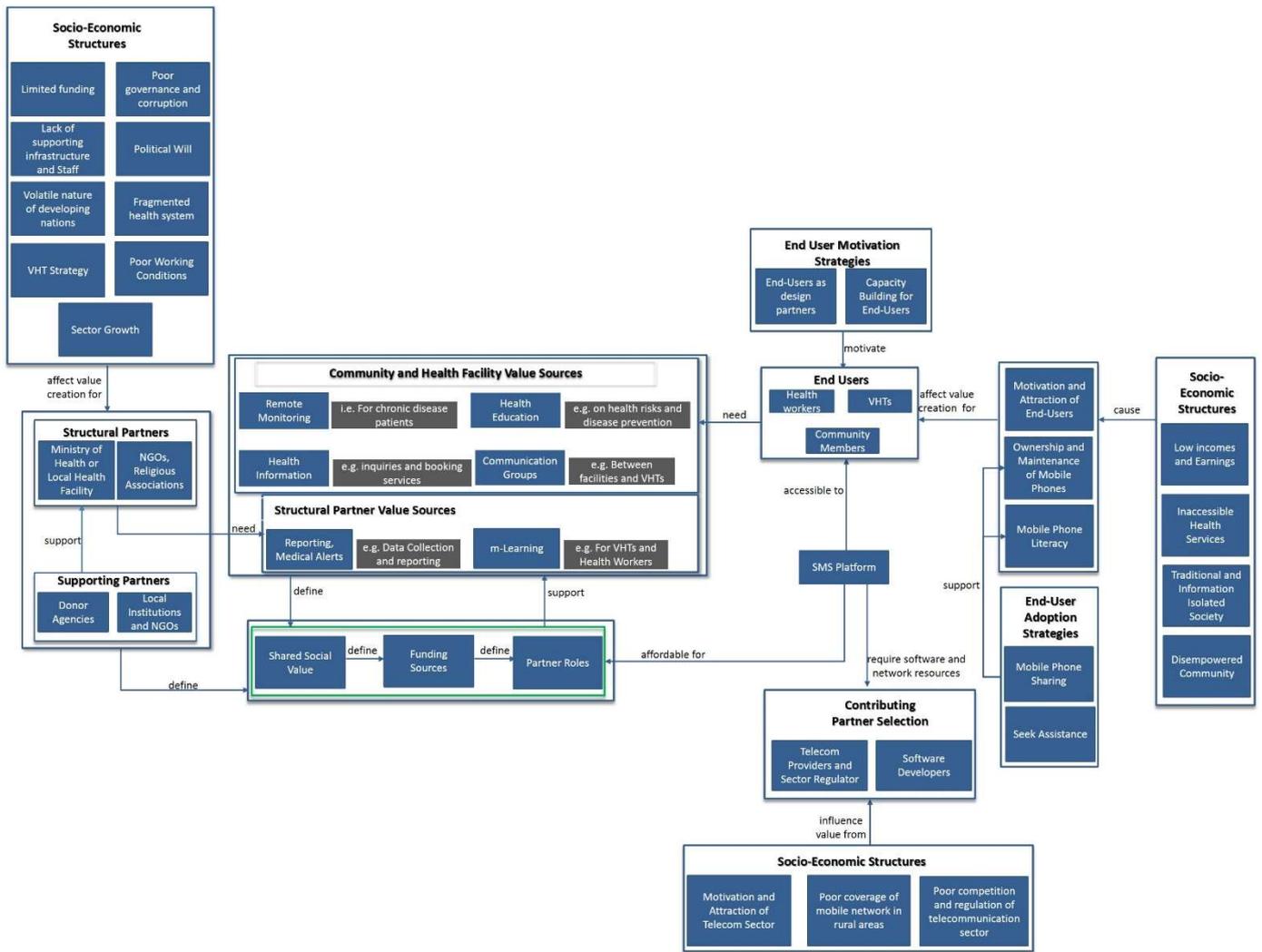


Figure 2: Context-aware model

Conclusion

Theoretical Contribution: significantly, the context-aware model is the primary contribution of this research. There are sustainability challenges in ICT4D projects that have been blamed on the lack of knowledge and understanding of developing contexts on the part ICT4D designers (Prakash and Rahul De', 2007; Lucas, 2008; Schuppan, 2009). Evaluation and research method application in the design process has also been absent from ICT4D projects (Mechael, 2009; Mechael et al, 2010; Tran et al, 2011; Tomlinson et al, 2013). Thus, by applying method and evaluation to this case study a context-aware model was developed with design principles that guide the design of viable m-Health service innovation. The model highlights design principles that guide an ICT4D designer on what creates value and what does not create value in a developing context. More specifically, the model describes whom the stakeholders are, what they need, and socio-economic factors that influence value creation and capture for these stakeholders.

For policy makers, the model highlights socio-economic factors in the context that can be translated into development goals. The survival of ICT4D depends on institutional and political support (Fillip and Foote, 2007; Ali and Bailur, 2007). Furthermore, the model demonstrates to policy makers at national and international level areas in the healthcare system and telecommunication sector that need to be

addressed. The gaps are recognized in the challenges and characteristics experienced by partners (structural, supporting and contributing).

Recommendations for ICT4D designers: It is important to note that stakeholders in the context (end-users and partners) have different views on what is of value. *Multiple-solution applications* are more likely to generate all-inclusive value for all stakeholders. It has also been observed that structural and supporting partners (governing institutions and donor agencies) can drive application design or they can be driven by end-users (health workers and community members). When partners drive them, institutional and political support is guaranteed, but may not be accepted and adopted by end-users. On the other hand, a solution driven by end-users may be perceived as valuable by health workers and by the community, but without partner support, long-term costs and maintenance needs may not be supported. In addition, are *Adoption and support strategies* that are necessary to ensure a compelling value proposition and a sustainable value network. It is possible to exclude some community members from accessing a service innovation unless strategies are developed to include all, especially the vulnerable, something that can be done by including all community stakeholders in the design process. Also, the nature of ICT4D is that initial funding comes from donor agencies who are short-term partners, though, findings and the model indicate that structural partners lack resources and capabilities to maintain service costs and expenditures, as well as human resources to support technical maintenance needs of the service innovation. Without doubt, building resources and capabilities of structural partners is necessary for sustainability.

Recommendations for Policy Makers: There is a need for *improved regulation of the telecommunication sector to include development-oriented service innovations*. Remarkably, it is not enough to have infrastructure and services, it is also necessary that these services are affordable for both the end-users and partners. It is equally important that telecom providers give priority to service charges on mobile network traffic categorizing ICT4D service innovations as development-oriented services.

Recommendations for future research: Basing on this study, there are three areas recommended for further research. The first concern is an extension of the scope of context. To note, the research focused on healthcare. However, mobile service innovations are applied in education, government and agriculture among others thus, context variables identified may not extend to these contexts. Further research using multiple cases is necessary for a more generic description of mobile service innovations in rural areas. The second concern is research methodology. Notably, Ethnography was used to study stakeholders in the context. While this methodology was appropriate for the community and to some extent healthcare workers, it was not appropriate for partners. We therefore cannot conclusively determine the causal effect partner characteristics might have on the viability of a service innovation. Hence, there is need to select a more appropriate methodology to study partners in m-Health value networks. The third area recommended for further research concerns the need for a theoretical framework appropriate for partners. The livelihood framework was meant to describe the poor and poverty. However, partners (structural, supporting and contributing) do not fall into the category of the poor. Therefore, the description we have in this research of these stakeholders is in relation the poor communities. Ultimately, there is for a research that treats these stakeholders independent of the poor for a more accurate description.