UNIVERSITY OF KWAZULU-NATAL

POTENTIAL ADOPTION OF MOBILE HEALTH TECHNOLOGIES FOR PUBLIC HEALTHCARE IN BURUNDI

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ACRONYMS

ARCT:	French acronym for Telecommunications Regulatory Authority
ART:	Anti-Retroviral Therapy
BBS:	Burundi Backbone System
CBHWs:	Community-Based Health Workers
CDS:	French acronym for Community Health Centre
CIRT:	Computer Incident Response Team
CSTIC:	French acronym for Sectoral Chamber of Technologies, Information and Communication
DHIS:	District Health Information System
EAC:	East African Community
GOB:	Government of Burundi
GPS:	Global Positioning System
GSMA:	Global System for Mobile Communications Association
HD:	French acronym for District Hospital
HIS:	Hospital Information System
IMCI:	Integrated Management of Childhood Illnesses
ITU:	International Telecommunications Union
MoC:	Ministry of Communication
MoH&A:	Ministry of Health and Fight Against AIDS
MTCs:	Mobile Telecommunications Companies
PEPFAR:	United States President's Emergency Plan for AIDS Relief
PHC:	Primary Healthcare Centres
PNSR:	National Programme on Reproductive Health
PIC:	French acronym for Communication Infrastructure Project
RBF:	Results Based Financing
RLCs:	Resource Limited Countries
SETIC:	French acronym for ICT Executive Secretariat
TOGAF:	The Open Group Architecture Framework
TPS:	French acronym for Health Promotion Technicians
VPN:	Virtual Private Network
VSAT:	Very Small Aperture Terminal
WHO:	World Health Organisation

ABSTRACT

Mobile health (or mHealth) describes the utilisation of wireless mobile communications devices in public and private healthcare. These include, but are not limited to, mobile telephones, personal digital assistants, and patient monitoring devices. Although the outcomes of mHealth interventions in developing countries have generally been assessed as positive, there is a need for designing mHealth interventions that are specifically tailored to the context of individual countries. It is in this context that this research investigates the potential adoption of mHealth technologies to provide healthcare services in Burundi from the institutional level point of view (Burundi's Ministry of Health and Fight Against AIDS (MoH&A) and the Ministry of Communication (MoC)), users point of view (primary healthcare professionals) and mobile technology point of view (mobile technology providers). Using three theoretical frameworks i.e. the Capabilities Approach (CA) model, the Diffusion of Innovation (DOI) theory and the Unified Theory of Acceptance and Use of Technology (UTAUT), this research firstly identifies the determinants and impediments to mHealth adoption in Burundi. It further describes how mHealth could be used to address the current challenges that the Burundi's Ministry of Health faces in terms of providing public healthcare services. It further proposes a framework for the adoption of mHealth in Burundi. At the institutional level and mobile technology point of view, semi-structured interviews were held with civil servants from the two Ministries and with mobile technology services providers. At the users' level, a survey was conducted with primary healthcare professionals from 47 primary healthcare centres. Findings reveal that mHealth adoption can contribute to disease prevention, disease management and the provision of quality healthcare in Burundi. Although there is limited knowledge of mHealth capabilities within the Burundi's public healthcare sector, there is a general willingness towards the adoption of mHealth notwithstanding challenges associated with its adoption. Although DOI construct-related factors such as relative advantage, compatibility, trialability and observability significantly influence the adoption of mHealth in Burundi, complexity does not. In addition, performance expectancy, effort expectancy and facilitating conditions are UTAUT constructs that significantly influence the adoption of mHealth adoption. The research advocates for an integrated and collaborative approach to address the impediments to mHealth adoption in Burundi.

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CHAPTER 1: INTRODUCTION

1.1. Introduction

The World Health organisation defines mHealth as "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants and other wireless devices. mHealth involves the use and capitalisation on a mobile phone's core utility of voice and short messaging service (SMS) as well as more complex functionalities" (WHO, 2011a:6). In developing countries, the adoption of mobile technologies as a means to provide healthcare services is triggered by the growth of mobile phone users (ITU, 2014) coupled with the rapid expansion of mobile networks (Aranda-Jan, Mohutsiwa-Dibe and LouakanoUTva, 2014), decreasing costs of mobile phones and innovations within the mobile technology industry. mHealth proves to be efficient in extending access to healthcare to populations in developing countries and improving the capacity of health systems to provide quality healthcare (Qualcomm, 2014). Particularly, mHealth initiatives have been effective in reaching the underserved population by addressing some crucial healthcare challenges. Such challenges include the shortage of skilled healthcare workers, lack of compliance and adherence to prescribed treatment, inadequate disease surveillance mechanisms, ineffective inventory and supply chain management systems, use of illegal drugs, inability to diagnose and treat patients and health-related information dissemination delays (Qiang, Yamamichi, Hausman and Altman, 2011).

A literature search reveals that Burundi is currently lagging behind in terms of mHealth adoption within the public sector compared to the rest of the East African Community[1] (EAC) member states. Currently, there are only two documented mHealth initiatives in public healthcare in Burundi. On one hand, a Rapid SMS[2]-based "KIRA Mama Project (Burundi Ministry of Health, 2014) is in a pilot phase (since September 2014) within the maternal and infant health department of the Ministry of Health and Fight Against AIDS (MoH&A). On the other hand, SIDA info is a hotline initiative designed to educate people about HIV/AIDS prevention and management amongst other interventions (ElGaddari, 2014). Although SIDA info was established 22 years ago

[1] The East African Community is made of 5 countries: Burundi, Kenya, Rwanda, Tanzania and Uganda
[2] Rapid SMS is an open source ICT tool used for rapid configuration of SMS for data collection, analysis, transmission, and logistics coordination from a low entry mobile phone (Dimagi, 2016).

(ElGaddari, 2014), a literature search suggests that its impact on HIV/AIDS prevention and management in Burundi has not been investigated. Similarly, although the Rapid SMS-based mHealth initiative had a positive impact on health outcomes in the neighbouring country Rwanda (Burundi Ministry of Health, 2014), its impact within the Burundi's context has not been evaluated as the project is still in its infancy. Hence, the potential use of mHealth within the context of Burundi's public healthcare service delivery has not been investigated. Particularly factors that may influence or impede the adoption of mHealth in Burundi have not been investigated. Thus, there is a risk of failure of current or future mHealth projects due to a lack of knowledge of determinants of and impediments to the adoption of mHealth in Burundi. In view of the benefits associated with mHealth adoption within Resource Limited Countries (RLCs) (Shao *et al*., 2015; Nyamawe and Seif, 2014; Lund *et al*., 2012; Chang *et al*., 2011, this research posits that mHealth could yield substantial benefits to public healthcare in Burundi, and if adopted, would enhance the processes of disease prevention and disease management and contribute to quality healthcare services in the country. Using survey responses from healthcare professionals, and also based on the interviewees' responses from the Ministry of Health and Fight Against AIDS (MoH&A), the Ministry of Communication (MoC), and mobile telecommunications companies, this research assesses if and how the country should adopt mHealth for public healthcare interventions.

The research employs three theoretical frameworks. Using the Capability Approach model, this research assesses the potential use of mHealth capabilities for disease prevention, disease management, and quality of healthcare services from the Burundi's healthcare professionals' point of view. From the Diffusion of Innovation (DOI) theory and Unified Theory of Adoption and Usage of Technology (UTAUT) constructs, this research further identifies the determinants of mHealth adoption within the context of the country. Lastly, the research identifies the major impediments towards mHealth adoption in Burundi and concludes by presenting a framework that will guide attempts to implement mHealth in Burundi.

1.2. Brief background and motivation for the study

In 2015, Burundi was classified as the poorest country in the World according to the International Monetary Fund (IMF) (AFP, 2016). In 2011, it is believed that 69% of people living in rural areas in Burundi were poor while the poverty level in urban areas sat at 34% (ADBG, 2011). In 2014, the ratio of doctors to inhabitants was 1:19,231, far below the WHO recommended ratio of 1:10,000. For nurses the ratio is 1:11,349 which is far less than the 1:3000 WHO recommended ratio (Burundi Ministry of Health, 2014). Qualified doctors and nurses were unequally distributed across the country with 50% of doctors and 21% of qualified nurses based in the capital city Bujumbura. In 2006, the Government of Burundi (GoB) introduced free healthcare services for infants and mothers but still in 2014, the country was far from achieving the Millennium Development Goals in terms access to healthcare (Burundi Ministry of Health, 2014). In 2010, the maternal mortality rate was still very high with 800 deaths per 100000 births (UNICEF, 2013) ranking the country the fifth highest for maternal mortality in the world (after Chad, Somalia, Sierra Leone and the Democratic Republic of Congo). It was predicted that the country will not be able to achieve the Millennium Development Goal number 5 of reducing the maternal mortality rate by 75% between 1990 and 2015. However, in view of the mHealth benefits as discussed in the literature review chapter (chapter 3), it is anticipated that the adoption of scalable mHealth interventions will help alleviate some of the health-related challenges that the country currently faces. A more detailed description of the study's context is provided in Chapter 2.

1.3. Problem statement, research objectives and research questions

Adedeji, *et al*. (2011) argue that the quality of health information systems in African countries is hampered by data incompleteness coupled with delayed and inadequate data analysis. The Global Health Initiative (GHI, 2011) indicates that Burundi's National Health System is weak as there is a lack of integration of information systems. This results in redundant data, making it difficult to monitor and manage the outbreak and spread of diseases effectively. Further obstacles to effective management and prevention of diseases in Burundi are inaccurate and outdated health data (GHI, 2011). This is mainly due to poor ICT infrastructure, which hampers the prospects of using automated systems to curb the shortcomings of prevailing manual systems within the

Burundi's healthcare system. Hence, devising effective interventions to manage pandemics and other diseases is a challenge due to lack of timeous and reliable data. As stated above, mHealth has the potential to improve the capacity of healthcare systems to provide quality healthcare. For example, mHealth can enable remote data collection, remote patients' treatment, and communication amongst field workers, remote training of healthcare workers, tacking diseases and epidemic outbreak, remote treatment and diagnostic support (Wave Consulting, 2011). All of these can enhance the healthcare delivery processes and improve the quality of healthcare especially in countries whereby the ICT and Internet infrastructure are poor. Burundi lacks suitable health infrastructure (Nyssen, *et al*., 2015). One of the ways to address poor access to healthcare in the country, is to devise mHealth interventions as mobile communications (primarily through telecoms) is growing rapidly in the country, is cheap and flexible (Schweitzer and Synowiec, 2012). However, the potential use of mHealth within the Burundian context has not been investigated. It is in this context that this study investigates and identifies what is needed to adopt mHealth within the public health sector to encourage effective prevention mechanisms and management of diseases in Burundi and at the same time enhancing the provision of quality healthcare in the Burundi's public healthcare system.

To study the potential adoption of mHealth in the public sector in Burundi, it is paramount to identify pre-conditions for the adoption of mHealth projects and to assess whether those conditions exist or not. Firstly, it is imperative to assess whether the current ICT environment and mobile telecommunications infrastructure make mHealth adoption possible. Secondly, the adoption of mHealth requires the buy-in of decision makers and those who will be impacted upon by the technology. Thus, the preparedness for the adoption of mHealth from the stakeholders' point of view needs to be assessed. Specifically, the healthcare professionals' inclination towards mHealth adoption needs to be determined, including the knowledge they have about mHealth and their ability to use mHealth devices and applications. In addition, it is important to investigate how mHealth technology would enable the country to achieve its national health-related goals. Furthermore, there is a need to identify the country specific technology-related and human-induced variables that need to be taken into consideration for mHealth to be adopted. Lastly, obstacles to mHealth adoption need to be identified.

Thus, the problem statement that guides this study is formulated as follows: **The potential use of mobile communications for enhancing public healthcare in Burundi has not been investigated**. This statement leads to the following main research question: **What is needed in order to adopt mobile health (mHealth) for healthcare services delivery in Burundi?**

Subsequent research questions that derive from the main research question and the corresponding research objectives are as follows:

Research objective 1: To assess healthcare professionals' readiness to adopt mHealth

Research question 1: What are health professionals' perceptions of the use of mobile health to provide healthcare services?

- To what extent are healthcare professionals at the Primary Healthcare Centres (PHCs) willing to adopt mHealth? (1a)
- To what extent do healthcare professionals at the PHCs know about mHealth? (1b)

Research objective 2: To identify the determinants of mHealth adoption

Research question 2: What are the determining factors for mHealth adoption in Burundi?

Research objective 3: To identify potential contribution of mHealth interventions in achieving the country's broad goals in the health sector

*Research question 3: What **potential** role can mHealth play in combating diseases in Burundi?*

- What is the perceived mHealth contribution to disease prevention in Burundi? (3a)
- What is the perceived mHealth contribution to disease management in Burundi (3b)
- What is the perceived mHealth contribution to quality of healthcare services in Burundi? (3c)

Research objective 4: To identify obstacles to mHealth adoption in Burundi

Research question 4: What are the impediments to mHealth adoption in Burundi?

1.4. Principal theories upon which the research is constructed

The adoption of mHealth requires a strategic and integrated approach and should support national health goals (WHO, 2011b). Similarly, this research approaches the adoption of mHealth using an integrated approach, combining information from various stakeholders into a linked approach for mHealth adoption. The conceptual framework proposes three levels that need to be taken into consideration when planning to adopt mHealth. These levels are institutional level, system level, and the healthcare professional level (see figure 1.1). The institutional level is made up of civil servants at the national level within the Ministry of Health and the Ministry of Information, Communication and Telecommunications[3] in Burundi. These two stakeholders at the institutional level are decision makers in terms of the implementation of the national health goals and ICT in the health sector. Hence, it is imperative that these decision makers understand the importance and appropriateness of mobile technology (system level) as a catalyst towards the attainment of the national health-related goals. Healthcare professionals are mandated to implement programs that are aligned with the institutional-level goals. Healthcare professionals' experiences and perceptions of adoption of mobile technology are critical components of successful implementation of mHealth initiatives. The institutional involvement to promote mHealth adoption at the healthcare professional level (through training, and policy formulation, for instance) is equally important. The proposed conceptual framework is presented in figure 1.1:

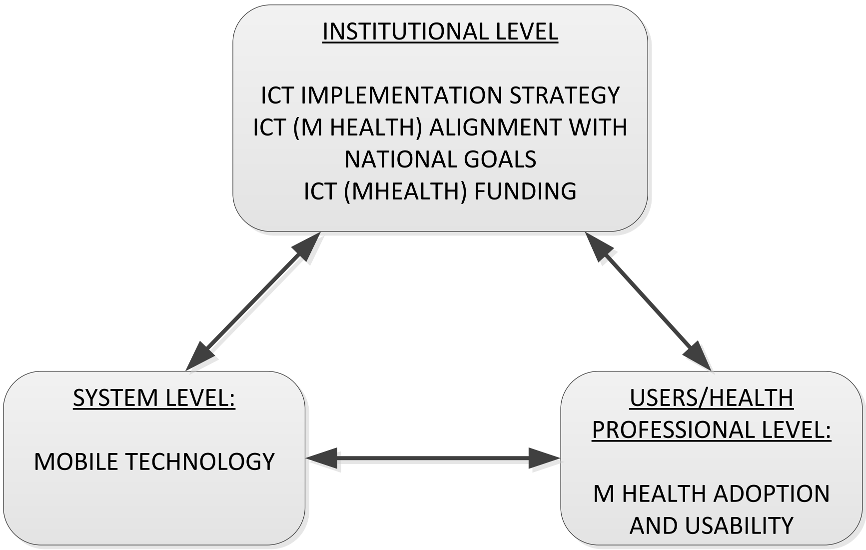

Figure 1. 1. Conceptual Framework

[3] The Ministry of Information, Communication and Telecommunications is commonly referred to as the Ministry of Communication

At the system level, mHealth adoption within the context of Burundi is approached from the Capability Approach (CA) model (Sen, 2001). The CA model is anchored on three (3) constructs namely Capabilities, Substantive freedoms and Functionings. Sen (2001) argues that peoples' use of their capabilities may lead to substantive freedoms such as getting education, access to healthcare, social participation, and freedom from oppression. However, such freedoms depend on the functionings which can be defined as what people would like to do or to be to obtain these freedoms. Capabilities can refer to the various skills that are acquired through the interaction with ICT (Grunfeld, Hak, Pin, 2011*)*. In the context of mHealth, this research posits that mHealth has the potential to enable people and health workers to receive or provide healthcare-related education and awareness programs, collect health-related data, monitor health-related cases, communicate and train healthcare workers, track disease and epidemic outbreaks and support patients' diagnosis and treatment (Vital Wave Consulting, 2009). This research further posits that the acquired capabilities through mHealth may lead to substantive freedoms such as prevention of diseases, disease management, and quality of healthcare in Burundi. The education and awareness capability empowers the community with the knowledge for disease prevention whilst the other capabilities empower healthcare professionals for disease management and also enhance the quality of healthcare service provision. However, within the context of this research, the attainment of such freedoms depends on what healthcare professionals may value doing. In this case, the attainment of such freedoms depends on the healthcare professionals' acceptance of mHealth capabilities. The Capability Approach model helps understand the role that mHealth may play to address some of the challenges that the country is facing within the health sector. It further helps in the assessment of the knowledge of mHealth capabilities from primary healthcare professionals' point of view.

At the user's level, mHealth is approached from the adoption/usage point of view using the DOI and UTAUT model constructs. The following section provides an overview of the models. A comprehensive description of all the theoretical models used in this study including their applicability in Information Systems research and relevance to this study is provided in the "theoretical frameworks" chapter (Chapter 4).

1.4.1. The DOI model

The DOI highlights the adoption process (phases) of an innovation/technology. According to the theory, the adoption process starts with the knowledge phase. In this phase, the user of a new technology is acquainted with it and becomes aware of the need for the technology. The next stage is the persuasion phase in which the user makes up his/her mind to adopt or not to adopt the technology. Rogers (2003) says that at the persuasion phase there are five (5) factors that affect the decision to adopt/not adopt the new technology:

1. Relative advantage: the degree to which an innovation (i.e. new technology) is beneficial compared to its predecessor
2. Compatibility: the extent to which a new technology meets the needs of the potential users/adopters and is consistent with their experiences and values
3. Complexity: refers to the extent to which a new technology is difficult to understand and/or use
4. Trialability: refers to the extent to which an innovation can be tested before its adoption
5. Observability: the extent to which a new technology provides tangible results (i.e. visibility of the results)

In the context of this research, the five factors of the persuasion phase are tested as possible determinants of mHealth adoption. This framework also ascertains the readiness of health professionals to adopt mHealth in terms of the knowledge they have about mHealth.

1.4.2. The UTAUT model

The UTAUT Model emanates from a combination of several theories. The model is based on four constructs namely performance expectancy, effort expectancy, social influence and facilitating conditions. The UTAUT model uses these four constructs to explain users' intention to use/adopt an information system. Venkatesh, Morris, Davis and Davis (2003) defines these constructs as follows:

1. Performance expectancy: is the degree to which a user or potential user of an information system believes that the system will contribute to the attainment of some benefits related to his/her job performance.
2. Effort expectancy: is the degree to which an information system is easy to use.

3. Social influence refers to the degree to which individuals perceive that influential people believe they should use a new information system.
4. Facilitating conditions: are defined as the extent to which an individual believes that there is technical and organisational infrastructure to support the use an information system.

Venkatesh, *et al*. (2003) also posit that gender, age, experience and voluntariness of use of a system are moderating factors of the users' behavioural intention to use an information system.

The UTAUT model is deemed adequate for this study as it assists in determining existing and required facilitating conditions for the adoption of mHealth in Burundi. The model further assists in establishing performance expectancy and effort expectancy factors that significantly influence the adoption of mHealth in Burundi. Thus, it is anticipated that the combination of the DOI and UTAUT constructs as used in the study will better help in identifying the determinants of mHealth adoption in Burundi from different perspectives (healthcare professionals, Ministry of Health, Ministry of Communication and mobile technologies providers).

The institutional level mainly helps in identifying the existing and required facilitating conditions for the adoption of mHealth in Burundi.

1.5. Methodology

The study adopts a positivist approach along with qualitative and quantitative data collection and analysis methods. On one hand, data was collected from 47 Primary Healthcare Centres (PHCs) in 5 provinces. On the other hand, data was collected from the Ministry of Health, Ministry of Communication and Mobile telecommunications companies using semi-structured interviews. From the Ministry of Health, two interviews were conducted with two members of the National Directorate for Health Information Services. The directorate is in charge of planning, organizing and disseminating health information throughout various departments within the Ministry of Health. From the Ministry of Communication, a semi-structured interview was held with the Director of the Centres for Information, Education and Communication for Peoples' Development (CIEP). Further interviews were conducted with four mobile telecommunications companies. Principal Component Analysis (PCA) was performed to deduce scores for each construct (within the guiding theoretical frameworks) that could be used for further statistical analysis. Further statistical analysis such as regression and correlation analyses were performed using SPSS Version 22 to extract meaningful relationships between mHealth capabilities and the potential determining factors of mHealth adoption. The Nvivo (version 10 and 11) qualitative data analysis software was used to analyse interviews' responses by themes.

An extensive discussion of the research methodology adopted in this study is provided in the methodology chapter (Chapter 5).

1.6. Significance of the study

Burundi is currently facing a number of challenges related to the delivery of healthcare services. Such challenges hamper the efforts geared towards the prevention and management of diseases in the country. In view of the mHealth capabilities, it is apparent that mHealth may assist in disseminating healthcare services to a large portion of the population that uses mobile devices, address (to a certain extent) the shortage of skills within the public health sector, enable timely and reliable data collection and dissemination for decision making. This study is the first study that investigates the determinants of mHealth adoption within the public health sector in Burundi using primary data collection and a tripartite and integrated approach. Gagnon, Ngangue, Gagnon and Desmartis (2016) advocate that although some determinants of mHealth adoption may be similar to other ICT applications, mHealth has idiosyncratic features that separate it from other ICT studies. The mHealth field thus deserves individualised, focused attention. Firstly, unlike other ICT applications within the healthcare sector, mHealth is mostly centresed on and driven by consumers within the healthcare ecosystem (Akter and Ray, 2010). In addition, the mHealth research field is characterised by descriptions of small scale mHealth interventions. Such descriptions are rarely based on theoretical frameworks (Heerden, Tomlinson and Swartz, 2012; Imran, Quimno and Hussain, 2016). Furthermore, the use of mHealth applications to provide healthcare services presents its own unique challenges, hence it warrants specific strategies (Gagnon, Ngangue, Gagnon and Desmartis, 2016). To address the lack of theoretical frameworks to the study of mHealth, this study uses three theoretical frameworks to investigate the adoption of mHealth capabilities in Burundi. The study adds a new integrated perspective of mHealth adoption to the body of knowledge, focusing on end users, technology and the ministry level (decision makers). In view of the relevance and benefits of mHealth, it is anticipated that the framework that derives from the findings of this study will enable the Burundi Ministry of Health and other stakeholders to make informed decisions in disseminating healthcare services using mobile technology. Such informed dissemination of mHealth could have a wider impact on the population, thus enabling the country to address some pressing issues related to the management and prevention of diseases in Burundi. Although mHealth research is maturing, there is still a need for evidence of challenges and limitations to its adoption, particularly in developing countries. Thus, this research further contributes knowledge to this gap and could be used as a reference for future mHealth project implementations within a similar country set up.

1.7. Outline of study evolving

This study is structured into 7 chapters:

Chapter 1 introduces the study
Chapter 2 presents the study background and context
Chapter 3 presents the relevant literature review
Chapter 4 presents a detailed discussion of the theoretical frameworks used in this study
Chapter 5 provides a detailed description of the research methodology adopted for the study
Chapter 6 presents the data analysis and results
Chapter 7 discusses the results from the analysis in Chapter 5
Chapter 8 concludes the study and provides recommendations in line with the findings in chapter 6. The chapter further outlines suggestions for further research.

1.8. Summary

This chapter introduced the study. It highlighted the purpose of the study, which is to investigate what is needed in order to adopt mobile health (mHealth) for healthcare services delivery in Burundi. It further highlighted the study's research objectives and associated research questions. In this chapter, it was argued that this study is significantly important as currently there are no empirical primary data that depict the determinants, challenges and potential for the adoption of mHealth in Burundi. This stems from the fact that mHealth is a newly introduced concept in Burundi. Thus, there is a need for more research that informs how mHealth may be introduced based on the country's contextual factors such as the socio-cultural, economic and political landscape of the country. It was further argued that the study introduces a new approach to the study of mHealth by using an integrated approach i.e. a combination of institutional, mobile technology and users' perspectives. Moreover, the chapter highlighted that the research uses a combination of qualitative and quantitative approaches to data collection. The chapter briefly described the data collection and analysis processes used in this study.

CHAPTER 2: THE STUDY'S CONTEXT

2.1. Introduction

The aim of this chapter is to provide the context of the study. To this end, the chapter firstly outlines the country's general profile. It subsequently describes Burundi's healthcare system and its challenges. Furthermore, this chapter emphasizes on the prevailing ICT environment by highlighting, the goals of the current national ICT policy, the state of mobile telecommunications, the state of ICT usage in Burundi's health sector, and the current major ICT Projects in Burundi.

2.2. Country's general Profile

Situated in East Africa, Burundi is a landlocked country with 18 provinces (Figure 2.1 and Table 2.1) with a surface area of 27,834 km^2 (ISTAfrica, 2014). The country has only one indigenous language (Kirundi) which is spoken throughout the country. Burundi has one foreign official language (in addition to the indigenous language), French, which is the main medium of instruction in public high schools and tertiary institutions. Although in 2014 the Government of Burundi adopted English as an additional official language, English is seldom spoken although it is gaining momentum due to the country's East African Community integration influence. Swahili is spoken by few people in the country compared to Kirundi, and French. According to 2015 estimates, Burundi had a population of approximately 11 286 017 (Countrymeters, 2016). In 2015, the country was listed by the International Monetary Fund (IMF) as the world's poorest country with a GDP of 315.20 US Dollars (AFP, 2016). The country is heavily dependent on foreign aid. In 2014, it was estimated that foreign aid represented 42% of the Burundi's national income, making the country the second highest foreign aid dependent in Sub Saharan Africa (CIA, 2016). While the country's economy was still recovering from a decade long civil war (1993-2005), in 2015 the country's GDP growth dropped by 7.2% due to the recent political crisis in the country (AFP, 2016). The crisis emanated from a controversial extension of a third presidential term, which resulted in foreign aid donors withdrawing their financial support (The Guardian, 2016).

Figure 2. 1.Map of provinces in Burundi
Source: United Nations (2016)

Table 2. 1. Details of Provinces in Burundi (GEOHIVE, 2016; Statoids, 2015)

Province	Capital	Area (km2)[4]	Population (2008 census)[5]
Bubanza	**Bubanza**	**1,089.04**	**338,023**
Bujumbura Mairie	**Bujumbura**	**86.52**	**497,166**
Bujumbura Rural	**Isale**	**1,059.84**	**464,818**
Bururi	**Bururi**	**1,644.68**	**313,102**
Cankuzo	**Cankuzo**	**1,964.54**	**228,873**
Cibitoke	**Cibitoke**	**1,635.53**	**460,435**
Gitega	**Gitega**	**1,978.96**	**725,223**
Karuzi	**Karuzi**	**1,457.40**	**436,443**
Kayanza	**Kayanza**	**1,233.24**	**585,412**
Kirundo	**Kirundo**	**1,703.34**	**628,256**

[4] Source: GEOHIVE (2016)

[5] Source: Statoids (2015)

Makamba	**Makamba**	**1,959.60**	**430,899**
Muramvya	**Muramvya**	**695.52**	**292,589**
Muyinga	**Muyinga**	**1,836.26**	**632,409**
Mwaro	**Mwaro**	**839.60**	**273,143**
Ngozi	**Ngozi**	**1,473.86**	**660,717**
Rumonge	**Rumonge**	**1,079.72**	**352,026**
Rutana	**Rutana**	**1,959.45**	**333,510**
Ruyigi	**Ruyigi**	**2,338.88**	**400,530**

2.3. Burundi's healthcare system

At the national level, the central coordinating body of Burundi's healthcare provision is the Ministry of Health and Fight Against AIDS (MoH&A). The country's healthcare coordination is organised into three hierarchical levels: the central, intermediate and peripheral levels (Government of Burundi, 2011). The central level is primarily mandated to formulate policies, mobilise and allocate resources, strategic planning, coordination and evaluation. This level consists of the office of the minister, a general health inspectorate, two general directorates, six departments, nine health programs and related services (Government of Burundi, 2011). The intermediate level comprises 17 provincial health bureaus. Each provincial bureau coordinates all health activities within its allocated province. It also supports health districts' functions and coordinates inter-sectoral collaboration (Government of Burundi, 2011). The peripheral level has 45 health districts, 63 hospitals and 735 primary healthcare centres (Government of Burundi, 2011). Health districts, hospitals and primary healthcare centres are spread across the 129 cities of the country (Government of Burundi, 2011). In Burundi, health districts are the cornerstone of the healthcare system (Government of Burundi, 2011). Each health district covers 100000 to 150000 residents (approximately 2 to 3 cities) (Government of Burundi, 2011). Each health district coordinates healthcare systems in the community, at primary health centres and at the district hospital within its jurisdiction.

In 2010, out of the 735 primary healthcare centres, 423 were public, 105 were run by faith missions and 207 were private (Government of Burundi, 2011). However, the private sector is not well integrated into the national health system (Government of Burundi, 2011). Primary healthcare centres are the point of entry into the Burundi's healthcare system. Each healthcare centre offers a minimum services package that includes health promotion and education services, prevention and primary treatment services, laboratory and pharmaceutical services, and in-patient observation (Government of Burundi, 2011). The referral system is comprised of first reference hospitals (63 hospitals of which 41 are public), second reference hospitals (3 hospitals) and the third reference hospitals (7 national reference hospitals) (Government of Burundi, 2011). The districts of the municipality of Bujumbura (the capital city) do not have first reference hospitals. Hence, patients from Bujumbura normally go directly to the national hospitals. The national hospitals from Bujumbura are therefore required to provide the minimum package (which is normally dispensed at the primary healthcare centres) in addition to other specialised healthcare services (Government of Burundi, 2011).

The Ministry of Communication, through its Centre of Information, Communication and Education for population development (CIEP) provides some support to the Ministry of Health in disseminating healthcare awareness programs through various media, mainly radio broadcasting and television. The Ministry's department in charge of health information dissemination focuses on themes related to breastfeeding, good hygiene, and infants' homecare and treatment.

Through its National Health Development Plan (2011-2015), the Government of Burundi adopted the principle of performance-based financing in order to achieve its national health goals (GHI, 2011). Performance-based financing (also termed Results-Based Financing or RBF) is a funding instrument whereby funds allocation and payment are determined by the achievement of pre-determined results (World Bank, 2013). RBF helps in improving the performance of the supply and demand of health systems, thus contributing to the universal health coverage. In an RBF set up, payments are only authorised after verification of the quality and quantity of health services delivered. In a healthcare facility for instance, individual health facilities are allocated funds based on the quality and quantity of services they produce (World Bank, 2013). Such services should be aligned with priority services defined at the national level. After verification of the provision of the predetermined services, healthcare facilities earn funds that can be used to cover the facility's operational costs or to pay performance bonuses to healthcare professionals based on predefined criteria. A portion of the funds could be used for savings in the account of the healthcare facility (the facility has the autonomy to use such savings but must give account as to how the money is spent) (World Bank, 2013). Evidence from African countries where RBF was implemented reveals that the financing framework can strengthen core health system functions and increase the efficiency and accountability of the health system (World Bank, 2013). A number of authors have recognised that RBF can increase healthcare professionals' motivation with the net effect of improving the quality of healthcare services provision (Morgan, 2010; Toonen, Canavan, Vergeer and Elovainio, 2009; Soeters, Habineza and Peerenboom, 2006). Through RBF, accountability is enforced by emphasizing the results before payment. It also leads to consistent monitoring of outcomes performance (World Bank, 2013). There is strong evidence to suggest that RBF produces better outcomes than other non-RBF funding frameworks. In a randomised trial set up in Rwanda (World Bank, 2013), the RBF program significantly contributed to the increase in the number of childbirths in health facilities. There was also an increase in children's preventive care visits and the quality of care in healthcare facilities that are linked to performance-based financing compared to those that are not linked to RBF. In Burundi and Zimbabwe, RBF contributed to an increase in the number of post-natal care visits. In order to ensure its longer term sustainability, RBF should be incorporated into a comprehensive health financing strategy. Proposed ways to accomplish this include setting civil servant salaries increases according to performance (through RBF framework) and investing a portion of the RBF funds into making healthcare facilities function better . In addition, RBF should be integrated into the government public health system and government financial system and should be aligned with the overall objectives and design of systems (World Bank, 2013). In 2013, in Burundi, government was funding 52 percent of the cost of RBF. It is also perceived that harmonising the use of donor funds with RBF can enhance the impact of donor funding. A number of funding organisations such as Global Fund, PEPFAR, and GAVI have embarked on an RBF path (World Bank, 2013). Thus, governments that want to secure funding from these institutions need to adopt the RBF. Burundi could use the same approach to attract funding for mHealth projects as the "Open RBF system" has been implemented for monitoring Results Based Financing (RBF) programs at the central and provincial levels in the country (Nyssen *et al*., 2015).

2.4. Healthcare system challenges

Since the outbreak of civil war in 1993, there has been an increase in cases of diseases in Burundi (IFRC, 2012). In addition to the challenge of post-war reconstruction, is the problem of the prevention and management of disease outbreak. The overall health status of the Burundi's population is precarious. According to the 2008 national census, the mortality rate was 15 per 1000 habitants. This is predominantly due a weak healthcare system, the prevalence of transmissible diseases such as Malaria, HIV/AIDS, tuberculosis, diarrhoea, preventable diseases (through vaccination), acute respiratory infections, which affect particularly pregnant women and children, chronic non-transmissible diseases, neglected tropical diseases, vulnerability of mothers, infants and adolescents, a heavy population density (310 habitants per km^2), high rate of acute and chronic malnutrition (6% and 58%) for infants between the ages of 0 and 5. However, the country, through its National Health Program (PNS) has made significant efforts towards providing healthcare services to a larger portion of the population. These efforts include the decentralisation of healthcare provision through Health Districts (since 2009), increase in universal access to healthcare services (50% of the population) through infants' (less than 5 years) and expectant mothers' free access to healthcare (since 2006) and the establishment of National Medical Assistance scheme for the informal sector, and the performance-based approach towards healthcare funding (since 2010).

The country's health information system is still in its infancy. This causes a delay in responding to emergencies, epidemic, and diseases outbreak. The following section discusses the country's ICT environment landscape with special focuses on the use of ICT in the healthcare sector.

2.5. The ICT environment

2.5.1. National ICT Policy

In 2004, Burundi adopted a National ICT Development Policy (IST Africa, 2014). The policy has since been adapted and a new policy that will span 15 years (2010-2025) was adopted in 2010. The new policy is an expression of the Government of Burundi (GoB) vision to provide universal access to ICT throughout the country in order to accelerate the country's economic growth. This signifies a positive move towards ICT expansion in the country. Furthermore, the GoB aims at making the country a centre of excellence and a regional reference point in ICT by 2025. The new policy has the following strategic goals:

1. To develop ICT human resources: to this end, the GoB plans to increase the number of trained ICT professionals.
2. To improve and adapt the political, judicial and regulatory environments to include ICT as a catalyst for economic development: the aim is to create an environment conducive for ICT development and to build an all-inclusive information society.
3. To improve ICT infrastructure: The aim is to have a well-developed and accessible ICT infrastructure; provision, and efficient use of funds for ICT infrastructure development; and to motivate and empower the private sector to invest in the ICT sector.
4. E-government, e-governance and Burundi online: the aim is to put in place public communication structures that supply online public services.
5. ICT and economic development: to put in place ICT applications that may improve the industrial sector.
6. ICT and social development: to use ICT applications to support the National Health Policy, to increase the number of youth, women and handicapped people who are trained in ICT.
7. Rural connectivity and universal access: to have an ICT network that enables universal access to communications by the entire population.
8. Research and development: increase ICT and industrial research and development capacity.
9. Electronic transactions and security: to ensure ICT network security
10. Development of national and regional contents: to develop local language content in order to promote larger scale utilisation of ICT applications by the population in all national sectors.

2.5.2. Mobile telecommunications

According to 2012 estimates, Burundi had 17,400 fixed phone lines compared to 32,600 in 2010 (ISTAfrica, 2014). Such a decrease in fixed lines was compensated for by an increase in mobile phones subscriptions which was estimated at 2.247 million mobile phones in 2012 compared to 1.98 million in 2011 (ISTAfrica, 2014). In 2014, Burundi had an estimated market penetration rate of 34% for mobile telecommunication, 0.1% for fixed landline telephones, and 4.9 % for Internet (Research and Markets, 2015). In the same year, Burundi had six mobile telecommunication companies: Leo U-com had 64% share of the Burundi market with 2,500,000 subscribers (Leo, 2014), Econet which is a subsidiary of Econet wireless, the Nepalese company Smart telecom, Tempo Africell, the state-owned ONAMOB and Vietel Telecom. Burundi had a 13% increase in mobile telephone users (Research and markets, 2015) at the end of 2013 (from 2.24 million users in 2012 to 2.53 million users in 2013). This is largely due to the network expansion of some mobile telecommunications companies (that previously covered the capital city only) to cover a large part of the country (Telegeography, 2014a). In addition, according to the Burundi National Telecommunications Regulator Agency (ARCT), the increasing competition amongst mobile telecommunications companies has led to a decrease in mobile handset costs and call prices, which could also justify the increase in the number of mobile users (Telegeography, 2014a). Such competition has led to the adoption of innovative mobile applications (by Mobile Telecommunications Companies) such as mobile banking. For instance, Econet introduced Ecokash, which allows Econet clients to send money via mobile phone (Econet Wireless, 2014). In addition, with Buddie Econet, prepaid Econet clients can deposit, withdraw, send money, or pay for goods and services (Econet Wireless, 2014). Leo has a 3G network and introduced Leo Manoti, a service that allows Leo clients to send and receive money from their mobile phones (Telecompaper, 2013). Smart Telecom launched its 3G network in September 2014 (Telegeography, 2014b). The provision of mobile banking by Burundi's telecommunications companies provides an opportunity for designing mHealth solutions that are interoperable with other mobile-enabled applications such as mobile banking. It is anticipated that accessing mHealth applications and mobile money applications on the same mobile platform would allow access and payment for mHealth services through one integrated solution.

2.5.3. ICT in the health sector

In a recent study conducted in five provincial health offices, five health district administrations and twelve hospitals in Burundi, Nyssen *et al*. (2015) discovered that computer hardware used in the health sector has often been supplied by donors for the implementation of specific donor-driven intervention programs. In addition, they posit that in Burundi's health sector, there is lack of Health Ministry-wide management of hardware (and computer equipment) distribution across various ministry's directorates, provincial and district administrations and hospitals. This creates an imbalance in terms of computer equipment distribution within the ministry. Generally, structures within the ministry that are supported by multiple donors have a lot of computer equipment while others do not have any computers at all (Nyssen *et al*., 2015). Moreover, healthcare centres that manage to secure funds for equipment do not have enough knowledge on how to integrate this equipment into their current activities (Nyssen *et al*., 2015).

Computer hardware specifications within the Ministry of Health are of a low standard with desktop Personal Computers (PCs) running on Windows XP or Windows 7 operating system. An exception is the Directorate of the National Health Information System which uses open source software such as Linux Mint or Ubuntu for a number of desktop and server computers (Nyssen *et al*., 2015). A large number of those PCs run at a very limited capacity due to virus infections. Such infections are due to a lack of budget for Internet access, thus keeping antivirus software outdated (Nyssen *et al*., 2015). In addition, electronic documents are frequently transferred between computers using removable disks (USB memory stick) which constitutes a channel for computer viruses propagation (Nyssen *et al*., 2015).

Hospital Information Systems (HIS) are only implemented in less than 10% of the 12 surveyed hospitals while most of the surveyed health facilities run OpenClinic GA[6]. Although most of the provincial and health districts use the GESIS system to report health data to the central level, a number of hospitals and almost all of the healthcare centres still rely on paper-based data collection methods (Nyssen *et al*., 2015). Healthcare administrative clerks and clinical staff manually record health/patients' data. Such data is then sent to the health district on a monthly basis although in some

[6] OpenClinic GA is an open source integrated hospital information management system covering management of administrative, financial, clinical, lab, x-ray, pharmacy, meals distribution and other data.

cases urgent diseases outbreak surveillance data is sent more quickly through SMS technology (Nyssen *et al*., 2015). Health districts then compile health facilities reports and send them to the provincial health administration authority, who in turn relay such information to the central health administration authority in the capital city Bujumbura. Healthcare centres keep at least 25 paper-based registers while approximately 75 registers are used in a single district hospital (Nyssen *et al*., 2015). In addition, the lack of integrated reporting mechanisms often leads to duplicated reports from healthcare facilities and from the district level, which poses an administrative burden (Nyssen *et al*., 2015). Furthermore, paper-based instruments are predominantly used for health record keeping in 90% of the hospitals (Nyssen *et al*., 2015). This compromises the quality of health information management in those hospitals. In 2014, the Ministry of Health initiated a pilot phase for the implementation of the District Health Information System (DHIS2) to replace the GESIS health data capturing system. In addition, by early 2015 it was expected that the iHRIS, a human resource information system would be in its pilot phase.

Although the central ministry's structures in Burundi have access to a wired or WiFi-based Local Area Network (LAN), connection to the Internet is often sponsored by donors. Such donor-funded Internet connectivity is always for a limited period of time and sometimes for a limited data volume (Nyssen *et al*., 2015). In most of the public healthcare facilities, Internet connection remains non-existent due to high broadband Internet prices and poor and unstable bandwidth offered by local Internet Service Providers (Nyssen *et al*., 2015). Despite the inadequate Internet bandwidth, most of the ministry's structures at the central level still perceive that having interconnection is an indispensable component to perform their daily activities (Nyssen *et al*., 2015). Outside national and provincial capitals, wired Internet connections are unavailable and 2G and 3G data networks performance is unpredictable (Nyssen *et al*., 2015). It is worth mentioning that the type of mobile Internet broadband determines the type, the amount and the speed of data that can pass through the mobile broadband carrier. 3G unlike its predecessors i.e. 2G and 1G has the capability of transmitting both voice and video data at a much higher speed ranging between 384KBPS to 2MBPS (Univercell, 2012). In addition to 3G capabilities, with 4G the speed of data transmission is further enhanced far above the 3G's (100MBPs to 1GBPS) (Univercell, 2012), thus allowing for faster real-time transmission of data.

Although some donor agencies have equipped some structures within the ministry with stable and reliable bandwidth through Very Small Aperture Terminals (VSAT-satellite) connections, such connections have high operating costs (Nyssen *et al.*, 2015). Sometimes such satellite Internet connections are unavailable due to inappropriate use (such as downloading Audio or Video files) which consumes the budgeted credit for such connections (Nyssen *et al.,* 2015). The installation of networks for Internet connection is seldom coordinated with some healthcare structures having several poorly performing parallel connections within the same site (Nyssen *et al.*, 2015). This is the case for the blood transfusion management site, which has four diverse wired Internet connections in addition to numerous donor-funded 3G-USB modems (Nyssen *et al.*, 2015).

Nyssen *et al.* (2015) argue that the ICT landscape within the health sector in Burundi is dominated by uncoordinated, ICT-led, donor-funded projects. The uncoordinated nature of the projects leads to the following issues:

Lack of standardisation: Most of the health information systems do not use international standards or coding systems. The exceptions are the upcoming District Health Information Systems (DHIS2) and Health Information Systems (HIS) modules that are using the ICD-10. This poses an issue pertaining to the integration of non-standard systems with other standardized one.

Data unavailability: Most databases that keep data related to donor-funded projects are hosted in the donor countries which poses a risk of inaccessibility to data by the Ministry of Health. In addition, many healthcare professionals use their personal laptops to perform their duties without adequate back up procedures or anti-virus protection. This presents a double dilemma. Firstly, as healthcare professionals use their laptops to perform their duties and carry them home, there is a risk that confidentiality and security of health-related information may be compromised. Secondly, without adequate measures to back up information and adequately shield the equipment from virus infections, loss of information is inevitable. One key principle of information systems design is data availability. Data should be available anytime it is needed. However, in Burundi, the lack of reliable communication channels such as the Internet delays the transmission and the flow of information across all levels within the ministry's health system.

Data protection issues: Data access within the Ministry is not organized according to the roles and designations of the personnel within the Ministry. In most cases, end users have either full access to all information within the ministry or no information access at all. Such a lack of effective data access control can lead to data access breaches.

Poor quality of field data: The lack of quality field data emanates from various issues. Firstly, there is complacency in terms of field data collection. Oftentimes, health ministry workers lack motivation especially in cases where field data collection is not done to address the needs of their specific department within the ministry. In addition, redundant health data collection processes, due to paper-based data collection instruments, present an administrative burden that makes data collection an undesirable task. Moreover, field data collectors do not have adequate qualifications to produce reliable data. Furthermore, due to the cumbersome paper-based data collection method, no one is accountable for the information produced (from the field data collection). Parallel health data collection from donor-funded projects and from the Ministry, results in fragmented data. As such, data collection is project specific, and its usefulness is reduced, as findings from such data collection cannot be generalised to the entire country.

Defective computers: Lack of maintenance of computers (often caused by the lack of a budget for computer maintenance) has caused even the few that are available to become defective.

Inadequate ICT infrastructure: Electrical power shortages are frequently observed throughout the country. Although Uninterruptible Power Supplies (UPS) are supplied with most of the computers within the ministry, their batteries are often defective and thus do not provide any support in case of power failures. In addition, affordable broadband Internet connectivity is mostly unavailable within the Ministry's structures.

Unregulated electronic health (eHealth) environment: Currently, there are no standards or regulations that can guide ICT adoption within the Burundi's health sector.

Lack of health applications: Generic office applications are the most frequently deployed software applications within Burundi's Health IT landscape. Very few health applications have been deployed.

Insufficient human capacity: The shortage of ICT experts within the Ministry of Health has led to ICT posts being occupied by incompetent and unmotivated staff. In addition, health IT education and training opportunities in Burundi are not aligned with the needs of health facilities and other ministries' directorates.

Organisational problems: Strategic ICT alignment to the ministry's organisational processes is lacking. Employing ICT professionals is often seen as an additional burden to the organisation rather than them being treated as a valuable asset within the ministry.

Lack of effective dissemination of information throughout the ministry: Dissemination of policies, regulations, and guidelines from the MoH&A's central decision-making body in Bujumbura to the rest of the structure is often limited by the absence of a reliable communication network.

Although ICT adoption in Burundi is low compared to its counterparts within the EAC, there are positive signs that indicate the country is on the path towards improving its ICT landscape. The following section discusses Burundi's current major ongoing ICT projects. The aim of this section is to portray the country's efforts towards providing infrastructure for digital connection in its quest to reduce countrywide digital divide.

2.6. Current Major ICT Projects in Burundi

2.6.1. Burundi's Backbone System

The development of the Burundi's national backbone, under the banner of Burundi Backbone System Company SM (BBS) and the current fibre optic project are the major indicators that signify the country's move towards providing a universal ICT infrastructure (ISTAfrica, 2014). BBS, a joint venture between local telecommunications companies, is a demonstration of how concerted efforts between government and privately-owned companies can bring a significant result in building an ICT-enabling environment. The 1,250 km fibre optic project is meant to cover the entire country with 3G access to Internet (Telecoms, 2010). The cable enables broadband connectivity to international networks, a shift from the prevalent satellite transmission for international voice and Internet traffic. The cable will also enable the installation of a network that will interconnect the capital city (Bujumbura) to all provinces and even further to neighbouring countries such as Tanzania, Congo DRC, and Rwanda. The network is a step forward towards e-government and e-education in the country. Amongst the benefits that the country is expected to reap through the network are enhanced quality services, high speed connection, reduced costs of Internet and data services, job creation and economic development (Telecoms, 2010). Figure 2.2 depicts the network installation throughout the whole country.

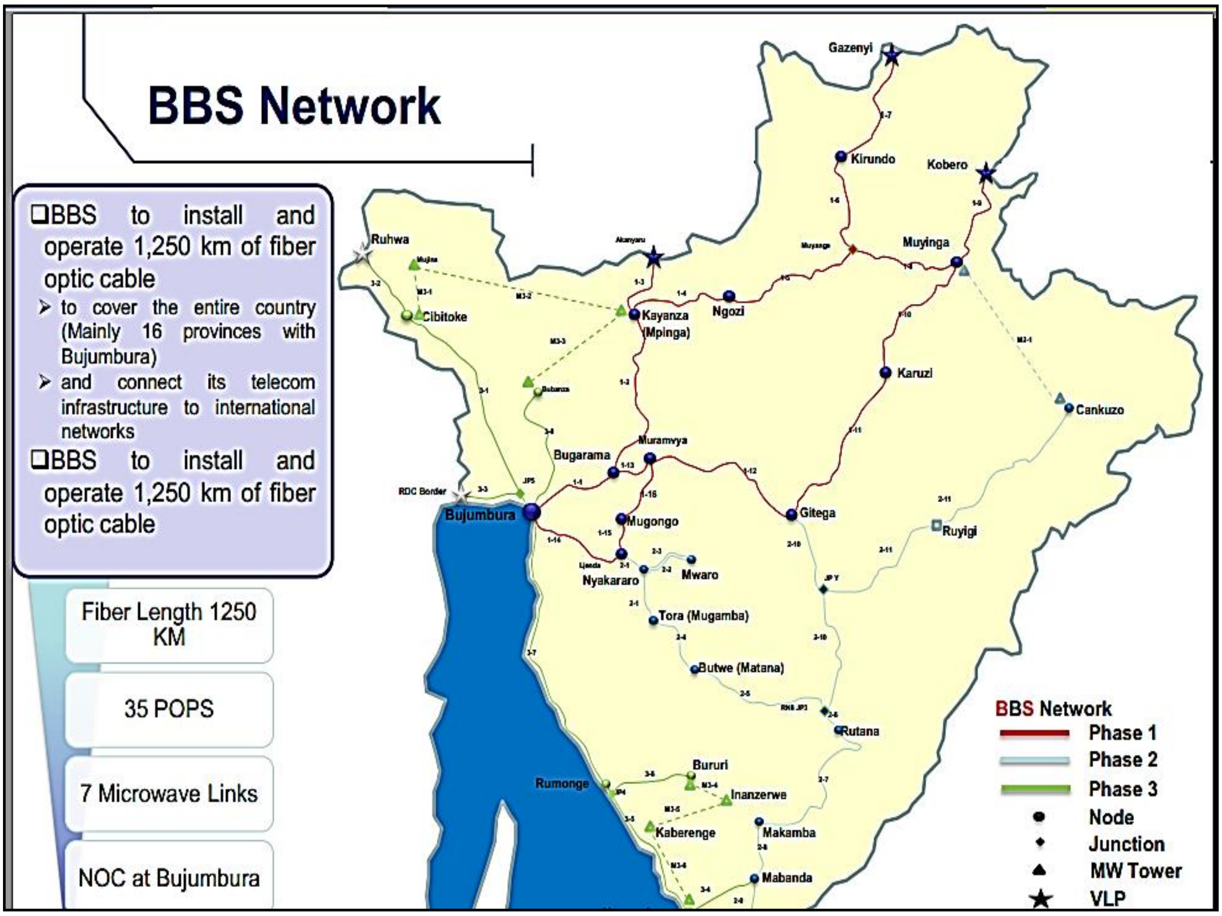

Figure 2. 2. Burundi Backbone System Network

Source: Burundi Ministry of Telecommunications (2015).

2.6.2. Bujumbura Metropolitan Area Network (MAN)

In October 2014, the Bujumbura MAN project was officially launched. The optic fibre network will connect public institutions such as the Presidency, Parliament, Senate, hospitals and courts. The National office of Telecommunications, the major owner of the MAN, will put in place the necessary infrastructure in various suburbs of the city. Such infrastructure will enable people to connect to the network at a price of 300 Burundi's francs per hour (0.19 US $) (Bujumbura News, 2014). The network is meant to reduce the costs and taxes related to connecting to international networks. Thus, it is meant to increase the Internet penetration rate in the country (which is less than 3.9% according to 2013 ITU statistics). The network will further increase access to information for socio-economic development in Burundi (Bujumbura News, 2014).

2.6.3. Broadband Wireless Network Project

Implemented by the International Telecommunications Union (ITU) over a period of 5 years (2009-2014), the project's main outputs are to deploy a broadband wireless infrastructure, to develop ICT applications and to train local experts on how to operate the deployed wireless communication networks (ITU, 2011). In addition, the project aims to develop a national ICT broadband infrastructure that will ensure free or low cost digital access to rural and remote areas, communities, hospitals and schools (ITU, 2011). A subsequent aim is to develop an impact assessment report (ITU, 2011).

2.6.4. Ongoing National Computer Incident Response Team (CIRT) Establishment

Led by the ITU, the aim is to build and deploy the required technical capabilities and to provide needed training to establish a national CIRT in the country. Once in place, the national CIRT will lead the tasks of identifying, defending, responding, and managing cyber threats (ITU, 2011).

2.6.5. Burundi Communications Infrastructure project

Supported by the World Bank and its partners, the project is meant to provide technical assistance to ICT projects including the implementation of the Burundi Backbone System and e-government. The project is meant to support an enabling environment for ICT adoption in Burundi (ISTAfrica, 2014).

2.6.6. Higher education ICT adoption and research capacity

Compared to other East African countries, Burundi is at its initial stages of developing higher education ICT research and innovation (Nyerere, 2013). The public University of Burundi (UB) now has an ICT network that can accommodate 500 users. The network provides access to the Internet and intercampus connectivity is achieved through a wireless link. The university currently has an ICT department that provides courses such as Components and Systems, Advanced Computing, Technology enhanced Learning. In addition, the country has 10 institutions of higher learning that provide ICT related courses (ISTAfrica, 2014).

Current mobile technology and ICT infrastructure development presents opportunities for sectoral development. In the health sector particularly, ICT has the potential:

1. To improve the way healthcare systems function by enhancing access and management of information (Chetley, 2006) and
2. To improve diagnostic methods and monitoring of public health threats (Chetley, 2006).

In the case of Burundi, this research posits that ICT has the potential to assist in addressing shortfalls that emanate from the lack of integration of information systems within the current Burundi's National Health system and inaccurate and outdated health data. In this case, ICT may be viewed as a catalyst for:

1. Accurate recording of disease and diagnosis-related information.
2. Accurate mapping of disease outbreak and spread.
3. Better coordination of countrywide interventions including better and informed allocation of resources to deal with disease outbreaks.
4. Sharing information.

2.7. Summary of chapter 2

This chapter provided the country's context in which this research is undertaken. The country's general profile depicts one of the poorest, landlocked country in the world, which heavily relies on foreign aid. Healthcare system challenges are mainly due to a weak and inefficient healthcare system. ICT utilisation in the health sector is characterised by uncoordinated donor funded projects, which limits the efficiency and sustainability of ICT utilisation in the Burundi's public healthcare sector. However, the increase in mobile phone subscriptions and the current government's endeavours in ICT projects, are positive signs towards a wider ICT adoption in the health sector. These developments are encouraging steps that can motivate the adoption of mobile-enabled interventions within the public healthcare sector.

CHAPTER 3: LITERATURE REVIEW

3.1. Introduction

mHealth research has gained momentum in the last decade. A literature search reveals that the scope of mHealth research ranges from social, economic and technology factors that influence mHealth implementation to the evaluation of mHealth impact on people's health. Fiordelli, Diviani and Schulz (2013) argue that systematic research on the impact of mobile technologies on health outcomes is scarce although there is a noticeable shift from assessing just the technologies to assessing their impact. This chapter firstly presents an overview of telehealth, telemedicine and mHealth. Subsequent discussions pertain to the use of mHealth applications including mHealth adoption within the East African Community (EAC), determinants of mHealth adoption, and the mHealth ecosystem. The chapter further discusses impediments to mHealth adoption and ends with a review of best practices for building sustainable and scalable mHealth interventions.

3.2. An overview of telehealth, telemedicine and mobile Health

Current literature testifies to the use of technology to provide healthcare services. The following section analyses some of the literature pertaining to the use of telehealth, telemedicine and mHealth within developing countries. Telehealth is an umbrella term that covers both the use of telemedicine, and mobile devices to provide healthcare services.

Telehealth is defined as "the use of advanced telecommunications technologies to exchange health information and provide healthcare services across geographic, time, social, and cultural barriers" (Reid, 1996:14). A study of the adoption of telehealth in Rwanda (Stapersma, 2005) explored the micro (individual level) and macro (society level) relevance of telehealth applications within the context of that country. Macro relevance refers to the extent to which a user of an IT system expects that the system will help achieve pre-set goals and solve problems (Spil, Schuring and Verkerke, 2004). The micro relevance refers to the extent to which IT use assists the user in accomplishing daily tasks (Spil, *et al.*, 2004). The study concluded that telehealth is pertinent to individual users but not so for the Rwandan society as a whole. Thus, telehealth in Rwanda should not be adopted in a standalone fashion. It should be accompanied by subsequent initiatives that enhance the transport system and provision of medicine amongst others (Stapersma, 2005). A cautious approach should be adopted when planning the implementation of telehealth initiatives. There is a tendency for telehealth to be adopted on an *adhoc* basis without considering the broader perspective of its adoption. In this case, there is a risk for the telehealth initiative to become obsolete once its initial purpose is accomplished, which could be a waste of resources.

The World Health Organisation (WHO) defines telemedicine as the "delivery of healthcare services, where distance is a critical factor, by all healthcare professionals using information and communication technologies for the exchange of valid information for diagnosis, treatment and prevention of disease and injuries, research and evaluation, and for the continuing education of healthcare providers, all in the interests of advancing the health of individuals and their communities" (WHO, 2010:9). The application of telemedicine is exemplified by the transfer of medical information through telephone and other networks (including the Internet) for remote medical consultation, examinations or treatment (Della, 2005; Mishra and Singh, 2008). In this case, telemedicine is a tool used to improve healthcare, by allowing less skilled health professionals to access skills and knowledge from remote specialists. Thus, telemedicine could have a positive impact on a developing country's healthcare system[7] (Isabalija, Mayoka, Rwashana and Mbarika, 2011). Notwithstanding the benefits of telemedicine, Isabalija, *et al*. (2011) contend that the use of telemedicine in developing countries is hampered by some challenges. A number of systems failed at their early stages as they failed to adapt to the country specific conditions where telemedicine is being implemented. In the case of Uganda for instance (Isabalija, *et al*., 2011:1), the critical impediments of telemedicine adoption are "lack of telemedicine policy, knowledge and skills and resistance to change by members of staff in hospitals." A study on the knowledge and perception of health workers towards telemedicine application in Nigeria (Shittu, *et al*., 2007) indicates that there is a need for basic training in the area of computing and associated communication systems in order to facilitate telehealth acceptance amongst health workers. The research suggests that healthcare professions join efforts in developing telehealth technologies in order to address these concerns.

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[7]According to Isabalija, *et al*.(2011), developing countries' healthcare system is characterised by recurring shortage of qualified healthcare professionals. Hence, telemedicine is viewed as one of solutions to address shortage of skilled staff through remote consultation, training and collaboration amongst healthcare professionals.

However, although telemedicine adoption is hampered by factors delineated above, Mishra and Singh (2008) attest that mobile phones are gradually being recognised as important ICT tools in remote and in rural areas of developing countries. This is mainly due to the rapid development and expansion of mobile infrastructure to reach remote areas. In the year 2013, the number of mobile subscriptions was almost equal to the total population of the planet and half of these were found in the Asia-Pacific region (ITU, 2013). The global expansion of mobile technology can assist in mitigating health-related challenges especially in low-income countries, where inadequate Internet connectivity hampers access to resources and real-time communication (Lester, Gelmon and Plummer, 2006). Portability, the 'always connected' status and data transmission capabilities of mobile phones are factors that make mobile phones more widely adopted than computers and Internet (Mitchell, Bull, Kiwanuka and Ybarra, 2011). Furthermore, mobile telephone use requires almost no training. Therefore, they fit easily into low-literacy populations that have little or no access to personal computers and the Internet (Sinha, 2005), making them an attractive ICT tool for healthcare services delivery.

mHealth interventions leverage various functions of mobile phones. Table 3.1 provides a brief overview of mobile phone utilities and purposes for which such utilities are used in healthcare interventions.

Table 3. 1. Use of mobile phone utilities in healthcare interventions

Types of communication	**Level of interaction**	
	One way	**Two way**
Text messaging	Appointment reminders Treatment reminders Health promotion Emergency notifications Surveillance Community mobilisation	Appointment confirmations Treatment compliance Patient diagnosis (using algorithms) Patient records
Voice services	Automated health information lines	Health call centres / staffed infolines Emergency toll-free lines Mobile telemedicine Patient monitoring
Voice and video services		Mobile telemedicine Emergency services
Internet connection	Health promotion Information initiatives	Population surveys Patient monitoring Surveillance Patient records Civil registration and vital Statistics Decision support systems

Sources: Fjeldsoe, *et al*., 2009; Lim, *et al*., 2008; Cole-Lewis and Kershaw, 2010; Krishna, *et al*., 2009; WHO, 2011a. *Adopted from* Marshall, *et al.*, (2013).

Text messages have been widely used as part of mHealth interventions. Authors argue that the relative ease of use of text messaging, low cost of SMS and public interests are amongst the reasons for wide use of SMS (Cole-Lewis and Kershaw, 2010; Terry, 2008). Thus, mHealth interventions that leverage the text messaging platform are more likely to reach a wider population base than other mobile-enabled capabilities (Marshall, *et al*., 2013). While mobile technologies may be used by a variety of stakeholders such as healthcare providers, patients, the general public or a combination of all stakeholders (Marshall, *et al*., 2013), mHealth services targeted to the general public tend to be less complicated. Such services include messages for awareness campaigns, appointment or treatment reminders, or help lines (WHO, 2011a). On the other hand, healthcare workers could use mobile technologies for advanced purposes such as diagnosis algorithms, mobile telemedicine, patient and population surveys (WHO, 2011a). The following section discusses the use of mHealth even beyond text messaging. Such discussion focuses on evidence-based use of mHealth applications and its consequent health outcomes.

3.3. The use of mHealth applications

The interactive nature of mobile health communication empowers users with the ability to self-monitor their health and other health-related knowledge (Cole-Lewis and Kershaw, 2010; Bakshi, *et al*., 2011; Moskowitz, Melton and Owczarzak, 2009; Cocosila, Archer and Yuan, 2009; Sidney, *et al*., 2011). mHealth applications also help to overcome the traditional geographical barriers to access to healthcare services such as lack of access to road facilities leading to public healthcare facilities. mHealth has also been deemed useful in reducing delays in diagnosis, treatment and disease outbreak reporting (Kahn, Yang and Kahn, 2010). The infrastructural costs related to implementing traditional types of ICTs such as desktop computers and landline phones make mobile technology a cost effective option especially in limited resource settings (Schweitzer and Synowiec, 2012; Mishra and Singh, 2008). The installation of landline phones requires telephone wires and desktop computers necessitate significant investment in electrical resources and may not be easily portable from one location to another (Marshall, *et al*., 2013). Kelly, *et al*. (2013) argue that smartphones equipped with GPS capabilities can be used for real time monitoring and mapping of regions with diseases and epidemics outbreaks. Mobile technologies can be used to provide training electronically, thus minimising the cost and time required for travel to access such training (DeRenzi, *et al*., 2012). They can also be used for the dispensation of healthcare information electronically to rural communities (Chang, *et al*., 2011), thus minimising the need for a healthcare worker. mHealth applications can be used for data collection for the purposes of planning and policy formulation. In this case, automated processes within the mHealth applications could also be used for data analysis and quality checks, thus overcoming shortcomings of paper-based systems (Mechael, *et al*., 2010) such as less accuracy, data duplication, and loss of critical data. mHealth applications may help government departments monitor the performance of health programs and identify areas that need more focus (Broens, Van Halteren, Van Sinderen and Wac, 2007). Aggregated data could be made public which increases transparency and public confidence (Sinha, 2010; Mechael, 2009). The use of mHealth applications also means that healthcare workers would spend less time in dealing with paperwork. The reduction in paperwork means that healthcare workers would spend more time on critical tasks such as treating patients (Vital Wave Consulting, 2009). Healthcare professionals' collaboration through mHealth applications allows them to access and share information and seek guidance that could be used for decision-making (Knight and Holt, 2010; Vital Wave Consulting, 2009).

3.1.1. The use of mHealth applications for education and awareness programs

A number of mHealth interventions that are geared towards healthcare awareness and promotion use text messaging technology (Cole-Lewis and Kershaw, 2010) as one-way or two-way communication. In Uganda for instance, "Text to change" mHealth intervention is a two-way communication for HIV/AIDS awareness that creates text-based messages that contain quizzes for users (Jamison, Karlan and Raffler, 2013). Such mHealth text-based initiatives are a low cost opportunity for reaching a wide population base. They also preserve the confidentiality of information and respondents' replies especially in cases where respondents have to disclose sensitive information such as HIV status and pregnancy status (Mukund and Murray, 2010; Bakshi, *et al*., 2011). Various authors suggest factors that need to be considered when implementing mHealth applications for health education and awareness interventions. These are literacy rate (DeTolly and Benjamin, 2012; Chang, *et al*., 2011), mobile phone affordability (Mechael, *et al*., 2010), and local languages (Vital Wave Consulting,

2009) amongst others. Nchise, Shu, Boateng and Mbarika (2012) referring to the AppLab[8] Uganda Project, indicated that cost of maintaining a mobile phone subscription is an important factor that needed to be considered for the successful implementation of the mHealth initiative. Users were willing to utilise the mHealth service as long as there was no charges (such as airtime charges) associated with its use.

3.1.2. The use of mHealth applications for remote data collection

Data collection through mHealth applications has often been credited with the merit of replacing paper-based systems, thus eliminating flaws created by such systems. In the specific context of developing countries, data collection through paper-based survey responses is very common (Marshall, *et al*., 2013). Data collection and analysis through paper-based systems often takes a long time and generates inconsistent and unreliable data (Mechael, 2009; Vital Wave Consulting, 2009). On the other hand, remote data collection through mHealth applications enables real time data collection and generates less erroneous data. Thus, stakeholders in healthcare provision such as policy makers can make timely decisions based on accurate and reliable data (WHO, 2011). For instance, in Tanzania and Kenya, SMS messaging was used to update drug stocks on a real time basis in health facilities, reducing instances of out of stock medicines and supporting drug stock management (Githinji, *et al*., 2013; Barrington, *et al*., 2010). The text messaging system led to timely data collection on drug stock levels, thus improving the availability and supply of drugs to clinics (Aranda-Jan, *et al*., 2014).

3.1.3. The use of mHealth applications for remote monitoring

This category includes the use of mobile phones to send patients health information, treatment and appointment reminders (Sidney, *et al*., 2011; Chen, Fang, Chen and Dai, 2008). South Africa's "Cell-Life" is a typical mHealth application, which is used by healthcare workers to collect and send information (to a central database for analysis) on treatment adherence, health status, and risky behaviours from HIV infected people (Vital Wave Consulting, 2009). The application has expanded to include other diseases such as tuberculosis. Improvement in treatment adherence was reported as a result of the use of such applications (DeTolly and Benjamin, 2012).

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[8] The Application Laboratory (AppLab) Uganda Project is a mobile-phone enabled application designed to educate users on issues pertaining to sexual and reproductive health

3.1.4. The use of mHealth applications for healthcare professionals' communication and training

In developing countries, healthcare professionals face challenges in terms of accessing adequate training and communicating with fellow health workers from remote locations. The burden imposed by oftentimes time-consuming, paper-based information recording and keeping is a constraint to healthcare professional development (Schweitzer and Synowiec, 2012; DeTolly and Benjamin, 2012). Mobile technologies allow healthcare professionals to receive information and diagnosis support, thus helping them to provide better healthcare services and also increase their knowledge (Chang, *et al*., 2012; Littman-Quinn, *et al*., 2011). In Botswana for instance, an mHealth pilot project showed that mHealth can be used to link health workers from remote areas to specialists for better diagnosis-related decision making (Chang, *et al*., 2012). mHealth-enabled training programs may be in diverse forms such as sharing diagnostic information and seeking help from fellow medical professionals about previously unseen, rare cases (Vélez, 2011; Chib, 2010; Knight and Holt, 2010).

3.1.5. The use of mHealth applications for disease and epidemic outbreak tracking

Déglise, Suggs and Odermatt (2012) point out that a lack of timely reporting of diseases to central decision makers often results in disease spread with a subsequent increase in treatment costs and deaths. Mobile technologies could be used for disease tracking by sending alerts to decision makers (Li, Moore, Akter and Ray, 2010; Aanensen, *et al*., 2009). Built-in GPS capabilities can also be used in conjunction with mobile technologies to create maps to identify areas of high disease outbreak incidents and further allocate adequate resources to deal with such incidents (Johnson and Blazes, 2007; Curioso, *et al*., 2005). In Uganda and Zambia, pilot mHealth projects demonstrated the feasibility of using SMSes to report malaria case detection and for disease surveillance (Asiimwe, *et al*., 2011; Kamanga, *et al*., 2010) leading to timely data reporting (Aranda-Jan, *et al*., 2014).

3.1.6. The use of mHealth applications for diagnostics and treatment support

mHealth applications can help healthcare professionals diagnose diseases accurately. Based on the information (such as patients symptoms, signs and other variables) provided by the healthcare worker through an interface, an mHealth application may take the user (in this case the healthcare worker) through diagnosis and treatment suggestions based on the already stored (within the mHealth application) medical information (Chib, 2010; Vélez, 2011). Then, specialist medical professionals can remotely offer diagnosis and treatment support (Luk, Ho and Aoki, 2008). In Tanzania, the Mobile e-IMCI© application guides health workers step-by-step through the World Health Organisation's IMCI (Integrated Management of Childhood Illnesses) protocol. The application helps healthcare workers improve their abilities to diagnose and manage childhood illnesses accurately (DeRenzi, *et al*., 2012). Table 3.2 summarises the purposes for the use of mHealth applications.

Table 3. 2. Summary of the purpose of use of mHealth applications (Marshall, *et al*., 2013)

mHealth applications (Vital Wave Consulting, 2009)	**Examples (WHO, 2011a)**
Education and awareness	- Raising awareness - Health call centres - Emergency toll-free telephone lines - Community mobilization and health promotion - Information initiatives
Remote data collection	- Health surveys and surveillance - Patient records
Remote monitoring	- Appointment reminders - Treatment compliance - Patient monitoring
Communication and training for health care workers	- Mobile telemedicine
Disease and epidemic outbreak Tracking	- Public health emergencies - Health surveys and surveillance
Diagnostics and treatment support	- Decision support system Telemedicine - Patient records

A review of published mHealth projects (spanning from 2003 to 2013) in Africa reveal that although most of these projects are pilot studies or Randomised-Control Trials[9] (RCTs) implemented at the community level, their results show that they are feasible and they have the potential to support healthcare systems in Africa (Aranda-Jan *et al.*, 2013). As many African states are trying to reach the prescribed targets for the Sustainable Development Goals (previously known as Millennium Development Goals-MDGs), mHealth is a tool that may assist in reaching those targets as explained in the following section.

[9] In a randomised controlled trial, participants are assigned to treatment conditions at random.

3.4. Potential use of mHealth to achieve the Sustainable Development Goals in the health sector

The need for universal health coverage led to the adoption and implementation of Millennium Development Goals (MDGs)[10] (currently known as SDGs) in 2000, by over 189 Member States of the United Nations. The MDGs promote gender equality and women empowerment, improving maternal health, combating HV/AIDS, malaria and other diseases, environmental sustainability and the development of global partnerships for development, eradication of extreme poverty and hunger and reduction of child mortality (United Nations, 2013). In line with achieving universal health coverage, which aims at ensuring that all people get access to health services they require (WHO, 2015a), there has been an increase in demand for quality but affordable health services. The support for universal health coverage has been seen as a guiding principle towards strong health systems and human development, implying healthy citizens who can contribute socially and economically (WHO, 2013; Mulley, Evans and Binagwaho, 2013). In spite of the efforts to achieve the Sustainable Development Goals (SDGs), the large gap between current coverage of health services and universal health coverage remains (WHO, 2015b). The African and Asian continents are burdened by heavy maternal mortality rates and other diseases, thus making them ideal candidates for mHealth interventions to achieve SDGs targets (Mehl, *et al*., 2014).

As many countries are attempting to reach the Sustainable Development Goals of combating AIDS, Malaria and Tuberculosis, mHealth is presented as a tool that could help patients to comply with medical prescriptions, assist in expanding treatment outreach, raising awareness of epidemics, and promoting behaviours that limit the spread of diseases, in order to meet those goals (Qiang, *et al*., 2011). It is estimated that more than 30 million people worldwide are living with HIV of whom close to half are on Anti-Retroviral Therapy (ART) (Mbuagbaw, *et al*., 2013). Poor adherence to ART can lead to virus resistance to drugs, AIDS and subsequent mortality (Mbuagbaw, *et al.*, 2013). Hence, there is a need to ensure that ART is taken consistently. Mobile, SMS-based, health interventions can improve HIV treatment outcomes by increasing the rates of patients' compliance to antiretroviral treatment. Such increased compliance may result in viral load suppression (Lester, *et al*., 2010) and reduced HIV transmission

[10] In 2015, the term MDGs (Millennium Development Goals) was replaced by SDGs (Sustainable Development Goals).

risk among persons living with the virus (Curioso and Kurth, 2007). Weekly HIV/AIDS related messages sent to AIDS patients were identified as likely to lead to a 95% ART adherence in Cameroon and Kenya (Mbuagbaw, *et al*., 2013). However, Déglise, *et al*. (2012) caution that HIV/AIDS prevention messages targeted to adolescents should be dispensed in modes and environments that cater for adolescents' preferred ways of communicating (such as the use of social media).

It is estimated that 80% of non-communicable diseases in the world are found in developing countries (WHO, 2011c). Hence, mHealth applications would be very useful for remote support of patients suffering from such diseases.

A shortage of suitably skilled human resources has been identified as a major impediment to achieving the Millennium Development Goals (MDGs). In 2012, there was a shortage of close to 2.4 million trained medical professionals and 4 million health workers (Dalberg, 2012) and African health systems are heavily constrained by this lack of trained and qualified health professionals (Siedner, *et al*., 2012; Azfar, *et al*., 2011). Thus, in developing countries, there is a need to develop substitute health workers to compensate for such a shortage (Dovlo, 2004; Hongoro and McPake, 2004). Community-Based Health Workers (CBHWs[11]) provide primary healthcare services in various developing countries and can be regarded as "substitute health workers" (Wootton, *et al*., 2009:44). The CBHWs are considered to be the lowest cadres within the Primary Healthcare (PHC) system and work within communities. One of the challenges in providing healthcare to rural and remote communities is the coordination of healthcare provision between different CBHWs, which leads to delayed healthcare delivery or unnecessary referrals due to unreliable communication infrastructures (Mehl, *et al*., 2014). CBHWs need to be empowered in the areas of mobile health so that they may become champions of mHealth provision through mobile technology. In this case, mHealth projects could be viewed as "social enterprises that fill the gap created by underperforming public health services" (Wootton, *et al*., 2009:50). Thus, mHealth should be adopted starting from the CBHWs in order to meet the target as stipulated in the health-related SDGs of developing countries.

[11]CBHWs provide "reproductive health and family planning, nutrition education, and community rehabilitation for convalescing and disabled patients. They are also agents for health promotion in the community in which they live and work. They also act as agents for socio economic development and community empowerment" (Wootton *et al*., 2009:23).

3.5. mHealth interventions in the East African Community (EAC)

In 2014, the East African region contributed to “over 30% of the global innovative healthcare delivery programs” with Kenya ranked second after India for its innovative eHealth programs (Excelsior Group, 2014, p. 1). A number of such programs are mHealth-enabled initiatives. The wide adoption of mHealth in the EAC is fuelled by the large number of mobile subscribers in EAC member states as depicted in table 3.3. The table also shows a significant difference in teledensity between Burundi and the rest of the East African countries. This further demonstrates that telephone penetration (including cell phones) in Burundi is the lowest in the region.

Table 3. 3. State of mobile subscriptions and use in East Africa (2013 estimates)
(WhiteAfrican, 2013)

COUNTRY	POPULATION SIZE (2013 ESTIMATES)	MOBILE SUBSCRIBERS	INTERNET USERS	OUTGOING AND INCOMING SMS	FIXED LINES	TELEDENSITY	VOICE TRAFFIC
Kenya	44,037,656	30,429,351	16,236,583 (36.8% of the population)	3.6 billion	251,567	78%	Data not available
Tanzania	48,261,942	27,395,650	5,308,814 (11%of the population)	4.3 billion	176,367	61%	7,662,504,921
Uganda	34,758,809	18,300,000	4,800,000 (13.8% of the population)	520 million	464,849	52%	215,110,452
Rwanda	12,012,589	6,039,615	903,964 (7.5% of the population)	26 million	42,323	57%	1,470,290,068
Burundi	10,888,321	2,995,000	157,800	Data not available	80,039	2%	157,800

A literature review on the performance of some of mHealth projects implemented within the region reveals positive results on health outcomes. In Uganda for instance, there were a variety of new entrants in the telecommunications industry with new and innovative technological solutions (Isabalija, *et al*., 2011). The *text to change* mHealth intervention in Uganda which used SMS-based quizzes for HIV/AIDS awareness for rural residents led to a 40% increase in HIV testing over a period of six weeks (Vital Wave Consulting, 2009). The Episurveyor system implemented in Kenya and Uganda for remote data collection enabled healthcare professionals to get timely access to healthcare data, thus making immunisation programs and responses to disease outbreaks more efficient (Vital Wave Consulting, 2009). In addition, as part of the Episurveyor implementation process, healthcare workers were trained to be self-sufficient in designing, programming and deployment of health surveys which eliminated a subsequent need for outside consultants (Vital Wave Consulting, 2009). Benefits associated with the *Uganda Health Information Network UHIN project* (see Table 3.4) implementation in Uganda include a 25% savings in the first semester of the project's inception coupled with an increase in job satisfaction and staff retention (Vital Wave Consulting, 2009). Table 3.4 reflects a summary of some of the major mobile-enabled health projects within the East African Community (EAC).

Table 3. 4. Mobile health interventions in EAC

Country	**Mobile-enabled project**	**Application projects**	**Description**
Uganda	Text to Change (TTC)	Education and awareness	In 2008, TTC was introduced in Uganda as HIV/AIDS and family planning awareness campaign via SMS (Vital Wave Consulting, 2009)
Kenya Uganda	EpiSurveyor	Remote data collection	In 2008, the program was introduced. EpiSurveyor enables the creation, sharing and deployment of forms (including health surveys) on mobile devices (Vital Wave Consulting, 2009).
Tanzania	Mashavu project	Remote monitoring	In 2009, the Mashavu project was introduced in Tanzania as a computer-based system that uses

Country	Mobile-enabled project	Application projects	Description
			mobile phones to track children's medical data/records such as height, weight, blood pressure, and lung capacity (Vital Wave Consulting, 2009).
Uganda	Uganda Health Information Network (UHIN)	Communication and training for healthcare workers	In 2003, UHIN was introduced. UHIN enables data collection and provides medical education to physicians through Personal Digital Assistants (PDAs) (Vital Wave Consulting, 2009).
Uganda	GATHER project	Disease and epidemic outbreak tracking	In 2009, GATHER was introduced in Uganda. The project was an attempt to provide disease surveillance through mobile phones (Vital Wave Consulting, 2009).
Tanzania	Mobile E-IMCI project	Diagnostic and treatment support	In 2008, mobile E-IMCI was introduced in Tanzania as a mobile phone-enabled software that provides step-by- step treatment plans for health workers (DeRenzi, 2008)

A literature search suggests that, in Burundi so far, there are only two documented mHealth interventions. On one hand, SIDA info is a toll free service that aims at providing information on HIV/AIDS upon request (ElGaddari, 2014). People residing in Burundi have the option of dialling 0800840800 to ask any questions pertaining to HIV/AIDS. The program has contributed to educating people on issues pertaining to prevention and management of the disease for the past 22 years (ElGaddari, 2014). However, to the best knowledge of the researcher, the impact of the system on health outcomes in Burundi has not been assessed. On the other hand, the "Kiramama" Rapid SMS is the only text (SMS)-based mHealth intervention reported so far and the project is still in pilot (testing) phase. The Rapid SMS system was firstly introduced in Rwanda and was successful within the Rwandan Health Ministry's Infant and Maternal Health Department (Burundi Ministry of Health, 2014). The following section discusses the system's successful implementation in Rwanda and projected adoption in Burundi followed by a discussion on lessons that could be learned in relation to its implementation in Burundi.

3.5.1. Rapid SMS system: A Rwandan successful mHealth implementation story

Rapid SMS is an open source ICT tool used for the rapid configuration of SMS for data collection, analysis, transmission, and logistics coordination from a low entry mobile phone (Dimagi, 2016). In 2010, Rapid SMS was used by CBHWs in Rwanda to monitor the health status of expectant mothers, new born babies, other health risks and infants' nutrition. The system was a success as the SMSes encouraged pregnant women to report to primary healthcare centres for check-ups and treatment. The system also contributed to the reduction of home deliveries and the tracking system for new born babies contributed to newly borns receiving treatments from their first day. There was also a reduction of pre-natal and maternal deaths as a result of the implementation of the system. The real time reporting feature of the system created a better link between expecting mothers and the healthcare system through the CBHWs. In 2012, the system was rolled to the entire country and post system implementation evaluation reveals a more than 50% decrease in maternal and new born deaths (figure 3.1). In addition, the system triggered an increase in new born deliveries at healthcare facilities compared to the system's pre-implementation (figure 3.2).

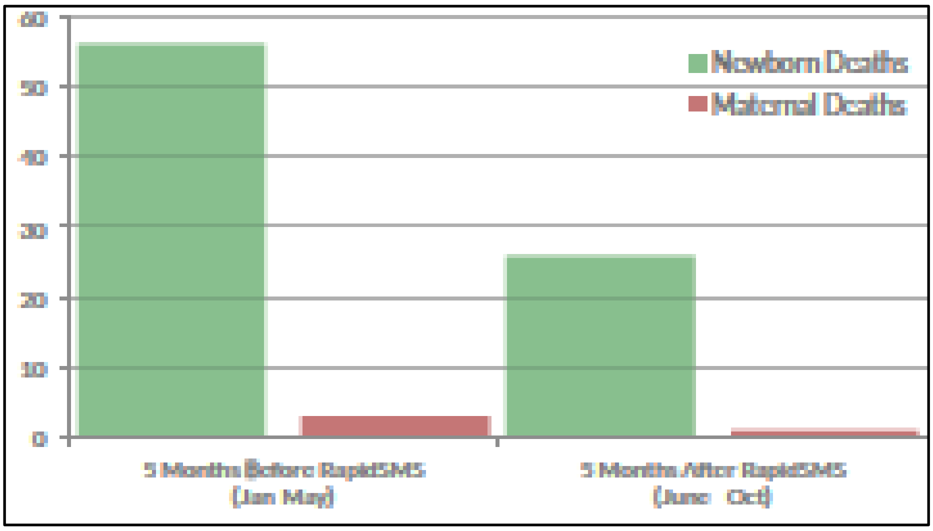

Figure 3. 1. Evidence of success of Rapid SMS in Rwanda: decrease in new born and maternal deaths
Adopted from: Burundi Ministry of Health (2014)

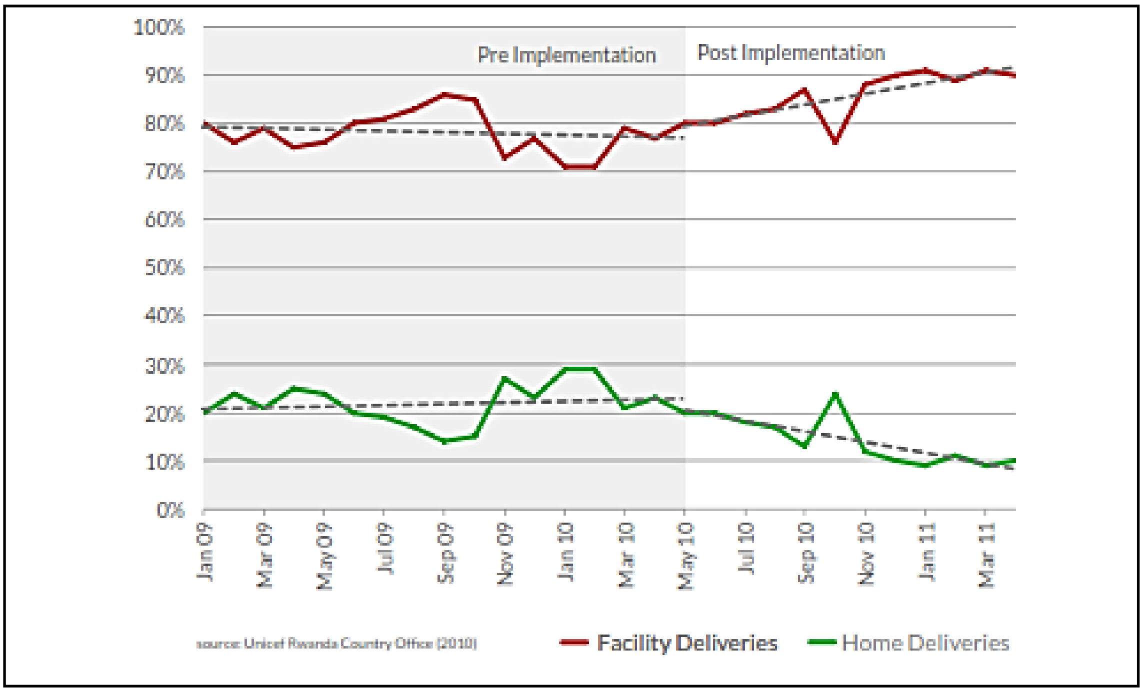

Figure 3. 2.Evidence of success of Rapid SMS in Rwanda: decrease in-home deliveries and increase in facilities deliveries
Adopted from: Burundi Ministry of Health (2014)

Drawing from the Rapid SMS system experiences from Rwanda, Burundi in partnership with UNICEF introduced the Kira-mama project, a Rapid SMS pilot project in two provinces (Muyinga and Gitega), towards the end of year 2014[12]. It was predicted

[12] As mentioned by the respondent from the Ministry of communication, there was a previous attempt to introduce Rapid SMS and U Report within the Ministry of Communication, which failed. Hence, this is a second attempt to introduce Rapid SMS in Burundi.

that the system would help achieve the Millennium Development Goals 4 and 5 by reducing the number of prenatal and maternal deaths. Rapid SMS was designed to work within the Burundi's Ministry of Health's maternal and infants' health program to empower CBHWs for greater efficiency in reporting. The main objectives of the program are to improve the monitoring of pregnant women up to 42 days after delivery, operationalise the auditing of maternal and neonatal deaths from Primary Healthcare Centres and at community level, improve urgent obstetrical and neonatal care in healthcare facilities and improve the monitoring of children aged between 0 and 59 months. This includes monitoring of vaccination, immunisation and detection of malnutrition cases.

As described in figure 3.3, a CBHW sends a message reporting a health-related case. The message is relayed to the Community Health Centre (CDS) and District Hospital (HD). Health Promotion Technicians (TPS) who are CBHWs' supervisors, monitor the messages and take adequate action. For instance, if an ambulance is required, the nearest health facility and district hospital are notified and feedback is given to the CBHW. The system enables the Ministry of Health to monitor the project's progress (through reports) by accessing the ministry's Rapid SMS central server. It is predicted that the Rapid SMS system will enable countrywide data collection on maternal and child health. After data collection, the central server then aggregates the data in a format that makes it easier for decision-making.

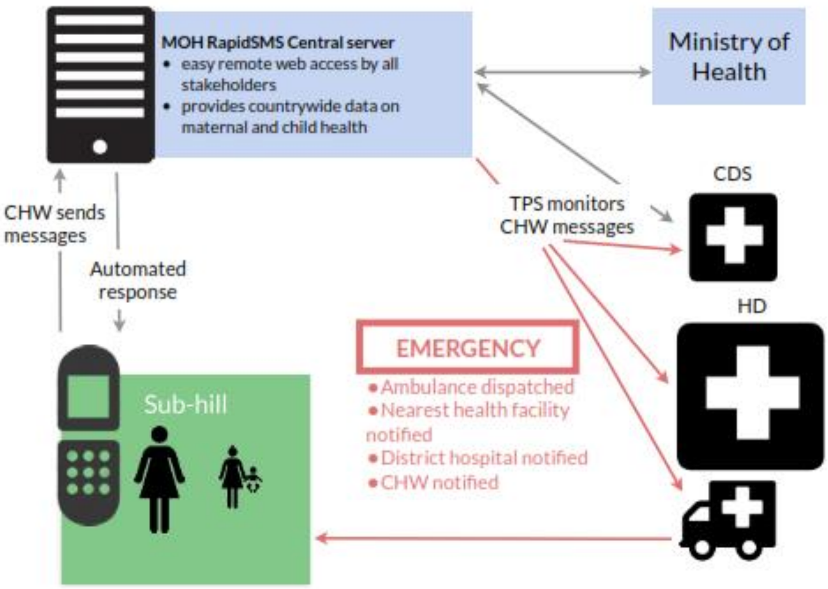

Figure 3. 3. Kira mama SMS based (projected) system's functionality
Adopted from: Burundi Ministry of Health (2014)

Text messages delivered through mobile phones have been shown to improve communication between Ministry of Health and health facilities in remote areas, between health workers and patients and between different managerial levels (Hoffman, *et al*., 2010; Pop-Eleches, *et al*., 2011; Lester, *et al*., 2010). Although the piloted system will primarily benefit mothers and infants, other stakeholders in public healthcare will benefit as well. These include the health departments in charge of National Programme on Reproductive Health (PNSR), health departments in charge of the National Health Information dissemination (SNIS), and the Ministry of Health in general. The system will collect key information that will help these departments make informed decisions about future healthcare interventions.

As the mHealth intervention in Burundi is still in the pilot phase, there is no outcome-based evidence yet to evaluate the performance of the system. However, based on the successful implementation of Rapid System in Rwanda, there are some lessons that Burundi can draw upon from its counterpart, Rwanda, in regard to the implementation of mHealth interventions as both countries share a similar historical and cultural background:

1. In the Rwandan case, only one major mobile service provider was involved in the project. The mobile service provider offered SMS services at 20% discounted rates which reduced the cost of the project (Burundi Ministry of Health, 2014). Thus, in the case of Burundi, in the light of the country's socio-economic environment, there is a need for partnerships (that bring benefits to both parties) between the Ministry of Health and mobile service providers in order to provide mHealth-enabled interventions that are affordable to the users.
2. Moreover, there was extensive consultation with CBHWs to ensure the success of the system (Burundi Ministry of Health, 2014). Such consultation brought forth agreement about the system's requirements and how the system could be customized for ease of use. Involving users in the development process of telehealth initiatives is critical (Wootton, *et al*., 2009). Gagnon, *et al*. (2004) advocate that the diffusion of telehealth and its application depends on its acceptance among healthcare practitioners. Thus, the participatory design approach is particularly suitable for mHealth adoption. Particularly, the involvement of users in interface design plays a role in the successful adoption and usability of mobile devices (Graves, Grisedale and Grünsteidl, 1998). In the

context of Burundi, such consultation with healthcare professionals including CBHWs is suggested. The consultation would be an avenue for training stakeholders in the use of the system in order to ensure a high response rate to the project (Pop-Eleches, *et al*., 2011).

3. Performance-based incentives were put in place in order to increase CBHWs adoption and ownership of the system (Burundi Ministry of Health, 2014). In this case, CBHWs were rewarded in order to achieve greater commitment to the mHealth-based intervention. Lester, *et al*. (2010) argue that providing adequate incentives is one of the factors that lead to a high response rate to mHealth projects. Hence, in the case of Burundi, it is imperative to provide incentives to improve adoption of the system. As mHealth is a new concept within the country, healthcare professionals might not be enthusiastic about its adoption if they do not foresee any reward from using it.

4. Telecommunications infrastructure, which provided the necessary support for communication, data flows, and links to the central database, was also key in the success of the project (Burundi Ministry of Health, 2014). At the time of implementation in Rwanda, 95% of the territory was covered by at least one mobile telecommunications network. Hospitals had cellphone modems and CHBWs had cellphones. In Burundi, however, none of the 6 mobile service operators (Smart, Africell, Onamob, Econet, Viatel and Leo) cover the entire country. Leo, the largest mobile service provider only covers 64% of the country's territory (Leo, 2014). Mechael, *et al*. (2010) advocate that government incentives may be required to extend telecommunications network coverage to cover remote areas where mHealth services are needed the most. Such could be the case for Burundi in order to fast track infrastructural development that will ensure countrywide mobile telecommunications networks coverage. Mobile cellphone penetration in the country is 31% (Lancaster, 2015) which means that a large portion of the population still does not have access to mobile phones, which impedes the scalability of mHealth interventions.
5. Additional facilities were put in place to support the outcomes of the mHealth-based intervention (Burundi Ministry of Health, 2014). All hospitals were adequately equipped to deal with birth-related complications and serious new born baby illnesses. In Burundi, there is a need to assess whether there are

sufficient resources to deal with the increase of reported cases that will emanate from the system's implementation.

3.6. Determinants of mHealth adoption

Low-cost, ease of use and wide spread availability are frequently mentioned as the main drivers for the adoption of mobile technology (Rotheram-Borus, *et al*., 2012; Zurovac, Larson, Sudoi and Snow, 2012; Lester, *et al*., 2010). High acceptance of mobile phones (Wakadha, *et al*., 2013; Rotheram-Borus, *et al*., 2012; Chang, *et al*., 2012) and mobile technology (Siedner, *et al*., 2012; Azfar, *et al*., 2011) amongst health professionals and patients and familiarity of use of mobile phones (Odigie, *et al*., 2012; Barrington, *et al*., 2010) have also been cited as drivers of mHealth initiatives in Africa. Another factor that makes mobile technology attractive is the alternative platform of communication that mobile phones offer, particularly in cases whereby people may have to divulge information that might stigmatize them. In this case, mHealth (particularly SMS-based systems) was mostly accepted in cases where sensitive information such as HIV status, could not be easily discussed during face-to-face consultations (Zurovac, *et al*., 2012). Projects have proved to be successful when adapted to local context and language (Odigie, *et al*., 2012; Zurovac, *et al*., 2012; Shao *et al*, 2015), when there is an mHealth or eHealth strategy in place, and when the local government is willing to set up a system that will integrate mHealth projects (Barrington, *et al*., 2010). Furthermore, mHealth projects tend to succeed when developed and implemented through public-private partnerships (e.g. participation of local private service providers) (VanderKop, *et al*., 2012; Chang, *et al*., 2011; Barrington, *et al*., 2010). Evidence of partnerships is exemplified by collaborations between institutions of higher learning in developed and developing countries, research institutions, non-profit organisations, public and private hospitals (Aranda-Jan, *et al*., 2014). Management and project design factors, such as providing adequate incentives (e.g. airtime credit) to ensure a high response rate to mHealth projects (Pop-Eleches, *et al*., 2011; Lester, *et al*., 2010) and providing training for staff and users (Haberer, *et al*., 2010; Nsanzimana, *et al*., 2012) are also important drivers of mHealth adoption. However, other contextual factors need to be taken into consideration, such as prior exposure to mobile devices and exposure to desktop computers (Wootton, *et al*., 2009). Table 3.5 provides a summary of the determinants of mHealth adoption.

Table 3. 5. Summary of determinants of mHealth adoption

Determinants	Source
Low cost, ease of use and availability of mobile technology	Rotheram-Borus, *et al*., 2012; Zurovac, Larson, Sudoi and Snow, 2012; Lester, *et al*., 2010
High acceptance of mobile phones amongst health professionals and patients	Wakadha, *et al*., 2013 ; Rotheram-Borus, *et al*., 2012; Chang, *et al*., 2012
High acceptance of mobile technology amongst health professionals and patients	Siedner, *et al*., 2012; Azfar, *et al*., 2011
Familiarity of use of mobile phones	Odigie, *et al*., 2012 ; Barrington, *et al*., 2010
Anonymity of respondents to mHealth initiative	Zurovac, *et al*., 2012
Adaptation to local context and language	Odigie, *et al*., 2012 ; Zurovac, *et al*., 2012; Shao *et al*, 2015
Presence of eHealth strategy ; integration of mHealth projects	Barrington, *et al*., 2010
public-private partnerships in mHealth development	VanderKop, *et al*., 2012 ; Chang, *et al*., 2011 ; Barrington, *et al*., 2010
Adequate incentives	Pop-Eleches, *et al*. 2011 ; Lester, *et al*. 2010
Training staff and users	Haberer, *et al*., 2010 ; Nsanzimana, *et al*., 2012
Prior exposure to mobile devices; exposure to desktop computers	Wootton, *et al*., 2009

The mHealth ecosystem is made up of various stakeholders that need to be considered in order to devise successful mHealth interventions. The following section presents the mHealth ecosystem with an emphasis on mHealth stakeholders and their responsibilities within the mHealth ecosystem.

3.7. The mHealth ecosystem

The mHealth ecosystem represents various stakeholders in the adoption and dissemination of mHealth initiatives within three spheres of reference: health, technology, and finance as illustrated in figure 3.4. The ecosystem aids in understanding the dynamics linked to stakeholders' participation in mHealth adoption and dissemination.

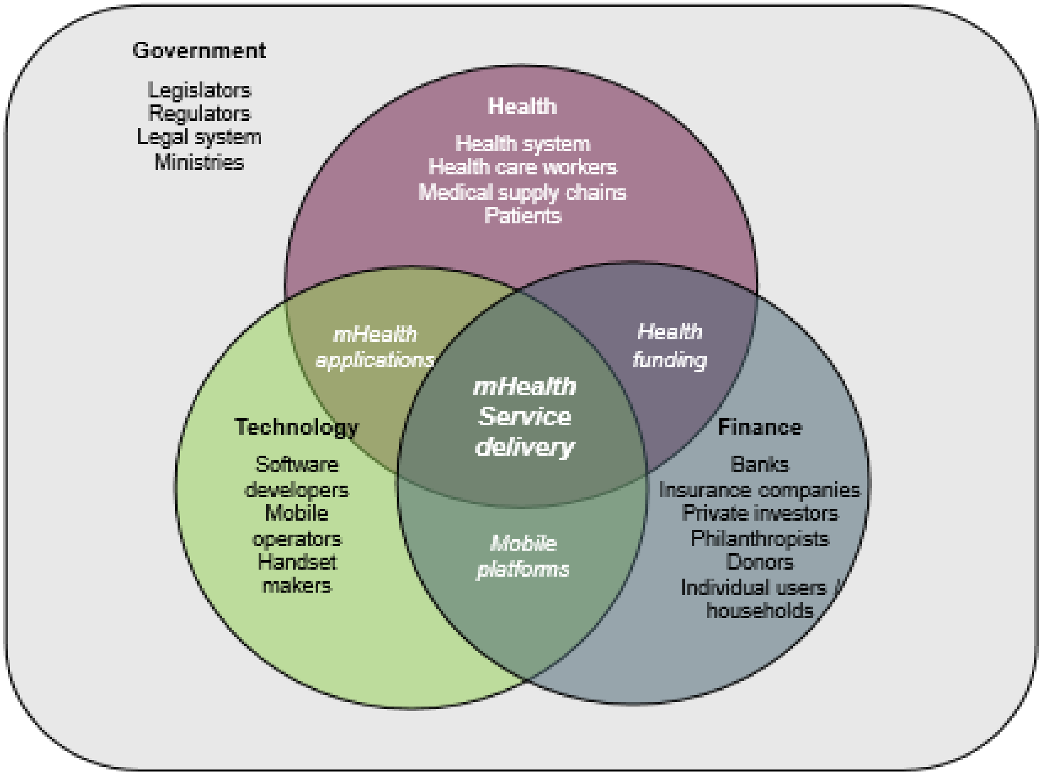

Figure 3. 4. mHealth ecosystem
Adopted from: Qiang, *et al*., (2011)

At the centre of the ecosystem is the mobile healthcare service delivery to the community. Such delivery is enabled by the existing healthcare system including the competency of healthcare workers, and medical supply chains (Qiang, *et al*., 2011). Healthcare providers, administrators, and outside experts are important agents within the ecosystem as they are key in identifying needed mHealth applications. Technology offers a platform that facilitates the delivery of healthcare services via mHealth applications. Software developers play an important role by developing mHealth applications, although such applications may not be always driven by the needs of a specific health system (Qiang, *et al*., 2011). In addition, sometimes, applications developers may be distinct from the implementers who may be a separate company or Non-Governmental Organisation (NGO) (Qiang, *et al*., 2011). The role of mobile network operators cannot be neglected as they provide the technical infrastructure to deliver mHealth services. The finance sphere ensures the realisation of mHealth initiatives by bringing on board various donors and funders. Donors may include multilateral agencies, NGOs, foundations and large companies that entirely or partially fund mHealth initiatives (Qiang, *et al*., 2011). Individual users, such as patients and other users, may trigger the need for and the creation of new mHealth applications.

These users also provide feedback that could be used to enhance existing mHealth applications. Insurance companies may be interested in mHealth applications to advertise and deliver their products to customers where other means of communication (such as regular mail, email) are unreliable (Qiang, *et al*., 2011).

National governments have influence over the three spheres (healthcare, technology and finance). The government's influence through its policies, regulations and strategies, affect the development and use of mHealth-enabled applications/services for healthcare interventions (Qiang, *et al*., 2011). The following section discusses how government policies and regulations influence the design and implementation of mHealth interventions.

3.7.1. Policies and regulations

Governments set national healthcare priorities which are then translated into policies and regulations. mHealth services that are aligned with the government healthcare priorities can be mainstreamed to reach regional and national scales (Vital Wave Consulting, 2009). mHealth programs are often funded by philanthropic organisations or for-profit business (as part of a corporate social responsibility initiative) (Vital Wave Consulting, 2009). In most cases, when the initial funding is exhausted, mHealth projects find it difficult to achieve scalability and sustainability, resulting in forced termination (Vital Wave Consulting, 2009). Hence, it is critical for mHealth projects to be aligned with the national health system agenda to secure government funding beyond the donor-funded period (Vital Wave Consulting, 2009).

Regulation of mobile service providers is another sphere of government's influence on the mHealth industry. This includes the regulation of mobile telecommunications service prices to mobile users, which significantly determine the extent of use of mobile technology countrywide. In Burundi, created in 1997, The "Agence de Régulation et de Contrôle des Telecommunications" (ARCT) is the countrywide Telecommunications Regulatory Authority (HIPSSA, 2013). ARCT provides oversight of the telecommunication sector by monitoring, regulating, and enforcing regulations within the telecommunications sector (HIPSSA, 2013). Furthermore, as part of its mandate, the regulator enforces tariff policy and grants permits for telecommunications network construction (HIPSSA, 2013). The Government of Burundi provides operating licences of market services after technical review by ARCT (HIPSSA, 2013). However, the country does not have price regulation within the telecommunication industry. This makes it difficult for the regulator to solve disputes due to lack of a costing tool (Nyssen, *et al*., 2015). The principle adopted in Burundi's law is a fixed price licence fee by government's statute, as opposed to competition by means of an open tender (Nyssen, *et al*., 2015) for licenses. The licence fees are generally determined based on the services provided by the mobile operator and its network coverage (Piper, 2016). In addition, mobile operators have to pay an annual royalty fee, which is generally fixed, at 2 % of the annual turnover of the telecommunications operators (Piper, 2016). Moreover other taxes to be paid by mobile telecommunications' operators include tax for incoming international traffic, tax on national traffic for mobile communication, ad valorem tax on GSM electronic communications and the Value Added Tax (Piper, 2016). The rates of fees and charges are set and revised by the government, following proposal by the Minister of Guardianship (Ministère des sceaux). In 2015, the Government of Burundi passed a new law to increase tax on mobile calls by 42 Burundi Francs (0.03 US dollars as per February 2016 exchange rate) (Siboniyo, 2015). Previously, in 2014, another tax of 0.32 US dollars was imposed on incoming calls from abroad in addition to other per minute taxes imposed to telecommunications companies. This caused a considerable drop in incoming calls from abroad (from 6.5 million minutes per month to 2.3 million) (Siboniyo, 2015). The same scenario was expected in 2015 due to the 2015 tax increase as alluded to by the Chairman of the Sectoral Chamber of Technologies, Information and Communication (CSTIC) (Siboniyo, 2015). The same opinion was echoed by civil society organisations, such as the association of consumers in Burundi, predicting that people would be likely to revert to much cheaper options for mobile communications such as the use of messages, social networks like Viber, WhatsApp, and other messenger applications instead of making calls (Siboniyo, 2015). Hence, there is a need for partnership between the government and mobile telecommunications companies to identify ways of providing mHealth interventions that are not costly to the users.

mHealth is most effective when integrated in a comprehensive eHealth strategy. However, Burundi does not have an eHealth strategy as opposed to its counterparts within the East African Community (Rwanda, Kenya, Uganda, and Tanzania) which have already established eHealth strategies. In Burundi, a lack of eHealth strategy may hamper prospects of private investment within the health sector. An eHealth strategy is viewed as a blue print that may guide strategic investments towards ICT implementation within the Burundi's health sector. Lack thereof may limit the private sector's enthusiasm to invest in long-term, sustainable, mHealth-led solutions. However, efforts are being deployed towards the implementation of an eHealth strategy in Burundi. In 2014, the Ministry of Health commissioned a study into the development of a national eHealth enterprise architecture based on The Open Group Architecture Framework (TOGAF) (Nyssen, *et al*., 2015). The study recommended eight aspects that should be considered while developing an integrated e-health enterprise architecture in Burundi (Nyssen, *et al*., 2015):

1. Centralisation of shared databases and applications by creating a national datacentres for the Ministry of Health in the capital city of Bujumbura.
2. Developing a Virtual Private Network (VPN) based healthcare intranet that would connect the central, provincial and district level health structures. Such a network should be configured in a way that it could be accessed through diverse technologies such as 3G, optical fibre and VSAT[13] (Very Small Aperture Terminal).
3. Implementation of shared applications within the public sector such as geographic information system, accounting software, unique central website, workflow management, a virtual library and the Ministry of Health's owned mail server to prevent loss of valuable information when healthcare staff leave the ministry.
4. Implementation and strengthening of health specific business applications including the District Health Information System ($DHIS_2$), Human Resource Information System (iHRIS), OpenRBF (for monitoring of Results Based Financing (RBF) programs), OpenClinic GA (for sharing health information), Hospital Information System (HIS)
5. The implementation of patient-oriented health data collection tools through smartphones and tablets at the community level and in healthcare centres.
6. The implementation of an SMS-to-IP gateway enabling health facilities that have only access to plain SMS and GSM connectivity to collect healthcare data via text messages.

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[13] VSAT is a satellite communications system that serves home and business users. VSATs are used to transmit narrowband data (e.g., point-of-sale transactions using credit cards), or broadband data (VoIP or video).

7. Developing at least three health informatics-teaching programs to cope with the need for human capacity building. These should include a Masters level course in Health Informatics (in collaboration with universities from neighbouring countries), a specialization program in applied health informatics for health professionals and a biomedical technician bachelor program.
8. The creation of an autonomous health informatics directorate at the Ministry of Health that will address the standardization and regulation of health informatics, health informatics infrastructure (such as datacentre and intranet) management, health informatics education and promotion and helpdesk and support functions (Nyssen *et al*. 2015).

As part of national strategies, governments may adopt regulations that support mHealth (Qiang, *et al*., 2011). For instance, the Burundian government may intervene in creating a regulatory framework that fosters the use of common standards for the transfer of information across mobile networks (Qiang, *et al*., 2011). This will make it easier for individuals to switch between mHealth services providers. In addition, interoperability of mHealth services is crucial to ensure mHealth scalability (Qiang, *et al*., 2011). The government-set standards for hardware and software can ensure that mHealth applications connect with each other and other mobile tools. Moreover, regulation of information and intellectual property helps determine applications available to individuals and health systems (Qiang, *et al*., 2011) as mHealth entrepreneurs may not be willing to invest in countries with weak intellectual property regulations. This stems from the fact that in such countries, investors may not be able to assert ownership of their software (Qiang, *et al*., 2011). Thus, government's adoption of ICT-related intellectual property laws is an important aspect that needs to be considered as an avenue to attract mHealth applications development that is specifically tailored to the local context.

Qiang *et al*. (2011) suggest key steps that governments should take in their efforts to implement mHealth. Figure 3.5 describes the steps, expected results and key considerations within each step.

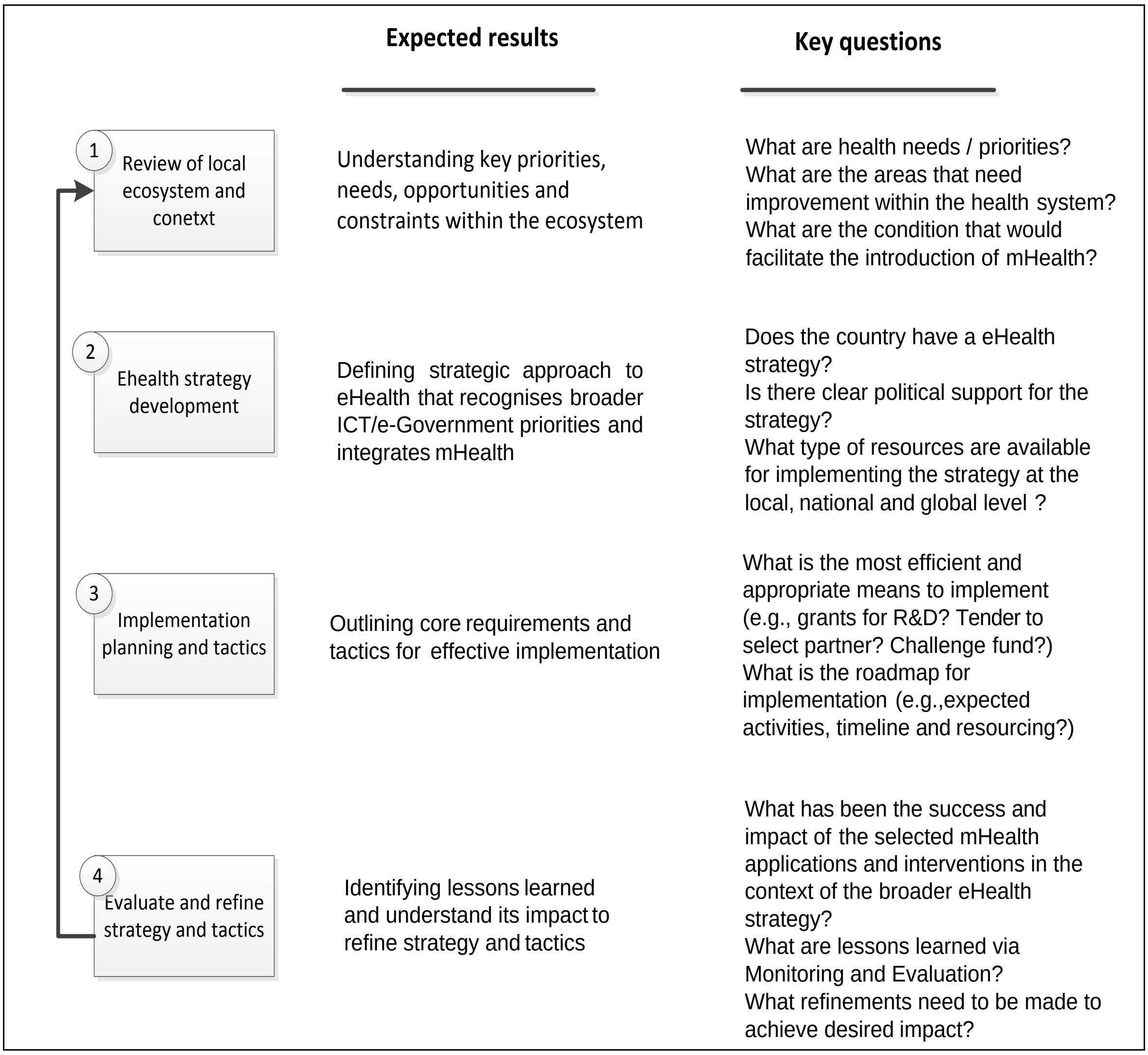

Figure 3. 5. Guidance for government efforts on mHealth initiativesFigure
Adopted from Qiang et al., 2011

3.8. Impediments to mHealth adoption

3.8.1. Scalability and sustainability of mHealth interventions

The mHealth report (Vital Wave Consulting, 2009) indicates that the major problem of mHealth adoption in developing countries is the issue of sustainability and scalability. Kochi (2013) argues that often donors invest in technologies to prove their applicability in a specific set up without having scalability in mind. Thus, additional funding is required beyond the initial set up phase for the sustainability of mHealth projects. It is critical for mHealth projects to be aligned with the national health system agenda to secure government funding beyond the donor-funded period (Vital Wave Consulting, 2009).

The private sector's participation in mHealth applications deployment could be one of the solutions to the sole reliance on donors' funds. However, such participation is hampered by a lack of regulatory policies that encourage private sector's participation in public mHealth projects (Excelsior Group, 2014). In addition, often governments fail to keep up with the pace of technology innovation. Hence, there is a need for mutual consultation between the private and public sectors in order to develop sustainable mHealth programs.

A Lack of demand-driven mHealth applications has fuelled a proliferation of mHealth initiatives that are experimental in nature. In Kenya for instance, it is estimated that most of the innovative health programs remain at their early stage of implementation, rely on donor funds and do not generate profit (Excelsior Group, 2014). In 2008 and 2009, Uganda had 23 mHealth pilot projects that did not scale up (Lemaire, 2011). Lack of coordination between mHealth applications results in clustered projects without the prospects of scalability. In addition, interoperability is an issue that needs to be addressed for large scale adoption of mHealth initiatives to materialise. In Kenya for instance, a survey of health information systems reveals that 33 applications with different protocols and incompatible standards were used for electronic medical records thus posing challenges for scaling them up (Qiang, *et al*., 2011).

3.8.2. Lack of understanding of market needs

A major condition for the success of mHealth projects lies on their ability to adapt to the local context and population's needs. Projects have an increased risk of failure when they have not been designed for or adapted to the specific context in which they are being deployed (Haberer *et al*., 2010). Some eHealth solutions have been implemented without a prior assessment of the unmet needs that they would address. For instance, Cargo (2012) states that the challenges that mHealth initiatives face in Kenya include lack of understanding of market needs. A better approach to designing mHealth interventions would be to start with the evaluation of unmet needs and then to proceed with the design of mobile technologies to address them.

3.8.3. Lack of mHealth integration into the healthcare system

Participation of the government, via the government's department in charge of public health, is a fundamental aspect for the success of mHealth projects. Particularly, without a national strategy and leadership in the government, pilot projects have very little chance of scaling (Kochi, 2013). Failure of mHealth projects may happen when there is a lack of integration into the healthcare system and, particularly, when roles and responsibilities have not been clearly defined at the various different hierarchical levels (government, managers to health workers) involved in implementation and operation (Jones, *et al*., 2012).

The role and level of involvement of governmental organisations is fundamental for project success during its lifespan. However, for the integration of mHealth into the existing systems, healthcare delivery processes need to be redesigned (e.g. change to electronic records) (Lester, *et al*., 2010). Moreover, a clash between a technology and public health culture often hinders prospects of scalability (Kochi, 2013). Healthcare providers need to develop the cultural and organisational capacity required to manage digital health information (Leon, Schneider and Daviaud, 2012). Lack of these capacities may lead to late reporting, lack of feedback and incomplete data collection (Leon, *et al*., 2012). Mechanisms that define how to use data collected are also required at the district and national levels (Hoffman, *et al*., 2010; Haberer, *et al*., 2010; Zurovac, *et al*., 2011; Githinji, *et al*., 2013; Tomlinson, *et al*., 2009). Evidence shows that the complexities associated with large mHealth projects implementation are not well understood (Jian, *et al*., 2012), in addition to the required standards to monitor and evaluate the projects (Pop-Eleches, *et al*., 2011; Siedner, *et al*., 2012). A lack of guidance and policies from the Ministry of Health and non-existent financial support from governments to deploy mHealth projects are regarded as reasons for failure (Asiimwe, *et al*., 2011).

3.8.4. Lack of adequate planning for mHealth implementation

Costs and logistics associated with the implementation of mHealth projects need to be carefully assessed. An underestimated assessment of resources required for a specific intervention may lead to project delays, and the initial project scope may be affected (Andreatta, *et al*., 2011; Chang, *et al*., 2012; L'Engle, *et al*., 2013). Lack of adequate planning may also affect available resources, as there could be occasional staff shortages, during the project lifespan (Lester, *et al*., 2010). This might result in staff overload, as they will have to deal with an increased workload due to the number of feedback messages or calls received in cases of interactive mHealth solutions (Kamanga, *et al*., 2010).

3.8.5. Technical and mobile device ownership issues

A mHealth system can be successfully implemented if it is easy to use and users are familiar with and have access to the technology. However, in some cases, although the technology may be easy to use, the system users' lack of skills to use the technology may hinder them from responding promptly to text messaging requests (Zurovac, *et al*., 2011; Zurovac, *et al*., 2012). To overcome this problem, some users (for example patients) may ask for support from their relatives or friends, but this may bring other problem particularly when one considers patients' data privacy. In terms of use and acceptability of mobile technology, issues regarding phone ownership such as high phone sharing, lack of money for credit recharge and male control over household phone ownership may also limit the results of an mHealth intervention (Haberer, *et al*., 2010; Chang, *et al*., 2011).

The capacity of mHealth projects is defined by the capacity of the technology itself. For instance, text messaging has a limited number of characters (Rotheram-Borus, *et al*., 2012), thus limiting the application of text messaging to specific types of interventions. Other technology-related problems are poor data quality and transfer (Rotheram-Borus, *et al*., 2012; Chang, *et al*., 2011), network connection loss, phone maintenance costs (Hoffman, *et al*., 2010), a lack of software flexibility and adaptability, and risk of human errors (Leon, *et al*., 2012). In addition to these technical challenges, legal issues arise in terms of privacy and security measures to be taken for obtaining, handling, and transmitting data.

Another major limitation for the implementation of mHealth projects is the coverage and accessibility of mobile technologies. Access to mobile phone networks in Africa is extensive, but not necessarily reliable. Infrastructure availability such as the presence of a reliable network, access to Internet and electricity (Ngabo, *et al*., 2012; Haberer, *et al*., 2010; Siedner, *et al*., 2012; Chang, *et al*., 2011) are important for mHealth projects to succeed.

Limited expertise in developing and maintaining software and hardware platforms may hinder projects implementation (Chang, *et al*., 2011; Tomlinson, *et al*., 2009), if technical training is not provided (Asiimwe, *et al*., 2011; Chin, *et al*., 2013; Zurovac, *et al*., 2012).

Personal security concerns also appear to be a hindrance to the adoption of mHealth. In one of the mHealth projects in South Africa (Cell-Life Project[14]), some CBHWs preferred to not carry their mobile devices due to fear of armed robbery (Skinner, Rivette, Bloomberg, 2007). Others objected to intrusion into their private life (in the case of Cell Life Project) which is perceived as a hindrance to the adoption of mHealth (Skinner, *et al*., 2007).

In the specific context of Burundi, the Executive Secretary for Burundi's Information and Communication Technologies (SETIC) argues that prices of Internet-based communication services have dropped to some extent but not to the users' expectations (Iwacu, 2014). The World Bank-financed national Optical Fibre network which was implemented within the Burundi's Communication Infrastructure Project (PIC) brought hope for a cheap Internet connectivity throughout the country (Iwacu, 2014). In the health sector, the Ministry of Health site in Bujumbura and some referral hospitals in Bujumbura were connected to the network by the end of 2014 (Nyssen *et al*., 2015). Although the network is more reliable than other networks available in the country and offers greater capacity and performance, towards the end of 2014, the network was running at less than 10% of its capacity due to low demand of bandwidth (Executive Secretary of SETIC, quoted in Iwacu (2014)). An increase in bandwidth demand will lower unit prices which will ultimately translate into end users getting higher connection speed for less money (Iwacu, 2014). According to the SETIC secretary (Iwacu, 2014), there is a need for awareness campaigns to stimulate the use of Information and Communication Technologies at all levels (government, private sector, and individual users). He further states that the aim should be to generate local content that can be transmitted over the network and hence increase the traffic of information across the network (Iwacu, 2014). In addition, he identifies low purchasing power, illiteracy rate, lack of infrastructure, outdated access networks and a limited number of ICT terminals connected to the Internet (computers, smart phones, tablets) as major

[14]A South African mHealth project to help HIV patients comply with drug therapy

impediments to the adoption of Internet- based services in Burundi. He also mentions the recurring electricity shortage as a hindrance to regular access, availability and continuity of ICT services in Burundi.

3.8.6. Sociocultural factors

Although technology acceptance is one of the reasons for the success of mHealth projects, even if users may perceive a pilot project as valuable, sociocultural factors still need to be considered. For instance, in some places SMS interventions may fail due to user's preferences for making voice calls or personal appointments (Andreatta *et al*., 2011; Hoffman *et al*., 2010; Zurovac *et al*., 2012). Hence, mHealth systems are more likely to succeed if socio-cultural factors pertaining to the target community are incorporated within the design of the systems.

The preceding sections described the potential impact and various use of mobile technologies to provide healthcare care services. In view of the current healthcare challenges in Burundi, mHealth is presented as one of the solutions that may help alleviate those challenges, thus contributing to the universal access to healthcare. A description of the mHealth ecosystem was also presented with specific references to Burundi. Furthermore, determinants of and impediments to mHealth adoption were discussed and areas where Burundi needs to focus (to ensure mHealth adoption success) were highlighted. The following section concludes this chapter by discussing best practices for building sustainable and scalable mHealth interventions.

3.9. Pillars for building sustainable and scalable mHealth interventions

In view of the challenges pertaining to mHealth implementation, solutions that will lead to sustainable and scalable mHealth solutions are much needed. The following section discusses four pillars for building sustainable and scalable mHealth interventions. These pillars were identified through a systematic review of literature pertaining to the implementation of scalable mHealth solutions.

3.9.1. Design mHealth for scalability at the beginning of the project inception

Drawing from lessons learned from a successful implementation of MOTECH[15], Wood (2013) suggests that in order to develop scalable mHealth projects, it is imperative to design mHealth in a way that is scalable right from the beginning. This involves designing mHealth-enabled solutions that will reach beneficiaries not just at the community level but also at the national level (Wood, 2013). This entails a shift from focusing on the technology implementation alone to an emphasis on what it will take for the technology to yield results within the context of each country or region. The shift will require a strategy to overcome obstacles such as frequent power outages in order for mHealth interventions to deliver their intended outcomes. Wood (2013) was echoed by Kochi (2013) who suggests that one should consider the costs of mHealth interventions beyond the pilot phase. Such considerations involve ensuring the wide availability of mobile devices and developing an infrastructure to ensure scalability of mHealth interventions. DePalomo (2013) argues that, although cellphones may be effective to address healthcare related issues, they do not provide solutions on their own. Partnerships with community health workers and community-based organisations to address socio-cultural impediments to mHealth adoption are essential. In addition, integrating mHealth services into the health Ministries' systems will assist in securing resources that will support the technology (such as fund allocations for mobile telecommunications infrastructure development to ensure wide cellphone coverage). In Rwanda, the successful implementation of a scalable Rapid SMS system was partially due to additional logistics that were put in place to support the outcomes of the mHealth-based intervention (Burundi Ministry of Health, 2014). Drawing from the experience with the implementation of an SMS-based system for health education, data collection and monitoring purposes in East Africa, Slaughter (2013) also shares the same views and mentions that understanding and overcoming obstacles to the adoption of mHealth is a key enabler of scalability. In the case of the SMS-based system (Slaughter, 2013), field agents were not accustomed to SMS technology, had cheap unreliable phones, and many had challenges keeping their phones charged. Hence, intensive training, incentives and helping field agents acquire solar chargers were the necessary

[15] Mobile Technology for Community Health (MOTECH) project is a mobile health program that sends messages to "pregnant parents" in their local language throughout their pregnancy and during the first year of their child's life, providing accurate information that helps them have a healthy pregnancy and new born.

ingredients to ensure scalability of the program. Furthermore, any mHealth initiative should be designed with the end users in mind (Kochi, 2013). Generally, when an mHealth tool is designed in a way that makes the end users' job easier and is easy to use, it is likely to be scaled. Conversely, mHealth project scalability may be in jeopardy if it is burdensome and not easy to use. Praekelt (2013) on the other hand argues that scalable mHealth solutions should not be hardware dependant, should analyse existing user behaviour and should engage the user in a two-way interaction.

Lemaire (2011) claims that scalability and sustainability factors include ensuring that hardware and software chosen for the pilot phase can be used on a broader scale and developing a long-term funding plan. He further argues that assessments are needed to identify the needs and demands of the beneficiaries to determine the appropriate mHealth implementation for a specific location. It is equally important to identify local health priorities, the existing players, available solutions within the mHealth ecosystem, local policies, and local settings and practices. Moreover, he posits that culture, language, reliability of mobile network signals, literacy levels and the existing healthcare infrastructure are all significant factors that need to be considered for a successful mHealth implementation. In order to ensure mHealth adoption in developing countries that includes even illiterate people, mHealth campaigns should be designed in a form of Interactive Voice Responses (IVRs) in addition to SMS messages (Maureen, 2014; Arora, 2015). This stems from the fact that IVR offers a voice-based, step-by-step, and easy to follow way of interaction that may be more appealing for illiterate people (Qiang *et al*., 2011).

Schaefer (2013) advocates the use of open source software to build mHealth systems. He claims that the use of an open source software, RapidSMS, allowed the project Mwana (an SMS based system that collects and disseminates healthcare data) to be replicated in other countries' settings. In addition, the use of the system eliminated the burden of licence fees payment. The human-centred design process, which aimed at involving the local community members, assured that the software would make sense in the local context and be easy for new health facilities to adopt (Schaefer, 2013).

Mechael (2011) (quoted in Lemaire, 2011) argues that there is a need to understand the health system environment and prevailing norms within which the mHealth system will be implemented. Hence, she suggests performing ethnographic studies and local environment assessment. This entails the identification of cultural and social norms that influence patients' behaviour and the ownership of the mHealth intervention as well as the political and policy-related factors that may affect the implementation and scalability of the intervention.

3.9.2. Secure mHealth support from key stakeholders

Securing buy-in with key stakeholders and aligning mHealth interventions with health priorities are also important for a project's scalability (Kochi, 2013). The sustainability of mHealth projects depends largely on support from the local community structures and national governmental agencies. Slaughter (2013) argues that it is very important to 'sell' the benefits of the technology rather than just instructing users to start using it. It is also crucial that mHealth projects are aligned with the national or global health agenda in order to secure the support of key stakeholders. Particularly, a project that is aligned with a national eHealth strategy is likely to be scaled (Kochi, 2013). On the same note, Wood (2013) suggests a close collaboration with government health ministries and designing mHealth systems that enhance existing health programs to improve the prospect of government's support for large scale implementation.

Lemaire (2011) posits that target beneficiaries of a mHealth intervention must be involved in the development of the intervention to ensure its successful uptake. Such involvement will assist in detecting any need for capacity building from the end users' perspective. Community leaders and CBHWs need to be trained on various aspects of the technology implementation. As part of the training, more emphasis needs to be laid on how they may support the intervention and hence benefit from it. mHealth initiatives need to have clear objectives that are aligned with local and national health goals. Such alignment may serve as a fertile ground for integrating the mHealth initiatives into the national health system, hence promoting long-term sustainability of the interventions.

Local communities' ownership of mHealth interventions can promote a positive response (from the community) to the interventions. Such ownership may also create a perception that the interventions add value to the community, which may trigger even more support from community members who had not yet adhered to the mHealth initiatives (Lemaire, 2011). A close partnership with the ministries in charge of public health can promote the integration of the project into existing health systems, enabling policy-making to support mHealth (Lemaire, 2011). The content of the mHealth initiative should be developed in consultation with local partners. Such partners will assist in defining key terms and themes so that the conveyed message is accurately understood by the intended recipients (Lemaire, 2011). Such partners could be traditional and community leaders, CBHWs or other healthcare agencies (Lemaire, 2011). For mHealth projects to scale up, technical expertise and resources from strategic partners, such as mobile network operators and technology companies, are needed (Lemaire, 2011). It should never be assumed that a project that proved to be successful in one context would be so in other contexts. Hence, partners must be secured and involved in a meaningful way in order to benefit from their skills and knowledge (Lemaire, 2011).

Fabiano (2013) suggests that building trust between the technology (and the information conveyed through the technology) and its users is a very important ingredient to scaling mHealth interventions. In this regard, trust can be built through personalised messages and iterative user testing of a technology. This testing would help identify socio-cultural barriers that may impede the adoption of mHealth interventions.

3.9.3. Avoid duplication of efforts

Lemaire (2011) further suggests that one should not reinvent the wheel but rather collaborate with organisations that have already embarked on mHealth implementation within the specific location. This entails mapping what existing players have already done and identifying what works and what does not in the local context. Schaefer (2013) suggests that in order to promote mHealth scalability, technology should be used to strengthen the existing mHealth interventions (as opposed to replacing them). The aim should be to leverage their efforts and learn from their successes and failures. Duplicating efforts can hinder the efficacy of mHealth and can prevent mHealth programs from securing funds and partners to support scale up.

3.9.4. Invest in mHealth projects' evaluation

It is important to invest in the evaluation of mHealth projects. An approach is needed to demonstrate the value of a specific mHealth program in order to justify further allocation of funds (Kochi, 2013). An impact evaluation of a mHealth project is an avenue to secure funding for large scale implementation if such an evaluation reveals positive outcomes (Kochi, 2013). Lemaire (2001) posits that there is a need for consistent monitoring and evaluation of mHealth projects. Such consistency will help government's stakeholders to realise the cost-benefit ratio associated with mHealth programs. Providing such evidence-based data can increase the government's buy-in and investment in the program. A major driver of mHealth scalability is the ability to prove the efficiency and efficacy of mHealth projects in achieving set goals and meeting both local and national healthcare priorities (Lemaire, 2011). This entails "putting in place meaningful and measurable metrics that not only indicate success but also guide adjustments that need to be made along the way" (Brooke Partridge, quoted in Lemaire (2011:30). Having a monitoring and evaluation plan in place is essential to ensure the effectiveness of mHealth programs (Lemaire, 2011). The implementation of mHealth programs should be flexible enough to respond to findings from monitoring and evaluation exercises to ensure that they remain relevant to the local health priorities and evolving beneficiary needs (Lemaire, 2011).

3.10. Summary of the chapter

Chapter 3 presented a review of literature pertaining to the adoption, use and implementation of mHealth. Although the literature presents positive outcomes from mHealth initiatives, there is not much evidence of mHealth adoption that goes beyond the pilot phases in developing countries. On the contrary, there is evidence of clustered mHealth projects that are either at pilot stage or experimental in nature especially within the context of Africa. However, the impact of mHealth can be wider should mHealth implementation be approached with scalability in mind. The prospects of scalability can only be envisaged if there are concerted efforts from various stakeholders within the mHealth ecosystem. Such concerted efforts are also necessary in order to overcome mHealth impediments outlined in this chapter. In the case of Burundi, so far, there is evidence of two mHealth interventions (SIDA info and Kiramama projects) for which impacts have not been evaluated. However, in Burundi, perceptions (from healthcare professionals) of the determinants, impediments and potential impact of mHealth interventions have not been investigated. To the best knowledge of the researcher, this study constitutes the first research that investigates the adopters' views on mHealth adoption in the country using an integrated theoretical framework. It addresses the gap found in the literature pertaining to limited research in the area of Burundi's adoption of ICT for development (ICT4D) in the health sector. The following chapter discusses the study's guiding theoretical frameworks.

CHAPTER 4: THEORETICAL FRAMEWORKS

4.1. Introduction

Studies in the field of mHealth have been conducted using different theoretical frameworks. However, a literature review suggests that the most commonly used theoretical frameworks in mHealth are the Diffusion of Innovation Theory (DOI), the UTAUT model, the Theory of Reasoned Action (TRA), The Theory of Planned Behaviour (TPB) and the Technology Acceptance Model (TAM). The following section reviews these theories. The Capability Approach model is included in this review as it is particularly relevant in the study of ICT for Development (ICT4D)-related interventions (see for instance Grunfeld, *et al*., 2011). The aim is to highlight the outcomes of the use of such theories within the field of mHealth to be compared against the findings from this research.

4.2. Capability Approach (CA) model

Drawn from the works of Sen (2001) and Nussbaum (2003), the CA approach is anchored in the idea of Development as Freedom (Sen, 2001) and the idea of Justice (Sen, 2009). The theory posits that the quality of human life cannot solely be evaluated through the lenses of economic factors (Sen, 2009, p. 225). Sen's work particularly has influenced the United Nations Millennium Goals and Human Development Index (Robeyns, 2005). Nussbaum (2000, p. 5) defines capabilities as "what people are actually able to do and to be, in a way informed by an intuitive idea of a life that is worthy of the dignity of the human being." In this light, the CA model may be considered as "a theory of human capability that takes into account key determinants of well-being such as education, health, and social participation" (Stillman and Denison, 2014:203-204). Sen (2001) argues that peoples' use of their capabilities may lead to substantive freedoms such as getting education, being healthy, social participation, and freedom from oppression. However, such freedoms depend on the 'functionings' which can be defined as the perceived important things people would like to do or what they would like to be in order to obtain these freedoms. Robeyns (2006) suggests that there are different ways the CA could be used to tackle a specific question. Johnstone (2007) posits that CA provides an opportunity for understanding and promoting the possibilities that ICT offers in the context of global development. In the context of this research, mHealth is seen as an enabler of individuals' capabilities. Specifically, mHealth can enable healthcare professionals to provide healthcare education and awareness programs, collect health data, monitor health cases, communicate and train fellow healthcare workers, track disease and epidemic outbreak and support patients' diagnosis and treatment (Vital Wave Consulting, 2009). This research posits that the capabilities acquired through mHealth may lead to substantive freedoms such as prevention of diseases, disease management and improved quality of healthcare in Burundi. However, the attainment of such freedoms depends on what healthcare professionals value doing. In this case, the attainment of such freedoms may depend on the healthcare professionals' acceptance of mHealth capabilities. The adaptation of the CA model is presented in figure 4.1.

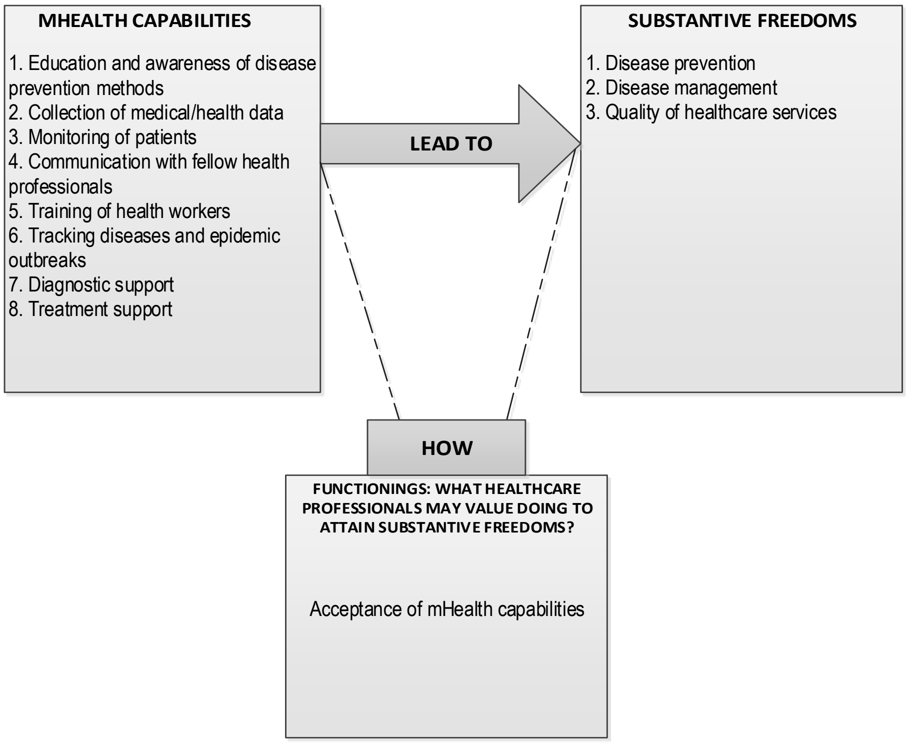

Figure 4. 1. Adaptation of the CA model to the study

The CA has been used in diverse settings such as information studies, development studies, philosophy, disability, material design, and indigenous studies (Stillman and Denison, 2014). Grunfeld, *et al*. (2011), in alignment with the CA's trio (capability, freedoms and functionings) argue that a participatory approach that reflects the choices that individuals and communities make in determining capabilities is needed in order to gain insights on the impact of ICTs on health, education and community development. They developed the capabilities, empowerment, and sustainability (CES) model which assumes that individuals and communities can use ICT to build capabilities, empowerment and sustainability "which in turn can improve their ICT infrastructure and skills" (Grunfeld, *et al.*, 2011, p. 152) in a virtuous spiral way. Oosterlaken (2009) advocates for capability sensitive technology design. He points out that technology design should not only reflect the social and technical choices and preferences of designers but also should adopt participatory design methods as some information (pertaining to the design of a specific technology) can only be obtained from people and communities themselves. Effective design methods therefore promote "personal and social/environmental characteristics that influence the conversion from resources into capabilities and functionings" (Oosterlaken, 2009, p. 94). Technology can thus be seen as a tool for 'capability expansion'. In the context of mHealth adoption, it is of paramount importance to involve stakeholders in the design of mHealth interventions. Such high importance stems from the fact that the concept of mHealth is very new in the country. Hence, it is important that technology designers design mHealth solutions that are relevant to duties performed by healthcare professionals. In addition, such solutions should be relevant to the socio-cultural context of the country. This research captures stakeholders' (including healthcare professionals) perceptions of what is needed for mHealth to contribute positively to healthcare provision in the country.

Toboso (2011) posits that socio-technical designers should take into consideration the functional requirements of people with different abilities and should develop the capability set that allows a person to function as fully as he or she wishes. In this case, capability can be measured in terms of an individual's capacity and freedom of choice to have ability (e.g., someone with mobility disabled hand), to take advantage of the "functionings" provided by a technology (e.g., voice commands rather than use of keyboard). Vaughan (2011) stresses that any development of capability sets or functionings has to consider physical and spiritual attachments to peoples' culture.

Zheng and Walsham's (2008) discussion of capability exclusion in the e-society (drawn from the CA approach) argues that ICT for development should take into consideration individual and social factors that influence people's ability to achieve well-being. In general, information literacy, which includes e-literacy, "should move beyond the scope of individual skills to a structural level social phenomenon which entails the diversity of human conditions and social contexts" (Zheng, 2007, p. 2).

Gigler (2011), focusing on information capabilities and information capital in rural villages in Bolivia, suggests indirect effects of ICTs on people's well-being. He indicated that improving humans' informational capabilities (such as literacy) is the most important dominant factor that determines the impact of ICTs on wellbeing. The author further posits that improving poor people's information capabilities will have an impact on their abilities to make choices to live the kind of life they desire. He further stated that one cannot assume that improvement in access to ICTs does necessary translate into use thereof, and improvement in peoples' lives. Hence, he implies that peoples' differences in capabilities determine whether they are able to translate existing opportunities into improved aspects of their lives. In the context of this research, although healthcare professionals' enhanced capabilities (empowered by mobile health through the 8 categories of mHealth capabilities[16]) may translate into enhanced healthcare services provision (disease prevention, management and quality of healthcare services), there is a need to identify the perceived underlying factors (DOI and UTAUT variables) as discussed in the following section (section 4.3) that may hinder or influence their adoption of mHealth. Such identification can assist in devising strategies to increase healthcare professionals' capabilities to adopt and use mHealth capabilities. For example, should complexity be a determinant to mHealth capabilities acceptance, it is assumed that healthcare training coupled with educational and awareness programs may increase their capabilities and enthusiasm towards the adoption of mHealth within the proposed eight dimensions.

Robeyns argue that capability is linked to "the idea of opportunity or advantage" (Robeyns, 2000:6). In his explanation of Sen's Capability approach model, Robeyns (2000) argues that a commodity must have a characteristic that is appealing to the user for it to be converted into a functioning. However, the author further argues that for a commodity to be translated into functioning to achieve certain goals depends on

[16] According to Wave Consulting (2009), mHealth capabilities can be classified in 8 categories: education and awareness, remote data collection, remote monitoring and treatment, communication with healthcare workers, training healthcare workers, tracking diseases and epidemic outbreaks, diagnostic support and treatment support.

personal and social characteristics that she termed as “conversion factors” (Robeyns, 2000:5) In the case of this study, the researcher posits that the opportunity or the advantage (capability) that is presented by mHealth can only be functional if the users in this case healthcare professionals perceive some benefits from it. The researcher posits that the functionality of mHealth capabilities can only be active if the users (healthcare professionals) accept and adopt those capabilities. In alignment with Robeyns’ conversion factors, the functionality of mHealth capabilities is enabled by determinants (including personal and social factors), of which some were identified in the literature. Aligning Robeyns conversion factors with the DOI and UTAUT model, Robeyns’ personal characteristics can be likened to individual characteristics of the DOI model (persuasion variables) and UTAUT model (performance expectancy and effort expectancy variables). Robeyns’ social characteristics (such as infrastructure and institutions according to Robeyns’ examples) can be compared to the facilitating conditions of the UTAUT model.

4.3. Technology acceptance theories

Technology acceptance is one of the most important fields of research in information systems (Venkatesh, et al., 2003). It contributes to an understanding of various factors that inform users’ intentions to adopt a technology and their usage behaviours of the technology (Sun, Wang, Guo and Peng, 2013). Figure 4.2 presents an overview of the commonly used technology acceptance theoretical frameworks.

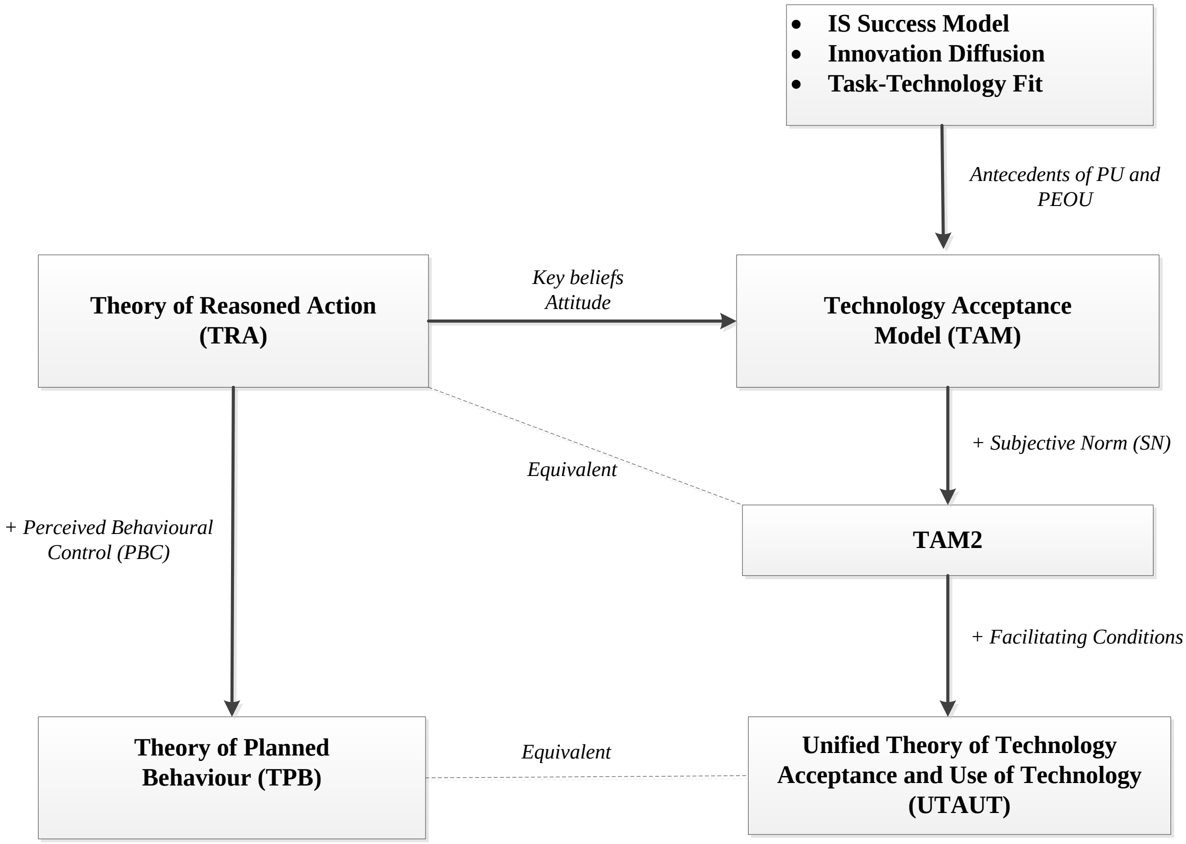

Figure 4. 2. Summary of technology acceptance theories
Adopted from Sun *et. al* (2013)

Amongst the theories presented above, Davis' (1989) TAM (Technology Adoption Model) is the most influential (Sun, *et al*., 2013). The model posits that from the users' perspectives, the intention to adopt a new technology depends on two factors i.e. Perceived Usefulness (PU) and Perceived Ease of Use of the technology (PEOU). PU is the extent of a person's beliefs that the use of a system would improve his/her job performance (Davis, 1989), while PEOU refers to the extent of a person's beliefs that the use of a system would be effortless (Davis, 1989). TAM derives from the TRA (Theory of Reasoned Action) (Fishbein and Ajzen, 1975) which argues that an individual's behavioural intention is determined by an individual's attitude and his/her subjective norms. In this context, attitude is defined as a person's feelings (either positive or negative) about displaying certain behaviour (Fishbein and Ajzen, 1975) and is formed based on the beliefs about the outcomes of certain behaviour. Subjective norm is "the person's perception that most people who are important to him think he should or should not perform the behaviour in question" (Fishbein and Ajzen, 1975, p. 302) and is formed based on an "individual's perceptions of social normative pressures" (Sun, *et al*., 2013:185). TAM's Perceived Usefulness and Perceived Ease of Use are drawn from the TRA's attitude factor (Sun, *et al*., 2013). Venkatesh & Davis, (2000) developed TAM2 by including the subjective norm in the TAM.

4.3.1. The UTAUT model

Venkatesh, *et al*. (2003) extended TAM2 to become the Unified Theory of Acceptance and Use of Technology (UTAUT) by including facilitating conditions as a factor that predicts the behavioural intention. Concepts used in other frameworks were renamed and perceived usefulness, perceived ease of use, and subjective norm were respectively termed as performance expectancy, effort expectancy, and social influence. Performance expectancy refers to the individual's perceptions that a system would increase his/her job performance (Venkatesh, *et al*., 2003). Effort expectancy refers to an individual's perceptions of the ease of use of a system (Venkatesh, *et al*.,2003). Social influence is the individual's perception on whether others (who have some influence on him/her) believes he/she should use a new system (Venkatesh, *et al*., 2003). Facilitating conditions refer to the individual's beliefs in the existence of the technical and organisational infrastructure to support the use of a system (Venkatesh, *et al*., 2003). Venkatesh, *et al*., (2003) includes gender, age, experience, and voluntariness of use as moderating factors of the UTAUT concepts. UTAUT and TPB have similar components which are performance expectancy and effort expectancy (as two components of attitude) (Benbasat and Barki, 2007).

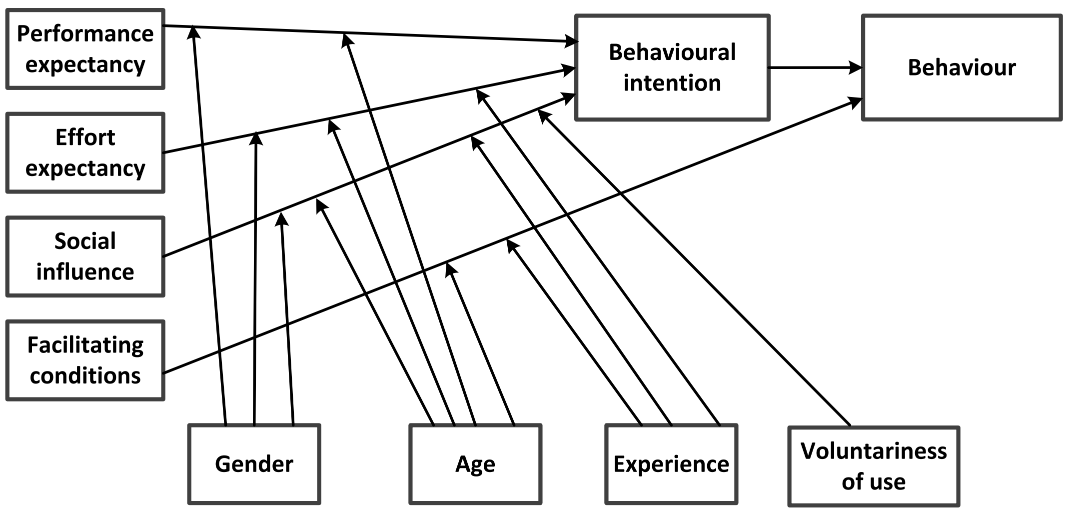

Figure 4. 3. UTAUT model
Source: Venkatesh, V., Morris, M., Davis, G. B. and Davis, F. D., 2003. User acceptance of information technology: toward a unified view. *MIS Quarterly*, 27, 1, 425-478.

Sun, *et al*. (2013) add that most empirical studies on Health Information Technology (HIT) acceptance published on or before 2013 were built from the technology acceptance theories. Among the many studies related to technology acceptance, the UTAUT model had been frequently used in the healthcare field (Wilson and Lankton, 2004; Chang, Hwang and Li 2007; Schaper and Pervan, 2007; Nuq, 2009; Puuronen, Vasilyeva, Pechenizkiy, Tesanovic, 2010). UTAUT is a comprehensive model that can be used to explain (users') usage intention of an information system. It combines the theories delineated above in addition to the model of PC utilisation, the Diffusion of Innovation (DOI) theory, and social cognitive theory. Venkatesh, *et al*. (2003), comparing UTAUT with other technology of acceptance theories concluded that the UTAUT theory accounted for 69% of intention to use IT, while other models explained approximately 40% of technology acceptance. Zhang, Cocosila, and Archer (2010), through a partial least square modelling data analysis, revealed that the perception of the usefulness (performance expectancy) of mHealth is the driving factor towards its adoption by canadian nurses. The finding echo previous findings (Venkatesh, *et al*., 2003; Moon and Kim, 2001) that revealed that performance expectancy (perceived usefulness) and effort expectancy (perceived ease of use) are the main determinants of the intention to use wireless mobile systems by homecare nursing personnel. Using an adaptation of the UTAUT model, Kijsanayotin, Speedie and Pannarunothai (2009) discovered that the intention to use health IT in community health centres in Thailand is driven by UTAUT related factors. These are performance expectancy (health IT usefulness), effort expectancy (ease of use), social influence (the fact that important others believe that one should use health IT), and voluntariness (the fact that one has a choice in the use of IT) with performance expectancy being the strongest predicting factor. Sun, *et al*. (2013) used the UTAUT model to identify factors that predict acceptance of mHealth services from the users' point of view. The authors, through structural equation modelling, found that response efficacy (the extent to which mHealth can help users to reduce health-related risks) was the most influential factor in predicting mHealth technology acceptance followed by subjective norm (social influence) and perceived ease of use (the degree to which a person perceives that a particular system is easy to use). In addition to these UTAUT factor, they further found that self-efficacy (the degree to which one has the ability to perform the advised action) is a significant predicting factor towards mHealth adoption. Wu, Wang and Lin (2007) also found that self-efficacy regarding using mHealth systems had a strong impact on healthcare professional behavioural intent to adopt a technology. One's perceived self-efficacy determines the perception of a system as easy/not easy to use (Venkatesh and Davis, 1996). An individual with low self-efficacy will choose a product that can be handled easily, notwithstanding the availability of better or advanced products. Ellen, Bearden and Sharma (1991**)** empirically confirm that self-efficacy is a significant factor that influence resistance to technological innovations. Other authors have also attested that self- efficacy is a significant factor to be considered in the study of resistance and diffusion of innovation (Tan and Teo, 2000).

A more recent systematic review (covering the period from 2000 to 2014) of factors that influence healthcare professionals' adoption of mHealth (Gagnon, *et al.*, 2016) reveals that perceived usefulness is cited as a facilitator for mHealth adoption in at least 18 studies followed by Perceived Ease of Use (cited in 10 studies). In those respective studies, it was established that healthcare professionals may not be willing to adopt mobile technologies if they do not perceive them as useful and easy to use. In South Africa, a study conducted to explore nurses' responses to a mobile point-of-care (POC) system reveals that lack of confidence in the system performance due to the system being slow, inaccurate and not fitting within the fast nature of nurses' work were some of the impediments to the mHealth intervention (Whittaker, Van Zyl and Soicher, 2011). Park and Chen (2007) and Wu, *et al*. (2007) found that behavioural intention to use smartphones and other mobile devices in clinical practice was largely influenced by the Perceived Usefulness (PU) of the technology. Using the Technology Acceptance Model2, Zhang, *et al*. (2010) similarly found that PU is the main factor that influences the adoption of mobile information technology by homecare nurses. These studies confirm the importance of performance expectancy and effort expectancy variables in the adoption of mHealth.

The social influence construct is best explained as the user's perception that the use of the technology or innovation affects how he or she is perceived among their peers. Hao, Padman and Telang (2011) argue that physicians under the influence of opinion leaders within the healthcare organisation, are three times more likely to adopt mobile IT than otherwise. Social influence among clinicians does not only relate to their peers' perceptions, but also to how their patients perceive their usage of mobile technology (McAlearney, Schweikhart and Medow, 2004). A study by Alsos, Dabelow and Faxvaag, (2011) reveals that doctors prefer devices that are standardised hospital-like tools as opposed to devices that look too personal and could be perceived negatively by patients.

Internal organisational training and technical support are facilitating conditions that are significantly associated with adoption behaviours among clinicians and nurses in particular (Hsiao, Li, Chen and Ko, 2009; Putzer and Park, 2010). In one study, however, technical support and training did not have any effect on the perceived usefulness and perceived ease of use of mobile healthcare systems (Wu, *et al*., 2007). Vandenkerkhof, *et al*. (2009) show that perceived control significantly predicted 45% of the variation in behavioural intent to adopt a mobile communication tool by clinicians. In focus groups conducted with doctors, participants were concerned about the reliability and security of mobile devices. Specifically, they were concerned about "dependency on the device as a substitute for clinical thinking", which indicates the importance of the perceived control factor among clinicians (McAlearney, *et al*., 2004, p. 1). Fear of losing the device or the information stored in it can also be considered to be an indication that self-efficacy constitutes an important element when accepting and using mobile technology in healthcare (Dearnley, Haigh and Fairhall, 2008). Nevertheless, clinicians' interest in adopting a system does not only rely on their own self-efficacy, but also on their perception of the extent to which their organisation is able to provide them with technical capabilities (Burgess and Sargent, 2007).

4.3.1.1. Applying the UTAUT model to the study

In line with the strength of the UTAUT model over other technology acceptance theories and the empirical evidence of the applicability and relevance of the model in mHealth adoption studies, UTAUT was adopted in the study to explain healthcare professionals' intentions to adopt mHealth within the context of Burundi. Particularly, the model is adapted to the study to enable a better understanding of factors that influence the adoption of mHealth in Burundi (research question 2). Variables (from the questionnaire) incorporated within the UTAUT model are presented in table 4.2. The choice of these variables was informed by the fact that mHealth is a new concept in the country. Hence, the researcher aimed at keeping the variables simple. It is worth noting that the researcher's aim was to bring awareness of the concept of mHealth in the country and to draw the attention of healthcare professionals of devising effective means of disease surveillance, reporting and mapping as opposed to the current paper systems used in the Burundian healthcare services. Hence, this research is a proof of concept, demonstrating the applicability of the UTAUT framework constructs within the field of mHealth in Burundi. The author acknowledges that these variables are not exhaustive. In addition, not all the constructs of the UTAUT were included in the study due to the limited knowledge of mHealth in the context of Burundi. Thus, this constitutes one of the limitations of the study. Further studies should look at incorporating the entire set of UTAUT variables within the context of mHealth adoption in Burundi.

Table 4. 1. Study's variables incorporated in the UTAUT model and depicted in the survey instrument (questionnaire)

Performance expectancy
Expansion of healthcare access (Qualcomm, 2014)
Convenience (Zurovac et *al*., 2012; Ventola, 2014)
Effort expectancy
Ease of use of mobile devices (Rotheram-Borus, *et al*., 2012; Zurovac, Larson, Sudoi and Snow, 2012)
Ease of use of mHealth applications (Lester, *et al*., 2010)
Facilitating conditions
Affordability of mobile devices (Mechael, *et al*., 2010)
Reliability of mobile technology infrastructure (Mehl, *et al*., 2014, Qiang, *et al*., 2011, Ngabo, *et al*., 2012; Haberer, *et al*., 2010; Siedner, *et al*., 2012).
Free access to mHealth via SMS Nchise, Shu, Boateng and Mbarika (2012)
Affordability of sending SMS (Nchise, Shu, Boateng and Mbarika, 2012)
Affordability of making calls (Nchise, Shu, Boateng and Mbarika, 2012)
Content of mHealth message/service in local language (Vital Wave Consulting, 2009)
Confidentiality of information (Mukund and Murray, 2010; Bakshi, *et al*., 2011)

Venkatesh *et al*. (2003)[17] argues that the root constructs of performance expectancy are perceived usefulness (Davis, 1989; Davis et al., 1989), extrinsic motivation (Davis et al, 1992), job fit (Thompson et al., 1991), relative advantage (Moore and Benbasat, 1991) and outcome expectations (Compeau and Higgins, 1995; Compeau et al., 1999). Two variables were singled out as part of the outcome expansions and formed the basis for the analysis of the impact of performance expectancy on mHealth adoption in

[17] Venkatesh et al. (2002) was not used in the construction of questionnaire as it pertains specifically to the use of mobile internet. Therefore, it does not reflect the wide range of mHealth capabilities.

Burundi. The variables are used to assess whether mHealth contribution towards access to healthcare services and the convenience that mhealth use presents, are determinants of mHealth adoption in the Burundi's context. These variables were previously identified in other research as important factors that need to be considered a far as mHealth adoption is concerned as depicted in table 4.2. Relative advantage construct was singled out and analysed separately as a DOI construct due to its particular importance in the context of mHealth adoption in Burundi. As mHealth is a new concept in the country, the researcher deemed it necessary to single it out in order to get a better understanding of the primary healthcare professionals' perceptions of the role/advantages of mHealth in Burundi. Such understanding would then inform the types of interventions that are needed in order to stimulate mHealth adoption.

Venkatesh *et al*. (2003) further argues that the root constructs of effort expectancy are Perceived ease of use (Davis, 1989; Davis et al., 1989, Complexity (Thompson et al., 1991) and ease of use (Moore and Benbasat, 1991). Perceived ease of use was singled out as the most important factor of the effort expectancy construct. As mHealth is a new concept in Burundi's healthcare, the researcher theorises that if mHealth devices and applications are not perceived to be easy to use, mHealth may not be adopted as a way of providing healthcare services in Burundi. In the same vein, complexity was singled out and analysed as part of the DOI factors for the same reasons.

Moreover, Venkatesh *et al*. (2003) argues that the root constructs of facilitating conditions are perceived behavioural control (Ajzen, 1991; Taylor and Todd, 1995), facilitating conditions (Thompson *et al*. 1991) and compatibility (Moore and Benbasat, 1991). The researcher considered facilitating conditions to be important predictors towards mHelath in Burundi. The researcher theorises that understanding the existing and required facilitating conditions for the adoption of mHealth is a very crucial step towards mHelath adoption in Burundi. Furthermore, compatibility was singled out as a DOI factor that may influence mHealth adoption in Burundi. The researcher alludes that if mHealth is not compatible with healthcare professionals' duties, their experience with mobile devices and their organisational working style, they may not adopt it.

The Information System (IS) success model, Diffusion of innovation (DOI) theory, and Task - Technology Fit Theory (TTFT) are often used to explain the antecedents of TAM factors or TPB factors (Wixom and Todd, 2005; Çelik and Yilmaz, 2011; Dishaw and Strong, 1999). This study pays particular attention to the DOI model due to its significance within the context of Burundi.

4.3.2. The DOI model

The diffusion of a technology is the process through which a technology is spread among members of a social system through certain media over time (Rogers, 1995). The theory postulates that an individual passes through five stages that forge his/her decision to adopt or not adopt a particular technology as summarised in table 4.2. A potential adopter firstly acquires the knowledge of the technology through some channels. For instance, new technology ideas can be communicated from one individual who is acquainted with the technology to other members of the society who have no knowledge about it (Cain and Mittman, 2002). Then, the adoption process graduates to the persuasion level whereby the individual forms a positive or negative attitude towards the technology. Rogers (1995) argues that five factors influence the individual's persuasion. The attitude towards a technology is shaped by the potential adopter's judgement of the benefits and risks of the new technology against the existing technology (relative advantage factor), his/her ability to try out the technology without total commitment and with minimal investment (trialability factor), the extent to which he/she can witness the technology adoption from others (observability factor), the extent to which the technology is easy to use (complexity factor) and the extent to which the technology is compatible with what he/she already know i.e. experiences, values, norms or culture (compatibility factor). The outcome of the persuasion phase is either the adoption and use (implementation phase) or rejection of the technology. After adopting the technology, the adopter may continue to use the technology (confirmation) or may discontinue its use after a certain period.

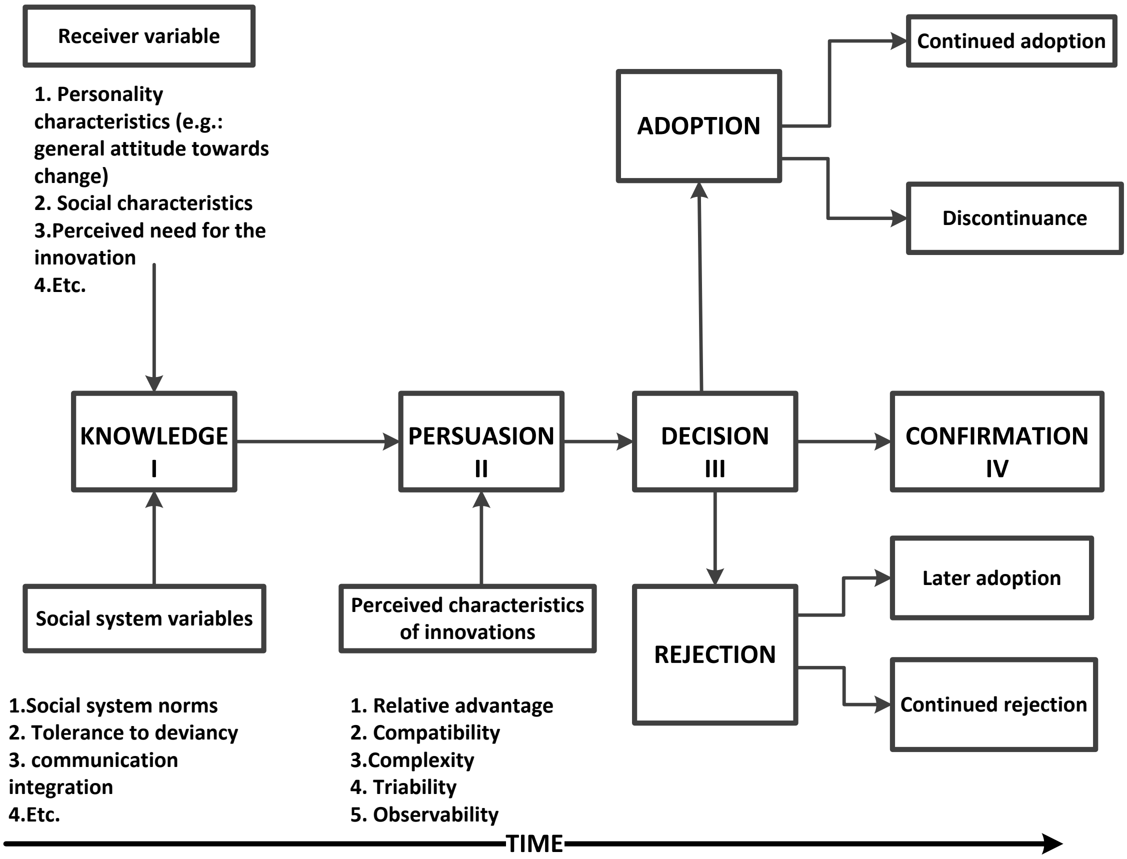

Figure 4. 4. The Diffusion of Innovation theory
Source: Rogers, 2003. Diffusion of Innovations. New York: Free Press.

Compatibility in prior research was found to be a critical factor than can predict users' technology adoption or resistance (Saaksjarvi, 2003). Tornatzky and Klein (1982) claim that there are two aspects of innovation compatibility. Firstly, it may refer to compatibility with the values or norms of the potential adopters. Secondly, it may refer to compatibility with the existing practices of the adopters. The former is a psychological or cognitive compatibility (e.g. compatibility with what people feel or think about a technology) while the latter is a more practical/operational compatibility (e.g. compatibility with people's practices). Holak and Lehmann (1990) argue that culture and previous experience with products can determine (to some extent) users' sense of comfort with innovation. Moreover, they further claim that if an innovation is perceived as compatible with past experience, principles, and life style, it will be relatively easily accepted. Tornatzky and Klein (1982) also argue that, from a theoretical point of view, perceived innovation compatibility is positively related to adoption and implementation of the innovation. Dunphy and Herbig (1995) and Tan and Teo (2000) support Tornatzky's claim and further state that compatibility is positively related to innovation diffusion rate and negatively related to users' resistance to innovation. On the other hand, the adoption rate of an innovation is affected by the old/existing system or technology. The more compatible the old/existing technology or system is, the less is the users' intention to adopt innovations (Dunphy and Herbig, 1995) and hence more users' resistance. Using Rogers's DOI theory, Putzer and Park (2010) found that compatibility was the most significant factor associated with the adoption of smartphones among nurses in community hospitals.

Hu, Chau, Sheng and Tam (1999) argue that health professionals are generally competent enough to learn and use a new technology. Thus, in most cases, they will use their own judgment when making decisions (thus social influence will not affect their adoption decision), and the technology complexity will not inhibit their technology acceptance. However, various other researchers have found that complexity is positively related to innovation resistance and negatively related to innovation diffusion (Dunphy and Herbig, 1995; Tornatzky and Klein, 1982). An innovation with considerable complexity requires additional skills and efforts in order to increase its adoption and decrease the possibility of users' resistance (Cooper and Zmud, 1990; Dickerson and Gentry, 1983; Tan and Teo, 2000). In their qualitative study, McAlearney, *et al*. (2004) found that doctors' perception that mobile devices are not easy to use in clinical practice is a barrier to mHealth adoption. It is generally believed that users easily adopt innovative products that are less complex (Holak and Lehmann, 1990). There exists a negative relationship between complexity and relative advantage. A product that is perceived as complex will be difficult for users to try and hence cannot be utilised for its advantages (Holak and Lehmann, 1990; Robert, 1998). Furthermore, Holak and Lehmann (1990) argue that there is a positive relationship between complexity and perceived risk as greater risk is associated with innovation that is perceived as more complex.

Relative advantage can be evaluated in terms of economic profitability, social benefits or time saved (Tornatzky and Klein, 1982), and in terms of perceived usefulness (PU) (Roberts and Pick, 2004). In general, the rate at which an innovation is adopted is positively related to the perceived relative advantage associated with such an innovation (Rogers, 1983; Tan and Teo, 2000), and negatively related to users' resistance (Dunphy and Herbig, 1995). Tornatzky and Klein (1982) also found a negative correlation between relative advantage and users' resistance to innovation's adoption. Agarwal and Prasad (1997) further found that relative advantage is the most important factor that influences users' inclination towards adopting or resisting an innovation. In a study conducted by Alsos, *et al*. (2011) on doctors' adoption of mHealth, the authors argue that doctors preferred using Personal Digital Assistants (PDAs) to paper-based methods due to the perceived relative advantage associated with the PDAs' user interface. The interface design reduced the doctors' need to memorise medications' names and associated dosages. Kidd (2011) further identified increased contact with patients, work efficiency, teamwork, and life-work balance (i.e flexibility that mobile technology offers) as determinants of mobile technology adoption and use by nurses. In addition, relative advantage has an impact on perceived risk. As users perceive considerable advantages associated with a new product/service, they tend to ignore its deficiencies/flaws, which then increases the prospects of the product /service use (Holak and Lehmann, 1990). Moreover, Holak and Lehmann (1990) states that compatibility is positively related to relative advantage while relative advantage is negatively related to complexity. A compatible product can be used effectively thus increasing its relative advantage. However, relative advantage may decrease if an innovation is perceived as complex as adopters may not be able to utilise it effectively (Robert, 1998).

Putzer and Park (2010) argue that observability has the potential to influence the adoption of mHealth by healthcare professionals. They state that when a user has an opportunity to observe an innovation, the innovation is more likely to be adopted (Putzer and Park, 2010). Specifically, observability has an influence on nurse adoption of smartphone for delivery of healthcare services in hospitals in the South Eastern United States.

4.3.2.1. Applying the DOI model to the study

In the context of this research, the following are mHealth variables (see table 4.2 and 4.3) that are incorporated within the DOI model to answer research question 1 (*What are health professionals' perceptions of the use of mobile health to provide healthcare services?*) and research question 2 (*What are the determining factors for mHealth adoption in Burundi?*). Specifically, these variables seek to assess what healthcare professionals know about mHealth (knowledge variables) and the determinants (persuasion variables) of mHealth adoption within the context of Burundi as depicted in Tables 4.2 and 4.3 respectively.

Table 4. 2. DOI Knowledge variables as used in the questionnaire

Knowledge variables
1.Use of cellphones for education and awareness programs
2. Use of cellphones for remote medical/health data collection
3. Use of cellphones for remote patients' treatment and monitoring
4. Use of cellphones for communication with fellow health professionals
5. Use of cellphones for training health workers
6. Use of cellphones for diseases and epidemic outbreak tracking
7. Use of cellphones for diagnostic support
8. Use of cellphones for treatment support
9. Frequency of cellphone use for searching medical information
10. Use of cellphone use for booking an appointment with a patient
11. Sending medical information to patient via SMS
12. Receiving medical information on phone via SMS
13. Purposes of using other mobile devices (if any)

Table 4. 3. DOI persuasion variables as used in the questionnaire

Persuasion variables				
Relative advantage	***Complexity***	***Compatibility***	***Trialability***	***Observability***
Usefulness: Park and Chen (2007) and Wu, et al. (2007) Roberts and Pick, 2004	Difficulty of use of mobile devices: McAlearney, *et al*. (2004)	Compatibility with duties: Moore and Benbasat, 1991	Testing mHealth before adoption: Ram (1987)	Need to see tangible results of mHealth adoption before adopting it (Putzer and Park, 2010)
Making job easier: Alsos, et al. (2011)	Difficulty to learn how to use mobile health applications: McAlearney, *et al*. (2004)	Compatibility with what is needed to execute daily tasks: Holak and Lehmann (1990)	MHealth adoption first and then evaluation of results: Ram (1987)	Need to be shown where mHealth worked before adopting it (Putzer and Park, 2010)
Reduction of the amount of effort spent on executing some tasks: Alsos, *et al*. (2011)	Not coping with using mHealth devices: McAlearney, et al. (2004)	Compatibility with experience with mobile: devices (Sun et al., 2013)	MHealth adoption because it has proven to work	No need to see tangible results: (Putzer and Park, 2010)

Persuasion variables				
			in other countries Ram (1987)	
Ability to reach a larger portion of the country's population (Lohnari, Patil and Patil, 2016)	Not coping using mHealth applications: McAlearney, *et al*. (2004)	Compatibility with organisational working style Moore and Benbasat, 1991	Willingness to adopt MHealth without trying it: Ram (1987)	
Larger portion of the population will benefit from healthcare services (Tezcan et al., 2011; Krishna et al., 2009; Blake, 2008)	Ease of use of mHealth devices: McAlearney, et al. (2004)	Compatibility with work ethics Holak and Lehmann (1990)		
Improvement in prevention and awareness of diseases (Vital Wave Consulting, 2009; Burundi Ministry of Health (2014)				

4.3.2.2. Rogers categorisation of innovation adopters

Rogers postulates that adopters of a technology can be grouped into five categories: innovators, early adopters, early majority, late majority, and laggards. The characteristics of each category are presented in table 4.4.

Table 4. 4. Characteristics of technology adopters

Category	Characteristics
Innovators	Venturesome Cosmopolitan Geographically dispersed contacts High tolerance of uncertainty and failure

Early adopters	Well respected opinion leadership Well integrated in social system Judicious and successful use of innovation
Early majority	Deliberate Highly interconnected with a peer system Just ahead of the average
Late majority	Sceptical Responsive to economic necessity Responsive to social norms Limited economic resources Low tolerance for uncertainty
Laggards	Traditional Local people Relatively isolated Precarious economic situation Suspicious

Adopted from Rogers (1995)

1. Innovators – This category is made of people who would be the first to adopt an innovation. They are venturesome, eager to try new ideas and willing to take risks. Innovators play an important role in the diffusion process as they are the first to adopt or launch a new idea (technology) into the social system from outside of the system's boundaries. Thus, they play a gatekeeping role within the DOI model.

2. Early Adopters – This category represents respected, opinion leaders. They are the ones who potential adopters look up to for advice and information about the new technology. They are generally sought as catalysts toward speeding the diffusion process. The role of the early adopter is to minimise uncertainty about a new technology by adopting it, and then to use his/her subjective assessment to diffuse it through interpersonal networks.

3. Early Majority – This category would adopt a new technology before the average member of a social system but rarely hold leadership positions. They take more time to adopt a technology than the first two categories hence may be qualified as deliberate followers.

4. Late Majority - They are sceptical and cautious to adopt a technology, and will only adopt an innovation after the majority has tried it. Pressure from the peers is an essential tool to motivate their adoption.

5. Laggards – They are traditionalist, very conservative adopters and very sceptical of change and are the last to adopt a technology. They are likely to adopt a technology much later than others, most probably after the technology has been superseded by another more recent technology or a recent version of the previous technology.

Rogers (1995) proposes that innovators tend to be very few among the adopters' population while most of the adopters are situated within the early or late majority as depicted in the adoption curve in figure 3.4.

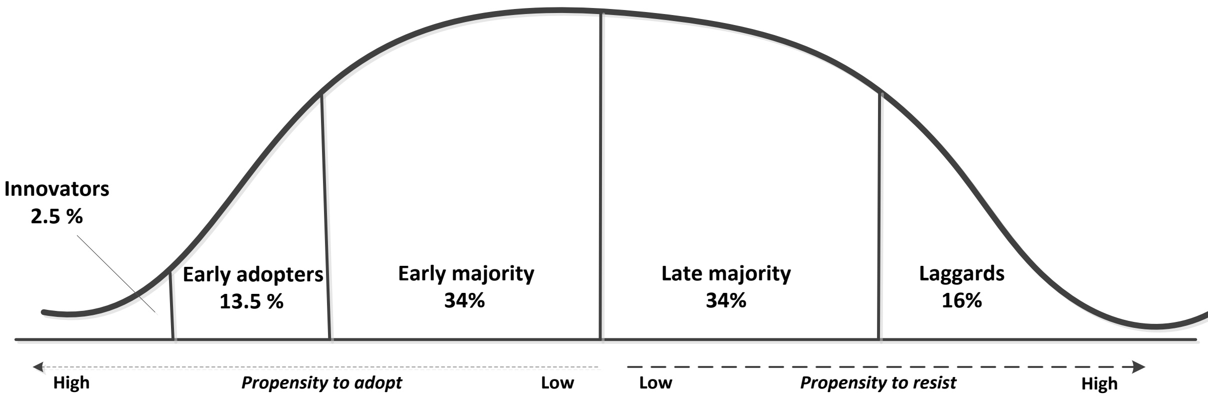

Figure 4. 5. Adoption of innovation curve
Adopted from Rogers (1983)

4.4. The extended Capability Approach model underpinning this study

Literature review identified what is currently known about Burundi, as far as mHealth adoption is concerned. It was mentioned in the literature that the increase in mobile phone users, the pilot phase of the Rapid SMS system and the current government's efforts towards the installation of countrywide internet networks are signs that may shape positively the country's path towards mHealth adoption. However, there are gaps that need to be filled pertaining to how mHealth should be implemented and the potential contribution of mHealth towards the country's healthcare provision. In the Burundi's context, the literature is silent about primary healthcare professionals' awareness of mHealth including their knowledge of mHealth capabilities and perceptions of mHealth as a tool for disease prevention, management and quality healthcare provision. Hence, the researcher theorises that for successful adoption of mHealth in Burundi, these gaps need to be explored in order to devise adequate strategies to stimulate mHealth adoption by healthcare professionals. Figure 4.6 depicts the researcher's conceptualisation of Burundi's path towards mHealth adoption.

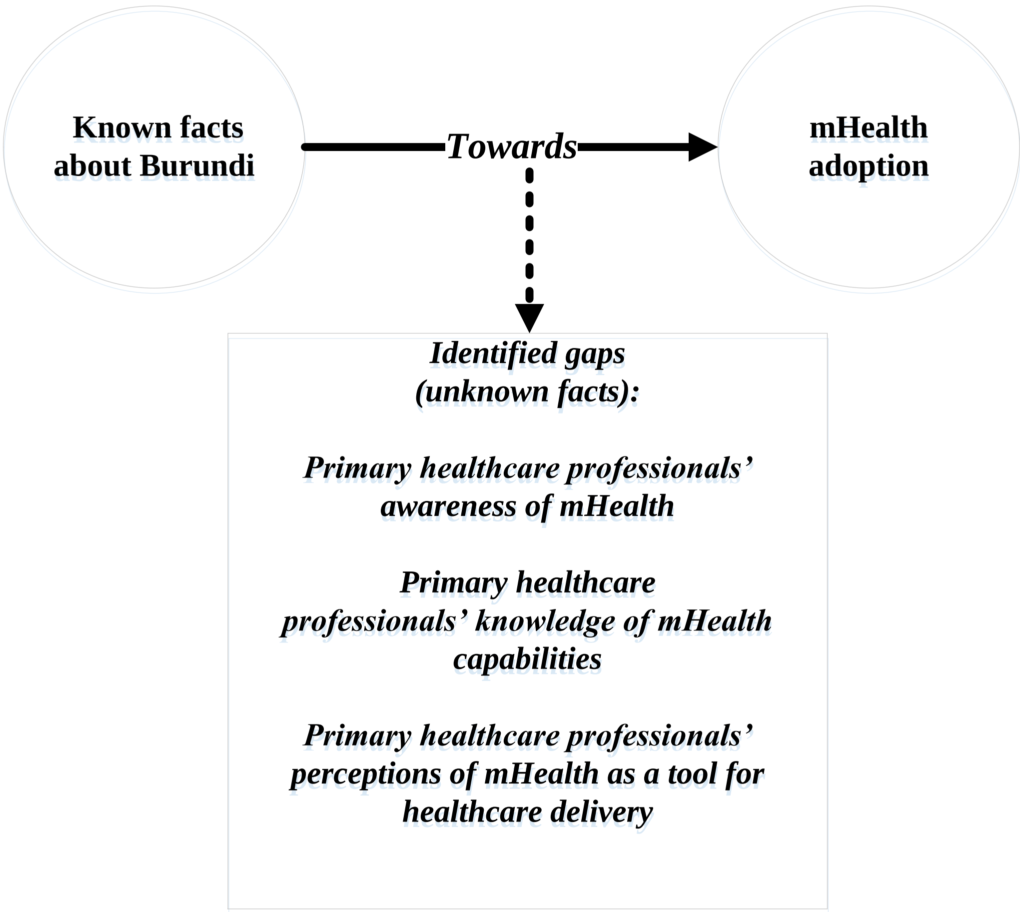

Figure 4. 6. Conceptual path towards mHealth adoption in Burundi

To address the gaps depicted in figure 4.6, this research employs integrated framework that encompass the CA, DOI and UTAUT constructs. The integrated framework posits that although mHealth capabilities may translate into disease prevention, disease management and quality of healthcare services, there are some variables that act as determinants of mHealth acceptance that need to be considered particularly within the context of Burundi. In essence, the framework helps in identifying what Burundi's contextual factors influence the adoption of mHealth. Furthermore, it assists in assessing if mHealth capabilities may lead to disease prevention and management and quality of healthcare provision.

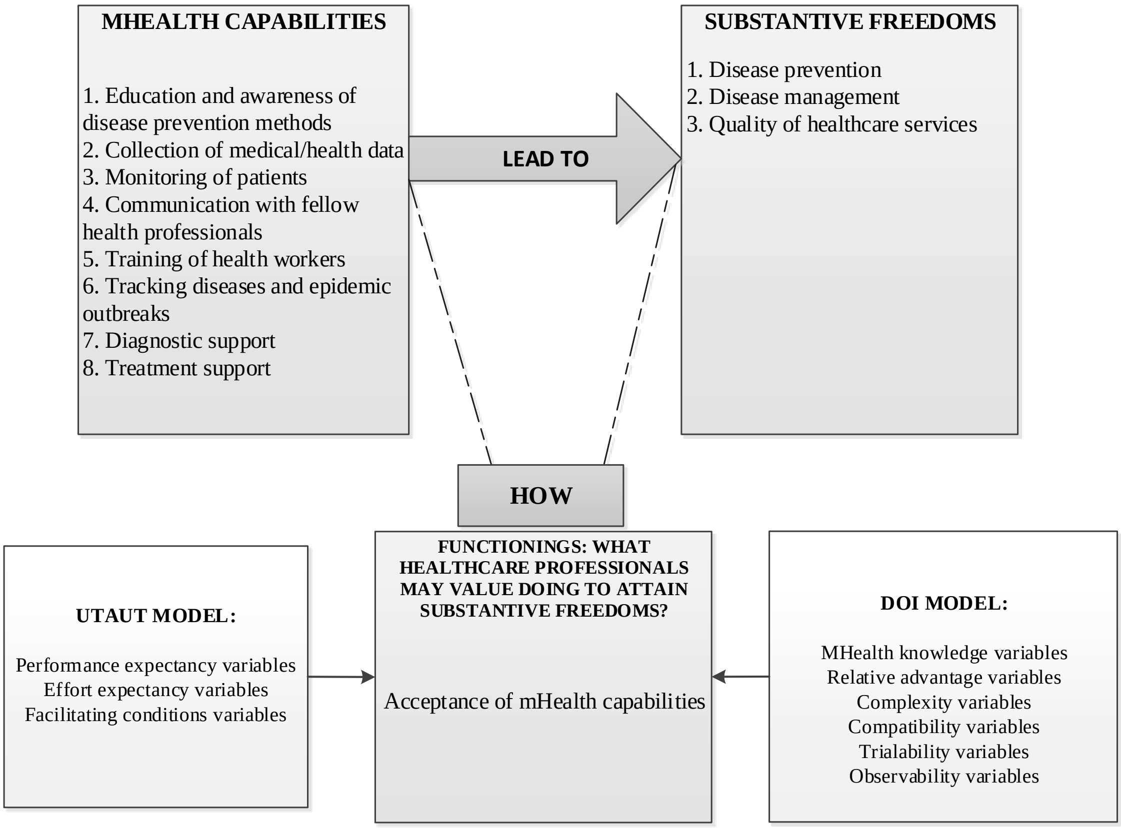

Figure 4. 7. Integrated framework-Extended Capabilities Model (CA-DOI-UTAUT)

4.5. Summary of the chapter

Chapter 4 discussed the Capability Approach (CA) model and the frequently used technology acceptance theories. It was discussed that the UTAUT model was adopted in this study due to its strengths over other technology adoption models. The DOI-persuasion factors are included in this research to complement the UTAUT factors. In this research, the CA model helps establish whether mHealth capabilities could lead to disease prevention, disease management, and quality of healthcare services in Burundi. The three models were integrated into an extended Capability Approach model, which is presented in figure 4.7.

CHAPTER 5: RESEARCH METHODOLOGY

5.1. Introduction

Mutai (2000) stipulated that a research methodology is a plan of action for studying a research problem and should outline how data will be collected, measured and analysed. Thus, the type of data required to answer the research questions informs a research methodology. This research methodology chapter discusses the research paradigm adopted in this study and research design, the target population, the sampling method and data collection methods, pre-test of data collection instruments, data collection and data analysis. Figure 5.1 depicts the steps followed in the study.

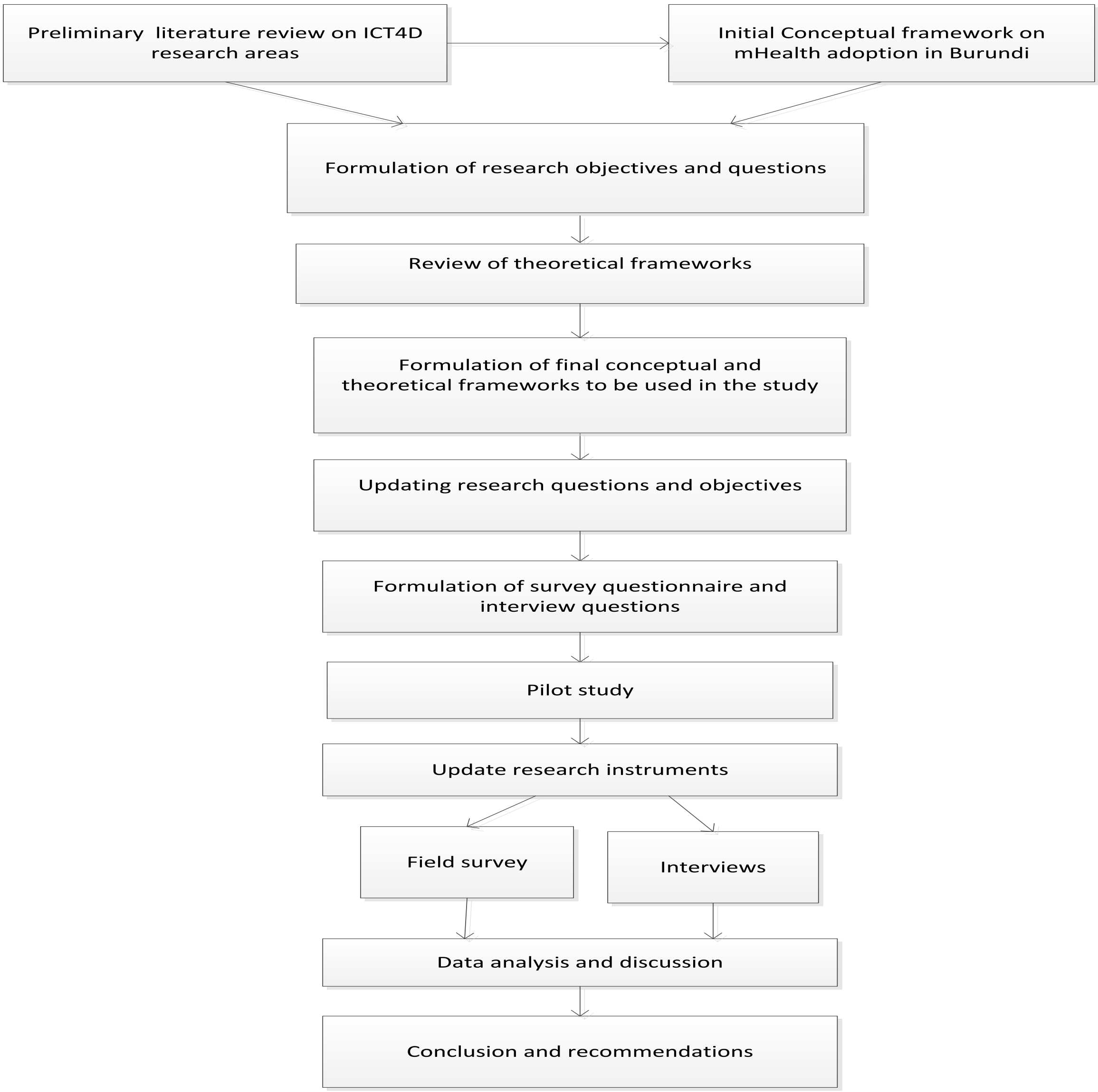

Figure 5. 1. Study approach

5.2. Research paradigms

Harré (1987, p. 3) defines a paradigm as "a combination of a metaphysical theory about the nature of the objects in a certain field of interest and a consequential method which is tailor-made to acquire knowledge of those objects." Hussey and Hussey (1997) emphasise the importance of researchers recognising and understanding their philosophical orientations within the paradigm adopted for a specific project. This section will highlight the two ontological stances in research and the researcher's position vis a vis such stances. It will further discusses the epistemology that guides this study in relation to the two prevailing epistemological stances in social sciences.

5.2.1. Ontology

Ontology is the study of being or reality. Ontological assumptions can be broadly divided into two categories: objective and subjective. An objective perspective considers reality as a set of objects that can be measured and tested, and which exist even when we are not directly perceiving or experiencing them (O'Gorman and McIntosh, 2015). An objective ontology thus assumes that reality exists independently of our comprehension of it, and that it is possible to establish and explain universal principles and facts through robust, replicable methods. In contrast, a subjective perspective looks at reality as made up of the perceptions and interactions of living subjects. This research takes the objective stance as it uses robust and replicable methods to answer the research questions.

5.2.2. Epistemology

Epistemology can be broadly defined as "the study of knowledge" (O'Gorman and McIntosh, 2015:59). Its aim is to identify ways in which one may develop valid knowledge. There are two major epistemological stances. On one hand, there is the positivist stance which aims at explaining principles while the interpretive stance aims at understanding relationships. A positivist epistemological approach is aligned with the quantitative methodology while an interpretive approach is aligned with the qualitative methodology.

Although there are many epistemological stances in social science research, the following section focuses on the two major ones i.e. positivist, and interpretivist stances. Similar to O'Gorman and McIntosh's (2015) argument, the researcher argues that an understanding of these stances is necessary in order to choose the appropriate approach for this study. Hence, the section depicts the researcher's understanding of these epistemologies and the application thereof in the study.

5.2.2.1. Positivism

Positivism is anchored in the idea that science is the only way to learn about the truth. Hence, the theory posits that knowledge can only be trusted if acquired through observation and measurement. Positivists view the world as "comprising discrete, observable elements and events that interact in an observable, determined and regular manner" (Collins, 2010:38). In a positivist approach, the researcher is limited to data collection and interpretation through objective approach. The findings of a positivist study are usually observable and quantifiable. Hence, positivism depends on quantifiable observations that lead themselves to statistical analysis. Moreover, in positivism studies, the researcher is independent from the study and there are no provisions for human interests within the study. Crowther and Lancaster (2008) argues that as a general rule, positivist studies usually adopt a deductive approach. A deductive research explores a known theory, testing the validity of the theory in a given circumstances (Wilson, 2010). This research adopts the deductive positivist approach as it tests the applicability of known theories to answer the research questions. Research findings in a positivist approach have been criticized for being only descriptive and lacking in-depth analysis (Dudovskiy, 2016). However, in addition to quantitative data collection methods, this research also employs qualitative methods in order to gain more insights on some of the issues that lacked in depth-analysis from quantitative analysis.

5.2.2.2. Interpretivism

Interpretivism was developed as a critique of the positivism stance in social sciences. Interpretive researchers argue that "the only way to access the truth is through social constructions such as language, consciousness, shared meanings, and instruments) (Myers, 1997:241). Hence, the theory emphasizes on the different meanings that people attach to things (Saunders et al, 2012). Hence, interpretive studies may employ different methods in order to reflect different aspects of an issue. Interpretivist approach is based on naturalistic approach of data collection such as interviews and observations. Secondary data research is also popular within the interpretivist philosophy. In this type of studies, meanings emerge usually towards the end of the research process. The interpretive stance is anchored into two basic assumptions. Firstly, reality is intersubjective and is based on meanings and understandings within the social and experiential contexts. Secondly, unlike positivism that takes an objective stance, interpretivist argues that people cannot be separated from their knowledge. Hence, it advocates for a clear link between the researcher and the research subject. Critics to the interpretivist approach argue that data gathered through the interpretivist approach is heavily impacted on by personal viewpoint and values. Hence, reliability and representativeness of data can be compromised. This is the major reason why this research does not use the interpretive stance. Rather, it uses a more quantifiable stance (positivism) together with qualitative and quantitative data collection methods. Qualitative data was collected mainly to bolster quantitative findings. Figure 5.2 compares the two paradigms

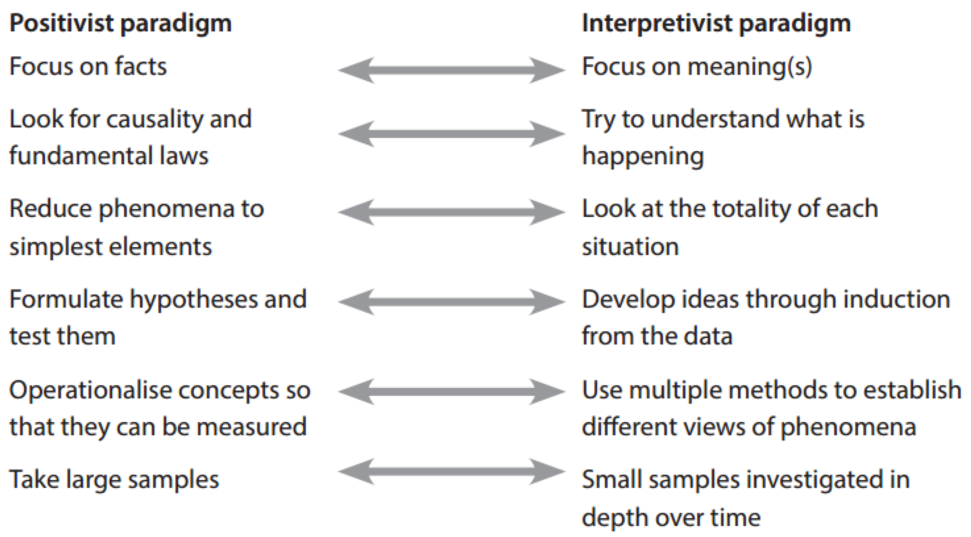

Figure 5. 2. Epistemologies with positive and interpretivist influence (O'Gorman and McIntosh, 2015)

5.3. Research design

Sekaran and Bougie (2010) identify four types of study:

- Exploratory study: is normally conducted when too little or nothing is known about a problem or phenomena at hand. This study is undertaken when no information is available on how similar problems or research issues have been solved.
- Descriptive study: is conducted in order to describe the characteristics of the variables being studied. Thus, the goal of a descriptive study is to describe

relevant aspects of a subject area within the context of individuals, organisations or industry.

- Hypothesis testing: usually undertaken to test the relationship between variables.
- Case study: is conducted for contextual analyses of similar situations in other organisations.

The nature of this study is descriptive. mHealth is a subject of ongoing research in Africa. mHealth studies are now maturing moving from the assessment of pilot projects to the assessment on how mHealth interventions can be scaled. However, to the best knowledge of the researcher, there is no research that has been conducted in Burundi on mHealth adoption at the primary healthcare centres thus far. To this end, an initial preliminary literature review was conducted to get acquainted with major concepts within the ICT for development (ICT4D) research arena. The preliminary literature review led to the conceptualisation of an initial guiding framework for mHealth adoption in Burundi. The guiding framework yielded various research objectives and questions that were trimmed to fit within suitable widely used theoretical frameworks within mHealth research. This process resulted in the formulation of the final conceptual and theoretical frameworks to be used in the study. Subsequently, research objectives and questions were updated according to the adopted frameworks. A survey questionnaire and interview questions were developed from the research questions and objectives. These research instruments were then updated based on the results of a pilot study conducted before field data collection. Results from the data collection were analysed, discussed and evidence-based conclusions and recommendations were presented.

The following section discusses the chosen research approaches (qualitative and quantitative) and the systematic step-by-step approach used for sample identification, field data collection and methods used for data validation and analysis.

5.3.1. Research Approaches

Qualitative and quantitative methods are two broad approaches that are commonly used in research. A quantitative approach seeks to measure a phenomenon objectively using numerical values and statistical analysis (Welman, Kreuger and Mitchell, 2005). It is aligned with the positivism paradigm and seeks to minimize the researcher's interference in the research process (Denzin and Lincoln, 2005). A qualitative approach goes beyond the quantification of data and seeks to find meaning that people attach to a specific phenomenon (Creswell, 1994).

Creswell and Plano (2007) contend that, in order to address the weaknesses of the two approaches, a combination of qualitative and quantitative approaches should be used. This study adopted such combined approach in order to answer the research questions. On one hand, a survey questionnaire was designed to collect data from primary healthcare professionals at primary healthcare centres. A survey questionnaire was deemed adequate as there is a large population of primary healthcare professionals. Hence, their perceptions would be best captured by a standardised means of data collection that could be administered to a wide sample (based on the population size). Thus, a questionnaire was designed and administered to primary healthcare professionals in remote parts of the country. On the other hand, semi-structured interviews were used to collect data from the Ministry of Health, Ministry of Communication and mobile telecommunications operators in the country. The details of the questionnaire and interview questions design and their alignment with the research objectives and questions are discussed in the next section.

5.3.1.1. Research instruments design

The survey instrument was designed into five sections. Section A captured general information of respondents such as age, gender, district and primary healthcare where the respondent work, the current designation of respondent, and how often the respondents use specific ICT tools such as landline phones, cellphones, laptop, desktop computer, Internet, wireless networks to perform their duties. Respondents had an option of listing and ranking (on a Likert scale of 1 to 5; 1=Never and 5=Very often) other ICT tools (that were not listed but currently in use) in addition to the ones listed in the questionnaire. The aim of section A was to capture the demographics of the respondents in order to get an understanding of the types of people that responded to the study. A subsequent aim was to assess the major ICT tools used by healthcare professionals. In this instance, the researcher specifically wanted to assess the respondents' familiarity with the use of cell phones. This was then compared to responses in section B, to assess the purposes for which cellphones are used in the healthcare professionals' work environment. Section B investigated current use of mHealth within the public health sector. To this end, this section captured work-related purposes for which the listed ICTs are used. The main aim of this section was to ascertain whether cellphones are currently used for mHealth interventions (based on Vital Wave Consulting's (2009) mHealth use categorisation) in the public sector or not. Subsequent aims were to identify the frequency of use (through a Likert scale of 1 to 5; 1=Never, 5=Very often) of cellphones for other purposes (besides mHealth) by primary healthcare professionals and ownership and purpose of use of other mobile devices (except cellphones) by primary healthcare workers. Section C assessed the potential for the adoption of mHealth by primary healthcare professionals in Burundi (through a Likert scale measure of 1=Strongly disagree to 5=Strongly agree). The section assessed whether primary healthcare professionals would accept the 8 mHealth capabilities as defined Wave Consulting (2009). It further aimed at identifying DOI (persuasion) factors that significantly influence the adoption of mHealth in Burundi. Section D assessed primary healthcare professionals' perceptions of the impact that mHealth capabilities can have on disease prevention and management and the provision of quality healthcare services s in Burundi (using a Likert scale measure of 1=Strongly disagree to 5=Strongly agree). Section E assessed the determinants of mHealth adoption while section F investigated obstacles to mHealth adoption.

As stated in the previous chapter, this research employed three theoretical frameworks namely the Capability Approach (CA), the DOI model and UTAUT model. Questions within the survey instrument (Section B, C, D and E of the questionnaire) were particularly aligned with each model in a way that makes the models relevant enough to answer the established research objectives and questions.

5.3.1.1.1. Alignment of the survey instrument with the Capabilities Approach model

As alluded to in the previous chapter, The Capability Approach model posits that capabilities (individual capabilities or those acquired through empowerment) may lead to substantive freedoms (such as access to healthcare). However, the attainment of such freedoms depends on what people are prepared to do in order to attain them (functionings). The three CA constructs were adapted in the study as follows: capabilities: mHealth capabilities; substantive freedoms: disease prevention, disease management and quality of healthcare services and functionings: acceptance of mHealth capabilities. On one hand, the CA approach was used to assess the knowledge of mHealth capabilities from the primary healthcare professionals point of view in alignment with research objective 1 (**To assess health professionals' readiness to adopt mHealth**) and its subsequent related research sub question 1b (*To what extent do healthcare professionals at the PHCs know about mHealth?*). The following are the mHealth capabilities about which primary healthcare professionals' mHealth knowledge was assessed in alignment with Vital Wave Consulting (2009) mHealth capabilities categorisation. These are: education and awareness programs, remote medical/health data collection, remote patients' treatment and monitoring, communication with fellow health professionals, training of health workers, diseases and epidemic outbreak tracking, diagnostic support and treatment support. Question 7.1 to 7.10, 8.5, 8.6 and 8.7 (See Appendix B were specifically designed to establish whether primary healthcare professionals have practiced in the past or are currently practicing mHealth. On the other hand, the CA model sought to deduce substantive freedoms that could be achieved through the acceptance of mHealth capabilities. In this regard, the model was used to gather primary healthcare professionals' perceptions in regard to using mHealth as a means to prevent and manage disease but also as an avenue to provide quality healthcare services in alignment with research objective 3 (**To identify potential contribution of mHealth interventions in achieving the country's broad goals in the health sector**) and research question 3 (*What potential role can mHealth play in combating diseases in Burundi?*). To this end, question 13.1 to 13.7 were designed (See Appendix B). Moreover, functionings (mHealth capabilities acceptance) were represented through questions 12.1 to 12.8 in alignment with research objective 1 (**To assess health professionals' readiness to adopt mHealth**) and research sub question 1a (*To what extent are healthcare professionals at the Primary Healthcare Centres (PHCs) willing to adopt mHealth?*). Table 5.1 summarises the alignment of questions within the questionnaire with the CA constructs and corresponding research questions/ objectives.

Table 5. 1. Alignment of the survey instrument with research questions/objectives and the Capability Approach model

Capabilities model constructs	**Research objectives**	**Research questions**	**Type of data collection instrument**	**Survey instrument design**	**Target population**
Capabilities	**Research objective 1**	**Research question 1b**	Questionnaire	Questions 7.1 to 7.10 Questions 8.5,8.6,8.7	Primary healthcare professionals
Substantive freedoms	**Research objective 3**	**Research question 3a, 3b and 3c**	Questionnaire	Questions 13.1 to 13.7	Primary healthcare professionals

Functionings	**Research objective 1**	**Research question 1a**	Questionnaire	Questions 12.1 to 12.8	Primary healthcare professionals

5.3.1.1.2. Alignment of the survey instrument with the Diffusion of Innovation (DOI) theory

The DOI model depicts four stages of an innovation adoption process: knowledge phase, persuasion phase, adoption phase and confirmation phase. The persuasion phase has five constructs namely relative advantage, compatibility, complexity, observability and trialability. The model through its persuasion constructs was adopted in the study to assess these constructs as possible determinants of mHealth adoption from the primary healthcare point of view in alignment with research objective 2 (To identify the determinants of mHealth adoption). Questions aligned to the model were grouped under the five persuasion constructs. mHealth complexity factors were represented by questions 12.9, 12.10, 12.14, 12.15 and 12.16 (see Appendix B). Questions 12.17 to 12.22 (see Appendix B) represented mHealth relative advantage; Questions pertaining to the compatibility construct were grouped under question 12.23 to 12.27 (see Appendix B); mHealth trialability was represented by question 12.28 to 12.31 (see Appendix B) and mHealth observability was represented from question 12.32 to question 12.34 (see Appendix B). Table 5.2 summarizes the alignment of questions within the questionnaire with DOI persuasion constructs and corresponding research questions/objectives.

Table 5. 2. Alignment of the survey instrument with research questions/objectives and the DOI theory

DOI constructs	Research objectives	Research questions	Type of data collection instrument	Survey instrument design	Target population
Complexity	**Research objective 2**	**Research question 2**	Questionnaire	Questions 12.9, 12.10, 12.14, 12.15 and 12.16	Primary healthcare professionals
Relative advantage	**Research objective 2**	**Research question 2**	Questionnaire	Question 12.17 to 12.22	Primary healthcare professionals
Compatibility	**Research objective 2**	**Research question 2**	Questionnaire	Question 12.23 to 12.27, Question 14.9	Primary healthcare professionals
Trialability	**Research objective 2**	**Research question 2**	Questionnaire	Question 12.28 to 12.31, Questions 14.13, 14.14	Primary healthcare professionals
Observability	**Research objective 2**	**Research question 2**	Questionnaire	Question 12.32 to 12.34	Primary healthcare professionals

5.3.1.1.3. Alignment of research instruments with the UTAUT model

From primary healthcare professionals' perspectives, the Unified Theory of Acceptance and Use of Technology (UTAUT) is used to identify determinants of mHealth adoption in Burundi through performance expectancy, effort expectancy and facilitating conditions constructs in alignment with research objective 2. On one hand, Question 14.2 and 14.3 (See Appendix B) were formulated to assess the influence of performance expectancy on mHealth adoption (mHealth capabilities acceptance). On the other hand, Question 14.11 and 14.12 (See Appendix B) were designed to investigate the influence of effort expectancy on mHealth capabilities acceptance (mHealth adoption). Required facilitating conditions to the adoption of mHealth in Burundi were assessed in question 14.1, 14.4, 14.5, 14.6, 14.7, 14.8 and 14.10. Furthermore, existing and additional required facilitating conditions were assessed through interviews with respondents from the Ministry of Health, Ministry of Communication and mobile telecommunications operators. Thus, from the Ministry of Health perspective, the existence of a strategy to secure long term sustainability of ICT in the health sector was investigated (Question 9 of the Ministry of Health interview guide); the role of the Ministry of Health and the government in funding ICT initiatives and promoting ICT adoption and use in the health sector was also investigated (Question 20 of the Ministry of Health interview guide). In addition, an additional open-ended question (Question 19) was added to the interview guide to identify additional factors that need to be considered to facilitate mHealth adoption in Burundi. From the Ministry of Communication, facilitating conditions for the adoption of mHealth in Burundi were assessed through questions 3, 4, 5, 6, 7 in Section B of the Ministry of Communication interview guide. From the mobile telecommunications operators' perspectives, facilitating conditions were investigated through the effect of the National ICT policy and National ICT Regulatory authority on mobile telecommunications services delivery (Question 6 and 7 of the mobile telecommunications interview guide); the current mobile telecommunications infrastructure adequacy to launch and disseminate mHealth interventions (Question 8 of the mobile telecommunications operators interview guide); and factors that need to be considered for the sustainability and scalability of mHealth initiatives in Burundi (Question 9 and 10 of the mobile telecommunications operators interview guide). Table 5.3 depicts the alignment of research instruments with research questions/objectives and the UTAUT model.

Table 5. 3. Alignment of the survey instrument with research questions/objectives and the UTAUT model

UTAUT constructs	Research objectives	Research questions	Type of data collection instrument	Survey instrument design	Target population
Performance expectancy	Research objective 2	Research question 2	Questionnaire	Question 14.2 and 14.3	Primary healthcare professionals
Effort expectancy	Research objective 2	Research question 2	Questionnaire	Question 14.11 and 14.12	Primary healthcare professionals
Facilitating conditions	Research objective 2	Research question 2	Questionnaire	From question 14.1, 14.4, 14.5, 14.6, 14.7, 14.8, 14.10	Primary healthcare professionals
	Research objective 2	Research question 2	Interview guide	Question 9, 19 and 20	Ministry of Health
	Research objective 2	Research question 2	Interview guide	Question 3, 4, 5 and 6 and 7	Ministry of Communication
	Research objective 2	Research question 2	Interview guide	Question 6, 7, 8, 9, 10	Mobile Telecommunications operators

Research objective 4 (**to identify obstacles to mHealth adoption**) and its subsequent related research question 4 (*What are the impediments to mHealth adoption in Burundi?)* were not particularly related to any of the models. Questions pertaining to impediments to mHealth adoption from the primary healthcare professionals' point of view were formulated after an extensive literature review of factors that impede the adoption of eHealth interventions in developing countries. These questions were incorporated in the survey instrument administered to primary healthcare professionals (question 15.1 to 15.7 of section F in appendix B). Perceptions of obstacles to ICT and mHealth adoption from the Ministry of Health perspectives were gathered through questions 12 and 18 of the interview guide respectively. From the Ministry of Communication, perceptions of impediments to mHealth adoption and plans in place to address them were investigated through questions 8 and 9 of the Ministry of Communication interview guide (see Appendix) respectively. Mobile telecommunications operators' perceptions of the impediments to mHealth adoption in Burundi were drawn from Question 11 of the mobile telecommunications operators interview guide (see appendix B). Other impediments reported in the subsequent chapters were drawn from the interview responses from the ministries and mobile telecommunications operators.

Furthermore, the potential contribution of mHealth interventions in achieving the country's broad goals in the health sector (research objective 3) was assessed from the Ministry of Health level through question 15 of the interview guide. Table 5.4 depicts the alignment of the research instruments with research objective 4/research question 4. It further depicts the alignment research objective 3/research question 3 with the interview guide for the Ministry of Health.

Table 5. 4.Alignment of the research instruments with research objective 3 and 4/research question 3 and 4Table

Constructs	Research objectives	Research questions	Type of data collection instrument	Instrument design	Target population
Impediments to mHealth adoption in Burundi	Research objective 4	Research question 4	Questionnaire	Question 15.1 to 15.7	Primary healthcare professionals
Impediments to mHealth adoption in Burundi	Research objective 4	Research question 4	Interview guide	Question 12 and 18	Ministry of Health
Impediments to mHealth adoption in Burundi	Research objective 4	Research question 4	Interview guide	Question 8 and 9	Ministry of Communication
	Research objective 4	Research question 4	Interview guide	Question 11	Mobile telecommunications operators
Contribution of mHealth interventions in achieving the country's broad goals in the health sector	Research objective 3	Research question 3	Interview guide	Question 15	Ministry of Health

5.4. Validity and reliability of the research instruments

5.4.1. Validity test

Wood, Roos-Kerr and Brink (2006) indicate that validity refers to the ability of the instrument to measure what it is intended to measure i.e. research hypotheses/objectives or questions. The aim is to ensure that the questions capture exactly what the research questions are intended to measure.

Leedy and Ormrod (2010) identify different types of validity tests:

i) Face validity: This assesses the extent to which an instrument looks like it is measuring a particular characteristic. This test relies on subjective judgment, thus does not guarantee that the instrument truly measures what it is intended to measure.

ii) Content validity: assesses the extent to which elements within a research instrument are relevant and representative of the construct (s) or domain being studied.

iii) Criterion validity: assesses the extent to which the outcome (results) of a research instrument correlate with another related measure. Thus, the criterion validity can only be established after the instrument has already been administered.

iv) Construct validity: assesses the extent to which a research instrument measures a characteristic that cannot be directly observed.

v) Multitrait-multimethod approach: is used when two or more different characteristics are each measured using two or more different approaches.

vi) Table of specifications: is used in conjunction with content analysis. The aim is to construct a measurement instrument that provides a representative sample of a particular content domain using a two dimensional grid.

vii) Judgment by a panel of experts: In this case, the research instrument is subjected to expert scrutiny. Experts in a particular subject area are requested to provide an informed opinion about instrument validity in relation to research questions/hypotheses at hand.

In the context of this research, the survey instrument was subjected to both content and face validity. Firstly, in terms of content validity, the researcher did a literature review to identify and understand how constructs pertaining to the theoretical frameworks were defined and used in various contexts. Such identification and understanding led to the researcher's classification of various variables identified in the literature into various constructs. Some variables were removed from the classification due to lack of clarity on how they fit into one or more constructs. In case where one variable fits into more than one construct, the mostly used classification of the variable from the literature was adopted. Hence, in this way, the researcher ensured that the research instrument's content is representative of the constructs being examined.

Research instruments were then translated from English to French (translated questionnaires are appended in appendix B). The process of translation was deemed necessary as the country is predominantly French speaking (in addition to the single indigenous language) and most of the government departments' documentation is written in French. The World Health Organisation (WHO, 2017) provides some steps to follow in terms of translating and adapting instruments for health-related data collection. These steps are essential to ensure that the content and face validity of the instruments are not violated through the process of translation. These steps are:

1. Forward translation

This first step entails the translation of the instrument by someone who is knowledgeable of the field under study and who belongs to target culture and whose primary language is the same as the target's population. To this end, a renowned translator from Burundi, under the guidance of the researcher, translated the questionnaire. The researcher who is from Burundi and proficient in French clarified some concepts that were not clear to the translator. Any word that was incorrectly translated (according to the researcher's judgement) was brought to the attention of the translator and further discussion led to a consensus of terms to be used for better clarity. The entire process of forward translation, which took a month, was iterative until an agreed version of the best possible translation was achieved. The WHO (2017), suggests that in this first phase, translators should avoid word for word translation but rather aim for the conceptual equivalent. In addition, words should be clear, concise and simple and should target the most common audience. Moreover, they should avoid jargon and should avoid any terms that could be considered as offensive to the target population. These guidelines were followed during the forward translation.

2. Expert panel

WHO (2017) suggests that in this next phase an expert panel should be convened in order to identify and resolve any discrepancies or inadequately translated words. To this end, the questionnaire was distributed to 2 key civil servants within the Ministry of Health and Aids for scrutiny to detect any ambiguity and lack of clarity of expression. These civil servants were chosen due to their vast experience in working with primary healthcare workers (as healthcare inspectors) in urban and rural areas.

3. Back-translation

In this third step, the questionnaire should be translated back to English. The emphasis should be on the conceptual and cultural equivalence as opposed to linguistic equivalence. To this end, the researcher translated the questionnaire back into English, in order to ensure that the translated questionnaire matches the initial constructs in the English version.

4. Pre-testing

This entails pre-testing the translated version with the target population. To this end, the questionnaire was pre-tested with 10 respondents in the province of Kirundo (Northern part of the country). Words that were not clear or ambiguous were replaced. At the end of this process, an updated version of the questionnaire was generated. The interview guide for mobile operators was pre-tested by one mobile telecommunications representative who suggested a way of simplifying questions for much better clarity. The interview guides for the Ministry of Communication and Ministry of Health were not subjected to any pre-test but rather, clarity and further explanations were provided during the interview process.

In terms of face validity, as stated above, the survey research instrument was subjected to expert scrutiny from two civil servants (who are very fluent in French) from the Burundi's Ministry of Health after the questionnaire was translated into French. Each construct represented in the questionnaire and question within the questionnaire was explained to them in French. The civil servants examined the questionnaire thoroughly and identified some ambiguity within the questionnaire mostly due to the process of translation. The questionnaire was then adjusted after the expert's scrutiny. In addition, the experts accompanied the researcher during the pilot test. Hence, they were able to assist in identifying items from the questionnaire that needed more clarity. The experts also assisted in the formulation of the final draft of the survey instrument after the pilot test. In this way, the questionnaire was deemed to have face validity.

5.4.2. Reliability test

Reliability refers to the consistency and accuracy of the instrument in addressing/measuring the problem under investigation. Leedy and Ormrod (2010) further identify the following types of reliability tests:

i) Interrater reliability: measures the similarity between two individuals' judgments about the same subject under study (such as product or performance)

ii) Internal consistency reliability: measures the extent to which items that measure the same construct produce similar scores.

iii) Equivalent forms reliability: measures the extent to which two different versions of the same research instrument produce similar results

iv) Test-retest reliability: measures the extent to which a single instrument produces the same results for the same people in two different occasions

The internal consistency reliability was tested statistically through the Cronbach's Alpha coefficient. The Cronbach's Alpha coefficient for each research question is presented and discussed in the next Chapter (Chapter 6).

Venkatesh *et al* (2013:14) argue that "generally, there are no accepted guidelines, expectations, or norms to discuss validity in qualitative data collection". Hence, many IS researchers rather provide extensive discussions of their engagement in the qualitative data collection such as the quality of data collection attempts, and rigorous data analyses and reporting (Guba and Lincoln 2005; Ridenour and Newman 2008). The researcher followed the trend as a discussion of qualitative data collection process is provided in the section detailing the data collection procedures (section 5.5)

5.5. Data collection

This section describes the chosen target population and the sampling method used in this study. Moreover, the section provides an in-depth discussion of the data collection process.

5.5.1. Target population and sampling methods

Health workers at the primary healthcare centres are in direct contact with the grassroots (population) at the community level. They are the primary agents for data collection from diverse groups of the population with different health cases (diseases). Therefore, they are the most relevant target group (amongst healthcare professionals) for the adoption of mobile technologies for healthcare-related interventions. Out of the 735 healthcare centres at the primary healthcare level, only those that fall under the public sector (i.e. those that are managed by the Ministry of Health) were selected. Hence, the target population from the Ministry of Health was primary healthcare professionals from 423 public primary healthcare centres. In addition, out the country's 18 provinces, 5 were chosen. These are Kirundo (North of the country); Cankuzo (East); Cibitoke (West); Makamba (South); Gitega (Centres). These provinces were chosen through the guidance of the Ministry of Health's 2 key civil servants that aided in the questionnaire pre-test. From the ministry's perspectives, these 5 provinces and the Capital city Bujumbura are the benchmarks used for pilot test, or for research related data collection by the ministry. Thus, the ministry considers those provinces as adequate representative samples that, combined, represents countrywide healthcare realties.

Following the ministry's example, the 5 provinces were chosen as representative of the 18 provinces. The choice of the 5 provinces reflects the two-way cluster sampling approach adopted in this study. Cluster sampling is used when the population is spread out over a large area (Sekaran and Bougie, 2010). Thus, the researcher can subdivide the population into small units (clusters). Leedy and Ormrod (2010) argue that in cluster sampling, clusters must enclose a heterogeneous mix of individuals. The capital city was intentionally excluded, as primary healthcare professionals within the capital city might not have as much experience in dealing with disease prevention and management as healthcare professionals in the other selected cities. This stems from the fact that capital city's residents tend to use hospitals rather than primary healthcare centres. Thus, it was deduced that input from primary healthcare professionals within the capital city might not be of great value. In a two-way cluster sampling, a researcher must ensure that elements within selected clusters have equal chances to be selected. Thus, primary healthcare centres and healthcare professionals within each centres were selected using probability sampling methods as explained in the following section. The following section describes the demographics of the sampled provinces and the sampling size and sampling methods used.

5.5.1.1. Sample's demographics, respondents' sampling methods and data collection procedures

As per the 2009 census, the Northern Province (Kirundo) has 4 health districts and 37 public primary healthcare centres that cover a total population of 636298. The Southern province covers a population of 428917 served by two health districts and 24 public primary healthcare centres. The Western province (Cibitoke) has 2 health districts and

34 public primary healthcare centres. The total population covered by these health facilities in Cibitoke province is 460626. The Eastern province (Cankuzo) has a population of 480865, 43 public primary healthcare centres and 4 health districts. Lastly, Gitega (at the centres of the country) has 4 health districts, 41 public primary healthcare centres which cover a total population of 715080. A detailed description of the demographics is presented in Table 5.5. The table indicates that in Burundi, healthcare infrastructure is not allocated evenly according to population size.

Table 5. 5. Detailed description of demographics within the sampled provinces.

Province	Location	Health districts	Number of public primary healthcare centres per health district	Population
Makamba	**South**			
		Makamba	15	228176
		Nyanza-Lac	9	200741
Cibitoke	**West**			
		Cibitoke	13	231890
		Mabayi	21	228736
Cankuzo	**East**			
		Cankuzo	13	116099
		Murore	10	105292
		Muramvya	9	148643
		Kiganda	11	110831
Kirundo	**North**			
		Kirundo	9	182528
		Vumbi	11	181400
		Busoni	8	146188
		Mukenke	9	126182
Gitega	**Centres**			
		Mutaho	5	172676
		Kibuye	10	187484
		Gitega	7	227276
		Ryansoro	9	127644

Primary Healthcare Centres (PHCs) in health districts within each province were contacted telephonically to find a suitable time to administer the questionnaire. However, not all the PHCs were available to allow the researcher to administer the questionnaire. This was mainly due to the fact that some PHCs were busy with healthcare interventions hence could not respond to the request. Additionally, some PHCs were located in areas that were not accessible by practicable roads, thus could not be reached (hence were excluded from the target sample). The number of primary healthcare practitioners who work at the PHCs varies depending on the population size covered by the centres (i.e. area of responsibility). However, a PHC would typically employ between 2 and 10 healthcare professionals. On the day of data collection, the researcher presented himself to the PHCs and requested the nurse in charge to gather all the healthcare practitioners at the centres. All healthcare practitioners at the centres were selected except those who either were absent on the day or were attending critical tasks (such as helping mothers deliver their babies). Once gathered, potential respondents were briefed as one group about the purpose of the survey. It was clearly explained that participation was voluntary and their rights to withdraw from the study was clearly expressed. In most cases, respondents voluntarily cooperated. However, the concept of mHealth was new to most of the respondents. Thus, the researcher was compelled to explain the concept and sufficient time was given for the respondent to ask questions[18]. Then, questionnaires were distributed to 250 respondents and the researcher remained at the site to clarify anything that was not understood from the questionnaire. It generally took 20 to 30 minutes to fill in the questionnaire. In total, out of the 250 distributed questionnaires, 212 usable questionnaires were collected, which denotes an 85% response rate. In Kirundo, data was collected from 64 respondents from 22 primary healthcare centres. In Gitega, 35 respondents from 7 primary healthcare centres filled the questionnaire. In Makamba, 36 respondents from 5 primary healthcare centres successfully completed the questionnaire. In Cibitoke, 46 primary healthcare professionals from 6 primary healthcare centres responded while in Cankuzo, 31 healthcare professionals from 7 centres completed the questionnaire. A detailed description of primary healthcare professionals who responded to the questionnaire is provided in the next chapter (Chapter 6). Data collected from healthcare professionals at the PHCs aimed to:

1. identify primary healthcare workers willingness to adopt mHealth and their knowledge about mHealth (research objective 1 and research question 1a and 1b);
2. identify the determinants of mHealth adoption in Burundi (research objective 2);
3. identify mHealth**'s** perceived contribution to fight diseases in Burundi (research objective/question 3);
4. identify perceived impediments to mHealth adoption (research objective/question 4).

[18] The researcher acknowledges that the extensive interaction with the respondents on the topic could have influenced their responses for some questions such as question 20 of the survey instrument

At the institutional level, data was collected from the Ministry of Health (MoH&A), and the Ministry of Communication. The aim of data collection at this level was to get an overview of government's perspectives (through the two ministries) on the use of mobile technologies to provide healthcare services countrywide. In addition, data collection at this level aimed at assessing the determinants of mHealth adoption (research objective 2), the potential contribution of mHealth interventions in achieving the country's broad goals in the health sector (research objective 3/research question 3a, 3b, 3c), and the obstacles to mHealth adoption in Burundi (research objective 4/research question 4). To request permission to collect data from the ministries, a letter was sent to the minister of health and the permanent secretariat of the Ministry of Communication. The letter contained a brief explanation of the research, its benefits to the country, a clause of no incentives/remuneration attached to the participation in the study and a specific request to allow workers within the ministries to participate in the study (See Appendix C). Permission was granted from the ministries. In addition, the ministries directed the researcher to the most knowledgeable people on the subject to be investigated within the ministries. The Ministry of Health suggested two key civil servants from the Directorate for Health Information Systems (DSNIS) within the Ministry: An ICT division manager and a communications officer. Appointments were made with the individuals and interviews with each of them were conducted on two separate days. The Ministry of Communication on the other hand suggested the director of CIEP with whom an appointment was made and an interview was conducted. The interviews were conducted following the interviews guide described in section 5.3. All interviews were recorded using a voice recorder after obtaining consent from the interviewees.

Mobile telecommunications operators were also included as part of the target population as they provide the enabling infrastructure for the dissemination of healthcare interventions through their mobile telecommunications networks. The mobile operators' perspective highlighted the required determinants and impediments for mHealth adoption within the country's socio-economic and technology context (Research objective 2 and Research objective 4 respectively). A written request to collect data was sent to directors of the companies. Four of the 6 companies consented. Details of the companies that participated in the research are purposely omitted for confidentiality reasons. A copy of the interview guide was requested by the directors and after giving their consent, they assigned a company's employee who they considered was best suited to address the content of the interview guide. Interviews were conducted on the companies premises on different dates.

In total, qualitative data was collected from 7 sources. 1 form the ministry of Communication, 2 from the Ministry of health and 4 mobile telecommunications operators' representatives. In choosing these 7 sources, the researcher did a preliminary informal investigation within the Ministry of health to identify stakeholders within public health sector that are involved in mHealth or ICT deployment for healthcare. The Ministry pointed to two key civil servants in charge of ICT deployment in the Ministry, which were then interviewed as previously stated above. The Ministry of communication was included due to its involvement in designing and deploying educational health interventions. Hence, the Ministry of Communication's perspective was deemed essential in capturing the potential determinants and challenges to the implementation of mHealth in Burundi. The author acknowledges that there are other stakeholders from NGOs that were not interviewed due to various reasons. These reasons mainly include lack of access to the relevant personnel to interview and the strenuous protocols to follow to interview the personnel. In addition, the country's ongoing political instability that followed shortly after the data collection could not allow the researcher to collect further information. These reasons are part of the limitations of the study.

The data collection process took 40 days. Quantitative data was coded into SPSS while the Nvivo software was used to classify qualitative data into themes pertaining to the various research questions. The data analysis process is discussed in details in the following section (section 5.6).

5.6. Data analysis

Prior to data analysis, a data cleaning process was applied to the quantitative data to ensure that each value assigned to each response (in the SPSS) was correct. This process allows the researcher to detect any invalid response and missing values. Although in a few cases respondents had omitted to respond to some questions, all of the 212 returned questionnaires were deemed usable and were subject to analysis. The quantitative data analysis process (through SPSS) entailed validity and reliability checks, descriptive statistics to describe the demographics of respondents by age, gender and geographic location, and adequate inferential statistical tests (Principal Component Analysis, Spearman correlation and regression tests) to answer the research questions. For qualitative analysis on the other hand, interviewee responses were coded into nodes using the Nvivo software. Furthermore, responses were grouped according to themes. Each of them represented a specific research objective/ research question. However, additional themes emerged based on the interviewee's responses. Through thematic analysis, models were generated from the Nvivo software. Such models graphically depict interviewees' responses based on each pre-defined theme or any theme that emerged from the responses.

Venkatesh et al (2013) argues that in a case whereby quantitative and qualitative data are collected concurrently, the data should be merged for a holistic understanding of the phenomenon or to compare results. The aim of such data integration is to draw in meta inferences which are defined as "narratives, theoretical statements, or a story inferred from the combination of qualitative and quantitative findings" (Venkatesh et al., 2013:18). Lewis and Grimes (1999) suggests two approaches in discussing the meta inferences, bracketing and bridging. The former's aim is to highlight differences found between the qualitative and quantitative findings and further attempt to give meaning to such differences. Bridging on the other hand, aims at finding consensus between the two types of findings. This research employed both approaches as similarities and differences are highlighted in the data analysis chapter (chapter 6) where comparison of the two data sets is possible.

5.6.1. Principal Component Analysis (PCA)

Principal Components Analysis (PCA) is a data reduction technique that creates components or factors that allows for the interpretation of relatively large series of data in a smaller number of units that can be meaningfully interpreted (SAS InstituteInc., 1989). Principal Component Analysis creates uncorrelated indices or components, where each component is a linear weighted combination of the mHealth capabilities variables or UTAUT variables or DOI variables. In each component, variables are given eigenvalues or scores, which can be interpreted as the weight by which each variable should be multiplied to obtain component score (Tashakkori and Teddlie, 2010). Variables with low standard deviations would carry a low weight while those with high standard deviations carry a high weight from PCA (Cohen, 1988). The component with the highest eigenvalue score explains the largest possible amount of variation in the original data. The second component (component with the next highest eigenvalue score) explains additional but less variation than the first component and is uncorrelated with the first component. Subsequent components are uncorrelated with previous components, while explaining smaller and smaller proportions of the variation of the original variables. Bryman and Cramer (2008) argue that PCA works best when variables are correlated and also when the distribution of variables vary across cases. The higher the degree of correlation among the original variables in the data, the fewer the components required to capture common information (Morrison, 2005). In this study, Principal Component Analysis (PCA) was used to generate the mHealth capabilities index, DOI factors indexes and UTAUT factors indexes. These indexes were used to determine key factors that influence mHealth adoption (through Pearson correlation analysis and regression analysis) within the Burundi's context. In addition, a mHealth impediments index was generated through PCA. The mHealth impediments index together with the mHealth capabilities index were used to determine significant obstacles to mHealth adoption.

5.6.2. Correlation analysis

Pearson correlation was used to ascertain if there is any relationship between DOI, UTAUT variables and mHealth capabilities acceptance. The Pearson product-moment correlation coefficient is a measure of the strength of the linear relationship between two variables (Lane, 2013). Pearson's coefficient *r* can range from -1 to 1. An *r* coefficient of -1 indicates a perfect negative linear relationship between variables while a coefficient of 0 indicates lack of linear relationship between variables. Conversely, if the *r* coefficient has a value of 1, the linear relationship between variables is perfectly positive. Cohen (1988) argues that a correlation coefficient of .10 depicts a weak association between variables, while a correlation coefficient of .30 is considered moderate. If *r* equals or is greater than .50, there is a strong correlation between the variables. In the context of this study, the Pearson correlation coefficient helped establish whether any of the theories constructs have a significant influence on the adoption of the mHealth capabilities in the Burundi's context using the indexes that were generated through PCA. Moreover, the Pearson correlation enabled the researcher to single out impediments that have an impact on the adoption of mHealth.

5.6.3. Regression analysis

Regression analysis is a statistical tool used to predict the value of one variable based on the value of one or more variables. Regression analysis generates an equation to describe the statistical relationship between one or more predictor variables (independent variables) and the response variable (dependent variable) (Frost, 2013). Regression analysis generates p values for each predictor values. The p values determine which predictors are significant enough to be included in the regression equation. A low p value (<0.05) indicates that the predictor is likely to be a meaningful addition to the regression model (equation) i.e. changes in the predictor's value are related to changes in the response variable. In this study, regression models were generated to depict statistically the extent to which changes in the independent variables of UTAUT, DOI and impediments factors effect changes in the acceptance of mHealth capabilities.

The statistical analysis methods described above were only applied to quantitative data. The following section describes the qualitative data analysis process.

5.6.4. Thematic analysis

Boyatzis (1998) argues that thematic analysis is a process of encoding qualitative information into a list of themes and a complex model with themes, indicators or qualifications that are related. To this end, interviews were tape recorded, transcribed verbatim into Microsoft Word 2013 and then loaded into Nvivo (version 10 and 11) as internal sources. Research questions were captured into the software as nodes (super nodes) and qualitative answers to each research question were coded into the corresponding nodes in various sub nodes. The super nodes were considered as the main themes while the sub nodes were considered as the sub themes. Additional themes emerged from the responses which were subsequently captured into the Nvivo software. Hierarchical models were generated to depict the relationship between the nodes and sub nodes based on the interviewee's responses.

5.6.5. Ethical considerations

According to Beauchamp and Childress (2001), there are four important moral principles to consider in a research project:

1. **Autonomy** refers to the individual freedom to choose to participate in a research project without fear and coercion and with knowledge and understanding of what the research is all about. The following steps were taken to ensure such autonomy: i) participants were asked if they were willing to participate in a research project, ii) if the participant was willing to participate, then a further explanation of what the research is about was given. Particular care was taken to listen and answer any queries/concerns emanating from participants. iii) After the explanation, respondents were asked if they feel comfortable to partake in the research. Those who felt comfortable with the research were then given the questionnaire together with an informed consent letter that they had to sign indicating that they understood the purpose of the study and were willing to participate in the study. The same process was followed for qualitative data collection, although the interview guide was not given to participants prior to the interview.

2. **Non-maleficence** means the intention to prevent any physical or psychological harm occurring to research participants. In this case, as part of the research approval procedures of the University of KwaZulu-Natal, an ethical clearance application was submitted to the Ethical Clearance Committee in which issues of maleficence were addressed. The research was then approved, which indicated that the research would not harm any participant.

3. **Beneficence** is the benefit that the research will bring to the participant and society. This study promotes the use of mobile technologies to provide healthcare services (mHealth). The adoption of mHealth has many potential benefits such as improved patients care, effective disease prevention and management, faster and effective response to disease outbreaks to name the few. The mHealth concept was clearly explained to the participants and its anticipated benefits within the primary healthcare context. However, participants were made aware that there were no incentives associated with their participation in the study.

4. **Justice** refers to all participants being treated equally without any preferential treatment. All participants were treated with respect. The participation in the research was entirely voluntary.

5.7. Summary of Chapter 5

Chapter 5 provided a detailed description of the methodology adopted in this study. The chapter highlighted the ontological and epistemological stances adopted in this study. In addition, the descriptive nature of this research was highlighted. The research employed a combination of quantitative and qualitative data collection methods to investigate the determinants of and impediments to the adoption of mHealth in Burundi. It was also highlighted that this combination of methods helped to assess healthcare professionals' knowledge of mHealth capabilities, and the identification of the contribution of mHealth towards combating diseases in Burundi. On one hand, a survey instrument was designed, tested, refined and administered to a sample of 250 healthcare professionals from 5 provinces of the country. A cluster sampling method was used together with some inclusion and exclusion factors prior to the administration of the questionnaire. On the other hand, interviews were conducted within Burundi's Ministry of Health, the Ministry of Communication and also within mobile telecommunications companies using a semi-structured interview guides. Responses from the questionnaires were subjected to a reliability test, Principal Components Analysis and appropriate descriptive and inferential tests (correlation and regression analysis) in order to answer the research objectives/questions. Ethical considerations were also highlighted in this chapter.

CHAPTER 6: DATA PRESENTATION AND ANALYSIS

6.1. Introduction

This chapter presents the statistical analysis of data collected through the survey instrument and semi-structured interviews. To this end, this chapter is divided into two sections. Section A analyses responses from the survey instrument. Firstly, it presents the demographic analysis of respondents followed by a reliability analysis to evaluate the internal consistency of the questionnaire items. Furthermore, each section within the questionnaire is analysed through suitable statistical methods. Section B provides a thematic analysis of the Ministry of Health, Ministry of Communication and mobile telecommunications' interviews.

SECTION A: DATA ANALYSIS FROM QUESTIONNAIRES

6.2. Demographics

The aim of the section is to present the general characteristics of the respondents. This section looks at the general profile of the research sample including the age, gender, designations of the respondents, and the demographic distribution of respondents per province.

6.2.1. Designation of respondents by age and gender

Table 6.1 indicates that most of female (93.1%, N=81) and male (76.5%, N=91) respondents were nurses. Most of the nurses (both female and male) were between the age of 26 and 35. Lab technicians were predominantly males (11.8%, N=14) within the age range of 26 and 35. Lab technicians are specifically trained for laboratory medical analysis. Thus, their roles are different from the nurses who would normally be involved in preliminary diagnosis and primary healthcare. All provincial health technicians were males and constituted the smallest portion amongst the male respondents (2.5%, N=3). Provincial health technicians, who are sometimes based at the primary healthcare centres, are specifically tasked to follow-up on the disease outbreak and spread and to design specific interventions for disease prevention and management at the community level. These technicians work closely with the primary healthcare centres. Most of the supervisors were male (7.6%, N=9) while the supervisory designation was the least represented within the female respondents (1.1%, N=1). The supervisory position is occupied by a senior nurse at the primary healthcare, district, or provincial level.

Table 6. 1.Designation of respondents by age and gender

Designation * Age * Gender Crosstabulation							
				Age			Total and percentage per designation
Gender				Between 18 and 25	Between 26 and 35	Above 35	
Male	*Designation*	*Nurse*	Frequency	10	54	27	91
			% of Total male respondents	8.4%	45.4%	22.7%	76.5%
		Supervisor	Frequency	0	3	6	9
			% of Total male respondents	0.0%	2.5%	5.0%	7.6%
		Lab technician	Frequency	2	14	0	16
			% of Total male respondents	1.7%	11.8%	0.0%	13.4%
		Provincial Health technician	Frequency	0	0	3	3
			% of Total male respondents	0.0%	0.0%	2.5%	2.5%
Female	*Designation*	*Nurse*	Frequency	9	48	24	81
			% of Total female respondents	10.3%	55.2%	27.6%	93.1%
		Supervisor	Frequency	0	1	0	1
			% of Total female respondents	0.0%	1.1%	0.0%	1.1%
		Lab technician	Frequency	1	3	1	5
			% of Total female respondents	1.1%	3.4%	1.1%	5.7%

6.2.2. Geographic distribution

As depicted in table 6.2, significant differences are observed in terms of gender distribution in the Northern provinces (Kirundo and Cibitoke), and Cankuzo (Eastern province) while there is an almost equal gender distribution in Gitega (at the centres of the country) and Makamba (in the Southern part of the country). Cibitoke is the only province that had more female respondents than male.

Table 6. 2. Geographic distribution

Gender	Province		Age			Total and percentage per province
			Between 18 and 25	Between 26 and 35	Above 35	
Male	Kirundo	Count	5	24	15	44
		% of Total male respondents	4.2%	20.2%	12.6%	37.0%
	Gitega	Count	1	12	5	18
		% of Total	.8%	10.1%	4.2%	15.1%
	Makamba	Count	2	11	6	19
		% of Total male respondents	1.7%	9.2%	5.0%	16.0%
	Cibitoke	Count	1	11	6	18
		% of Total	.8%	9.2%	5.0%	15.1%
	Cankuzo	Count	3	13	4	20
		% of Total male respondents	2.5%	10.9%	3.4%	16.8%
Female	Kirundo	Count	4	10	5	19
		% of Total male respondents	4.5%	11.2%	5.6%	21.3%
	Gitega	Count	3	8	6	17
		% of Total male respondents	3.4%	9.0%	6.7%	19.1%
	Makamba	Count	0	12	5	17
		% of Total male respondents	0.0%	13.5%	5.6%	19.1%
	Cibitoke	Count	2	14	11	27
		% of Total male respondents	2.2%	15.7%	12.4%	30.3%
	Cankuzo	Count	1	8	0	9
		% of Total male respondents	1.1%	9.0%	0.0%	10.1%

6.3. Reliability Analysis

The reliability analysis, based on the sections of the questionnaire, is presented in this section. The Cronbach's Alpha statistic was used to evaluate the internal consistency of the questionnaire items to verify the reliability of the questionnaire and its subsections. Leech, Barret and Morgan (2005) argue that the Cronbach's alpha coefficient should be above 0.7 to deduce reliability while Igbaria and Livari (1995) suggest that the average variance should be above 0.5 for the tested items to pass the reliability test. The yes/no response type questions were not included in the reliability analysis but all questions with ordinal scale (Likert scale) answers were included in the reliability analysis.

The results in table 6.3 show the reliability statistics for the sections of the questionnaire and the questionnaire as a whole.

Table 6. 3. Questionnaire reliability statistics (per section of the questionnaire)

Construct	N	Number of questionnaire items	Cronbach's Alpha	Comment
Q.6. ICTs used to perform duties at work	187	5	0.703	adequate internal consistency
Q.7. Current use of mobile health (mHealth)	126	8	0.815	High internal consistency (Reliability)
Q.8. Purpose and frequency of use of cellphone	185	7	0.628	Close to adequate internal consistency
Q.12. Potential adoption of mHealth	153	34	0.823	High internal consistency (Reliability)
Q.13. Perception of the role of mHealth capabilities in fighting diseases	204	6	0.805	High internal consistency (Reliability)
Q.14. Determinants of mHealth adoption	183	14	0.854	High internal consistency (Reliability)
Q.15. Obstacles to m MHealth adoption	207	7	0.816	High internal consistency (Reliability)
Overall	85	81	0.788	High internal consistency (Reliability)

Table 6.3 shows that there is internal consistency within each set of questions from question 6 to 7 and from question 12 and 15 (i.e. $\alpha > 0.7$). The coefficient for question 8 is very close to 0.7. The overall measure of reliability for the whole questionnaire (Cronbach's Alpha statistic = 0.788) indicated that there is overall high internal consistency in the questionnaire items. Thus, the questionnaire can generally be deemed to be of adequate reliability.

A further reliability test was carried out based on the grouped factors. These factors were used to calculate the mHealth capabilities acceptance index, the DOI index, the UTAUT index and mHealth impediments index. This second reliability test was deemed necessary to validate the internal consistency of items within the grouped factors. The results of the validation are presented in table 6.4. The table shows that there is internal consistency within each group.

Table 6. 4. Questionnaire reliability statistics (per grouped factors)

Variables	Number of items	Cronbach Alpha coefficient	Comment
mhealth capabilities	8	0.823	Adequate: coefficient>=0.7
DOI factors	23	0.707	Adequate: coefficient>=0.7
UTAUT factors	8 items	0.745	Adequate: coefficient>=0.7
Impediments	7 items	0.816	Adequate: coefficient>=0.7

6.4. ICT usage at work

The various forms of ICTs and the extent of their usage are summarized in this section. Results presented in figure 6.1 indicate that cellphone was the most used ICT with 79.1% of the respondents indicating that they use it often or very often. Walkie-talkies (two-way radios) are the least used forms of ICT. Sinha (2005) indicates that mobile phones fit easily where there is little or no access to personal computers and the Internet, making them an attractive ICT tool for healthcare services delivery. The results concur with her findings, as computers and the Internet are seldom used by healthcare professionals at work, thus making mobile phones an alternative ICT tool to be used for healthcare-related purposes.

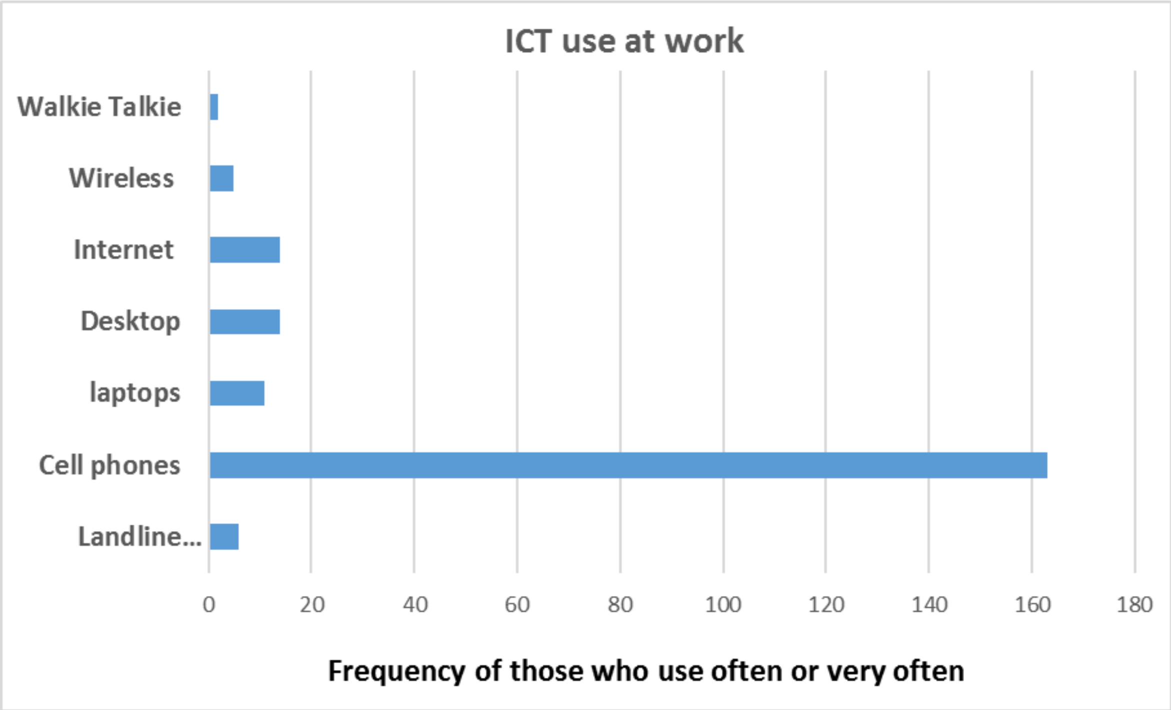

Figure 6. 1. ICT use at work

6.5. Purpose for ICT use

This section assesses the kinds of ICTs used in line with mHealth capabilities. The purposes for ICT use listed in table 6.5 are key applications for mHealth in developing countries (Vital Wave Consulting, 2009). Table 6.4 indicates that cellphones are mainly used to make calls for the purpose of communicating with fellow healthcare professionals (89.3%), remote medical or health data collection (63.7%), patients' treatment and monitoring (42.5%) and tracking diseases and epidemic outbreak (40.1%). The most used tool for education and awareness programs is the image box (59.4%) although it cannot be classified as an ICT tool. An image box is a manually-operated illustrative frame used to display various images related to healthcare for educational purposes. Other not specified non-ICT related methods were mainly used to train healthcare professionals, support diagnosis, and treatment. The table also shows that paper forms are used for remote medical/health data collection and flowcharts are used for diagnostic and treatment support.

Table 6. 5. Purpose for ICT use (in alignment with mHealth capabilities)

Purpose for ICT use	***Cellphones***	***Image box***	***TV***	***Laptop***	***Landline Phone***	***Other***
Education and awareness programs	27	120	13	2	1	39
	13.4 %	59.4%	6.4%	1.0 %	0.5%	19.3
Remote medical/health data collection	***Cellphones***	***Paper forms***	***Landline phones***	***Laptop***	***Internet***	***Other***
	130*	32	4	5	4	29
	63.7%*	15.7%	2.0%	2.5%	2.0%	14.2
Training healthcare professionals	***Cellphones***	***Landline phones***	***Laptop***	***None***	***Other***	
	47	1	10	45	65	
	28.0%	0.6%	6.0%	26.8%	38.7%	
Tracking diseases and epidemic outbreak	***Cellphones***	***Landline phones***	***None***	***Other***		
	73*	1	42	66		
	40.1%*	0.5 %	23.1. %	36.3%		
Diagnostic support	***Cellphones***	***Flow charts***	***None***	***Other***		
	39	21	40	75		
	22.3%	12.0%	22.9%	42.9%		
Treatment support	***Cellphones***	***Flow charts***	***None***	***Other***		
	36	29	40	72		
	20.3%	16.4%	22.6%	40.7%		
Patients treatment and monitoring	***Cellphones***	***None***	***Other***			
	71*	55	41			
	42.5%*	32.5%	24.6%			
Communication with healthcare professionals	***Cellphones***	***Landline phones***	***Other***			
	183*	4	18			
	89.3%*	2.0 %	8.8%			

*Cellphones are mainly used for phone calls.

6.6. Frequency of cellphone use

Figure 6.2 indicates that the three main reasons that cellphones are used for are medical or healthcare-related (i.e. searching for medical information: freq=29.6%, booking an appointment with a patient: freq=22.5% and sending medical information to patients via SMS: freq=16.1%) although a low number of primary healthcare professionals use cellphones for such purposes. In addition, in question 9, 51.66% (N=109) of respondents indicated that they have received, at least once, medical information on their cellphone via SMS. This indicates that some respondents were familiar with mHealth options (although they might not be aware that they were using mHealth). The use of cellphones for social networking (connecting to Facebook or twitter), Internet browsing, and cellphone banking are the least used options.

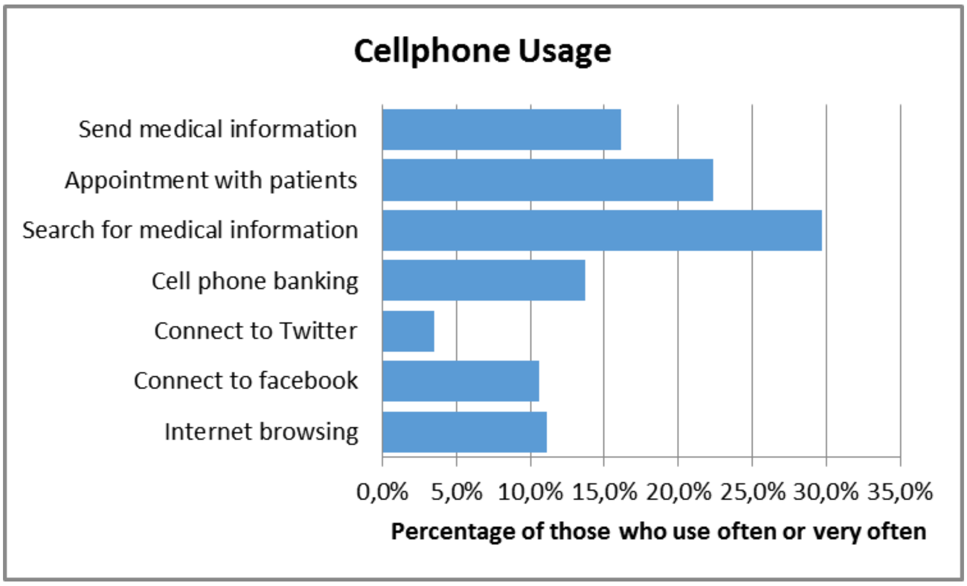

Figure 6. 2. Purpose and frequency of cellphone usage

6.7. Ownership of mobile device other than cellphones

Table 6.6 indicates that 93.40 % of respondents do not own any other mobile device apart from their cellphones.

Table 6. 6. Ownership of other mobile device than cellphone

10: Do you own any other mobile device except your cellphone?	Yes	14	6.60%
	No	198	93.40%

6.8. Factors affecting mHealth capabilities acceptance

mHealth capabilities were addressed by question 12 of the questionnaire. The results outlining mHealth capabilities acceptance are presented in table 6.7. The percentages of respondents who agree or strongly agree with the various usages of mHealth capabilities are generally high, hence most respondents acknowledged the capabilities of mHealth. Moreover, correlation and linear regression analysis were performed to ascertain if there are any significant relationships between variables derived from the Diffusion of Innovation (DOI)/Unified Theory of Acceptance and Use of Technology (UTAUT) constructs and mHealth capabilities acceptance.

The researcher acknowledges that items in tables 6.8, 6.24 and 6.25 may be confusing as the dependent and independent variables are both conflated into one in each item. The researcher would like to clarify what was measured was the independent variables i.e. complexity, facilitating conditions, performance expectancy and effort expectancy respectively against the dependent variable i.e. mhealth adoption. However, this did not affect the results of this study as the data analysis portrayed in those tables and the discussion thereafter refer to influence of those variables on mHealth adoption. Hence, this should be treated as wording oversight without any negative impact on the results as the initial purpose of these items and the analysis are achieved. Future research should be designed in a way that separate the independent and dependent variable in one variable statement.

6.8.1. mHealth capabilities acceptance

In table 6.7, the most highly ranked mHealth capability is communication between fellow health professionals using mobile devices (% agree or strongly agree=94.2%) while the monitoring and treatment of patients using mobile devices received the least acceptance (51.2% agreed or strongly agreed). This is not surprising as section 6.5 already indicated that cellphones are mostly used for communicating with fellow healthcare professionals and less for diagnostic and treatment support. Thus, it was expected that the acceptance level of mHealth use for communication purposes would be high and less for treating patients.

Table 6. 7. mHealth capabilities

mHealth Capabilities acceptance	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Variation**
12.1: I would accept to send SMS to make people aware of different methods of disease prevention	20 9.5%	13 6.2%	29 13.7%	101 47.9%	48 22.7%	**70.6%**	**3**	0.645	**Percentage of total variation = 45.19%**
12.2: I would accept to collect medical/health data by means of mobile devices	10 4.7%	10 4.7%	15 7.1%	119 56.1%	58 27.4%	**83.5%**	**2**	0.623	
12.3: I would accept to monitor and treat patients using mobile devices	40 19.5%	25 12.2%	35 17.1%	78 38.0%	27 13.2%	**51.2%**	**8**	0.734	
12.4: I would accept to communicate with fellow health professionals using mobile devices	5 2.4%	4 1.9%	3 1.4%	103 49.5%	93 44.7%	**94.2%**	**1**	0.376	

mHealth Capabilities acceptance	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Variation**
12.5: I would accept to train health workers using mobile devices	24 11.5%	33 15.8%	31 14.8%	75 35.9%	46 22.0%	**57.9%**	**7**	0.659	
12.6: I would accept to track diseases and epidemic outbreak using mobile devices	13 6.3%	22 10.7%	31 15.0%	92 44.7%	48 23.3%	**68.0%**	**4**	0.700	
12.7: I would accept to use mobile devices for diagnostic support	14 6.8%	25 12.1%	29 14.1%	93 45.1%	45 21.8%	**67.0%**	**5**	0.791	
12.8: I would accept to use mobile devices for treatment support	17 8.3%	21 10.2%	30 14.6%	98 47.8%	39 19.0%	**66.8%**	**6**	0.762	

In order to generate an overall index that represents the acceptance of mHealth capabilities, Principal Components Analysis was used. Principal Components Analysis (PCA) is a data reduction technique that creates components or factors that allows for the interpretation of relatively large series of data in a smaller number of units that can be meaningfully interpreted. PCA is used because it maximizes the usage of information in the variables or questions that form the construct of mHealth capabilities or any other constructs that will be derived from the questionnaire items.

The use of mobile devices for diagnostic support (question 12.7) has the highest PCA score of 0.791, which means it has more influence (hence more importance) on the calculation of mHealth capabilities acceptance index. PCA scores or loading scores (listed in the loading column) are the weight by which each variable (in this case mHealth capabilities acceptance variables) should be multiplied to obtain the main (or overall) component score (or index) (Tashakkori and Teddlie, 2010). Thus, statistically, the overall mHealth capabilities acceptance index is constructed as follows based on the 8 items (from question 12.1 to 12.8) that represent the mHealth capabilities:

mHealth capabilities acceptance index[19]= 0.645×**Q12.1** +0.623×**Q12.2** + 0.734×**Q12.3** + 0.376×**Q12.4** + 0.659×**Q12.5** + 0.700×**Q12.6** + 0.791×**Q12.7** + 0.762×**Q12.8**

[19] This index is not a regression equation but a summary index that shows an individual's score on mHealth capabilities

The overall index in this section and other subsections assist in the determination of correlation and regression coefficients to determine the relationship between the mHealth capabilities acceptance and factors that may influence or hinder such acceptance.

6.8.2. mHealth complexity

Results depicted in table 6.8 show that difficulty of usage of mHealth devices (question 12.9) is the least concern for most respondents as only 26.3% agreed or strongly agreed that they would not adopt mHealth because of difficulty of device usage. In fact, 50.3% (21.5% strongly disagreeing and 28.8% disagreeing) showed that mobile device usage is not a problem. However, 24.4% were not sure about mHealth complexity. 64.7% of the respondents agree or strongly agree that they would adopt mHealth because mHealth devices are easy to use. In the overall calculation of complexity index, Q12.16 has a negative and small coefficient (-0.042) because it is the opposite of the other negatively worded item in question 12.9.

The overall complexity index is constructed as follows based on the 5 items (from question 12.9, 12.10, 12.14, 12.15, 12.16) that represent the complexity factor:

DOI-complexity = 0.690×**Q12.9** +0.679×**Q12.10** + 0.726×**Q12.14** + 0.762×**Q12.15**×-0.042×**Q12.16**

Table 6. 8. mHealth complexity

DOI Factors: Complexity	**Frequencies**							**Main Principal Component**	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Variation**
12.9: I would not adopt mHealth because mobile devices are difficult to use	44 21.5%	59 28.8%	48 23.4%	39 19.0%	15 7.3%	**26.3%**	**5**	0.690	Percentage of total variation = 40.93%
12.10: I would not adopt mHealth if mHealth applications are difficult to learn	37 18.0%	56 27.2%	53 25.7%	41 19.9%	19 9.2%	**29.1%**	**4**	0.679	
12.14: I will not cope with using mHealth devices	43 20.8%	41 19.8%	44 21.3%	44 21.3%	35 16.9%	**38.2%**	**3**	0.726	
12.15: I will not cope with using mHealth applications	36 17.1%	43 20.4%	48 22.7%	43 20.4%	41 19.4%	**39.8%**	**2**	0.762	
12.16: I would adopt mHealth because mHealth devices are easier to use	10 4.8%	20 9.7%	43 20.8%	82 39.6%	52 25.1%	**64.7%**	**1**	-0.042	

6.8.3. mHealth relative advantage

Table 6.9 shows that more than 70% of respondents strongly agree or agree with the relative advantages associated with mHealth. The fact that mHealth makes one's job easier (82.3%) and the usefulness of mHealth (81.3%) are the first two most agreed upon mHealth advantages.

The overall relative advantage index is constructed as follows based on the 6 relative advantage factors (from question 12.17 to 12.22):

DOI-RelativeAdvantage=0.545×**Q12.17**×0.679×**Q.12.18**×0.595×**Q12.19**×0.809×**Q12.20**×0.816×**Q12.21**×0.776×**Q12.22**

Table 6. 9.mHealth relative advantage

DOI Factors: Relative Advantage	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	Agree+ strongly agree	Rank	Loading	Variation
12.17: mHealth is useful to me	6 2.9%	12 5.8%	21 10.1%	90 43.3%	79 38.0%	**81.3%**	**2**	0.545	**Percentage of total variation = 50.58%**
12.18: mHealth will make my job easier	6 2.9%	5 2.4%	26 12.4%	102 48.8%	70 33.5%	**82.3%**	**1**	0.679	
12.19: M-heath will reduce the amount of effort spent on executing some tasks	8 3.8%	13 6.2%	38 18.0%	91 43.1%	61 28.9%	**72.0%**	**6**	0.595	
12.20: mHealth would enable me to reach a larger portion of the country's population	8 3.8%	12 5.8%	27 13.0%	93 44.7%	68 32.7%	**77.4%**	**3**	0.809	
12.21: A larger portion of the population will benefit from healthcare services if mHealth is implemented	10 4.8%	10 4.8%	36 17.1%	91 43.3%	63 30.0%	**73.3%**	**5**	0.816	
12.22: There will be an increase in prevention and awareness of diseases should mHealth be adopted	6 2.9%	9 4.3%	33 15.9%	98 47.1%	62 29.8%	**76.9%**	**4**	0.776	

6.8.4. mHealth compatibility

Although more than half of the respondents generally agree with the compatibility variables as depicted in table 6.10, compatibility with what is needed to execute daily tasks is the most agreed upon while compatibility with work ethics is the least agreed upon.

The overall compatibility index is constructed as follows based on the 5 compatibility factors (from question 12.23 to 12.27):

0.812×**Q12.23**×0.779×**Q12.24**×0.640×**Q12.25**×0.796×**Q12.26**×0.579×**Q.12.**

Table 6. 10. mHealth compatibility

DOI Factors: Compatibility	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Variation**
12.23: mHealth is compatible with my duties	8 3.8%	10 4.8%	34 16.2%	106 50.5%	52 24.8%	**75.2%**	**2**	0.812	**Percentage of total variation = 52.88%**
12.24: mHealth is compatible with what I need to execute my daily tasks	6 2.9%	8 3.8%	27 12.9%	105 50.2%	63 30.1%	**80.4%**	**1**	0.779	
12.25: mHealth is compatible with my experience with mobile devices	14 6.7%	29 13.9%	52 24.9%	83 39.7%	31 14.8%	**54.5%**	**4**	0.640	
12.26: mHealth is compatible with my organisational working style	12 5.7%	23 11.0%	45 21.4%	96 45.7%	34 16.2%	**61.9%**	**3**	0.796	
12.27: mHealth is compatible with my work ethics	16 7.6%	33 15.7%	51 24.3%	76 36.2%	34 16.2%	**52.4%**	**5**	0.579	

6.8.5. mHealth trialability

Table 6.11 indicates that most respondents agreed (84.7%) that they would first test mHealth before adopting it and only few (9.1%) would adopt mHealth immediately without trying it. The overall trialability index is constructed as follows based on the 4 trialability factors (from question 12.28 to 12.31):

0.771×**Q12.28**×0.872×**12.29**×0.543×**Q12.30**×0.143×**Q12.31**

Table 6. 11. mHealth trialability

DOI Factors: Trialability	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	Agree+ strongly agree	Rank	Loading	Reliability statistics
12.28: I would first test mHealth before adopting it	4 1.9%	11 5.3%	17 8.1%	104 49.8%	73 34.9%	**84.7%**	**1**	0.771	**Percentage of total variation = 41.75%**
12.29: I would first adopt mHealth and then evaluate the results	14 6.7%	17 8.2%	16 7.7%	98 47.1%	63 30.3%	**77.4%**	**2**	0.872	
12.30: I would adopt mHealth anyway because it has proven to work in other countries	6 2.9%	11 5.3%	71 34.1%	74 35.6%	46 22.1%	**57.7%**	**3**	0.543	
12.31: I am willing to adopt mHealth immediately without trying it	84 40.2%	65 31.1%	41 19.6%	14 6.7%	5 2.4%	**9.1%**	**4**	0.143	

6.8.6. mHealth observability

Table 6.12 indicate that most respondents (82.5%) would want to see where mHealth worked before adopting it.

The overall observability index is constructed as follows based on the 3 observability factors (from question 12.32 to 12.34): 0.558×**Q12.32**×0.714×Q**12.33**×Q-0.654×**Q12.34**

Table 6. 12. mHealth observability

DOI Factors: Observability	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	Agree+ strongly agree	Rank	Loading	Variation
12.32: I need to see tangible results of mHealth adoption before adopting it.	11 5.2%	19 9.0%	24 11.4%	98 46.7%	58 27.6%	**74.3%**	**2**	0.558	**Percentage of total variation = 41.62%**
12.33: I need to be shown where mHealth worked before adopting it	2 0.9%	13 6.1%	22 10.4%	104 49.1%	71 33.5%	**82.5%**	**1**	0.714	
12.34: I do not need to see tangible results of mHealth. I will adopt it because I know it will work for me	61 28.8%	53 25.0%	41 19.3%	43 20.3%	14 6.6%	**26.9%**	**3**	-0.654	

6.8.7. Relationship between DOI factors and mHealth capabilities acceptance

After outlining the mHealth capabilities acceptance and the factors that might influence such capabilities acceptance in the above sections, this section now analyses the relationship between DOI factors and mHealth capabilities acceptance. The dependent variable is the overall index representing mHealth capabilities acceptance discussed in section 6.8.1 above. The DOI factors (complexity, relative advantage, compatibility, trialability, observability) are the independent variables that affect the dependent variable. The overall indices of the DOI factors generated through the PCA are used to analyse the relationships (through correlation and regression analyses) between DOI factors and mHealth capabilities acceptance.

6.8.8. Correlation analysis of mHealth capabilities and DOI factors

The correlation results for mHealth capabilities and DOI factors are presented in table 6.13. According to Cohen (1992), the effect size of the Pearson correlation coefficient (*r*) is small if the value of *r* varies around 0.10, moderate if *r* varies around 0.30, and large if *r* varies around or more than 0.50. An effect size is an objective and standardised measure of the magnitude of observed effect (Field, 2005). The Pearson correlation is computed using the following formula:

$$r = \frac{N \sum xy - \sum(x)(y)}{\sqrt{N \sum x^2 - \sum(x^2)][N\sum y^2 - \sum(y^2)]}}$$

Where r = correlation coefficient; N = number of pairs of scores; $\sum xy$ = sum of the products of paired scores; $\sum x$ = sum of x scores; $\sum y$ = sum of y scores; $\sum x^2$= sum of squared x scores; and $\sum y^2$= sum of squared y scores

The results show that mHealth capabilities are significantly and positively correlated to DOI-relative advantage with a high effect size (correlation=0.502, p-value=0.000), DOI-compatibility with moderate effect size (correlation=0.370, p-value=0.000), DOI-trialability with low effect size (correlation=0.270, p-value=0.000) and DOI-observability with low effect size (correlation=0.160, p-value=0.027). Correlation between complexity and mHealth capabilities is statistically not significant (correlation= -0.057, p-value=0.451).

Some of the DOI factors are also correlated among themselves as depicted in table 6.13. DOI-compatibility is negatively correlated with DOI-complexity (correlation= -0.233, p-value=0.002) meaning that an increase in perceptions of mHealth compatibility is related to a decrease in perceptions of mHealth complexity. In addition, DOI-compatibility and DOI-relative advantage are positively correlated (correlation=0.543, p-value=0.000) i.e. an increase in perceptions of mHealth compatibility is related to an increase in perceptions of mHealth relative advantage. DOI trialability is positively correlated with DOI relative advantage and DOI compatibility. This may imply that the more the respondents try mHealth, the more they will perceive positively the advantages related to mHealth adoption and the more they will perceive positively mHealth as compatible with their duties, what they need to execute their daily tasks, their experience with mobile devices, their organisational culture and their work ethics. DOI-Observability is positively correlated with DOI-trialability. An increase in the need to see tangible results of mHealth, need to be shown where mHealth worked before adopting it, is associated with an increase in the intention to test mHealth, evaluate mHealth results before adopting mHealth.

Table 6. 13. Correlations of mHealth capabilities acceptance and DOI factors

	Pearson Correlations		**M-Health Capabilities acceptance**	**DOI Factors**			
				DOI_Complexity	DOI-Relative Advantage	DOI-Compatibility	DOI-Triability
DOI Factors	DOI_Complexity	Correlation	-0.057				
		p-value	0.451				
		N	176				
	DOI-Relative Advantage	Correlation	0.502**	-0.127			
		p-value	0.000	0.090			
		N	179	180			
	DOI-Compatibility	Correlation	0.370**	-.233**	0.543**		
		p-value	0.000	0.002	0.000		
		N	182	183	194		
	DOI-Triability	Correlation	0.270**	-0.008	0.304**	0.313**	
		p-value	0.000	0.919	0.000	0.000	
		N	181	182	193	195	
	DOI-Observability	Correlation	0.160*	0.058	0.089	0.065	0.259**
		p-value	0.027	0.429	0.213	0.355	0.000
		N	190	189	197	202	199

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

6.8.9. Regression of mHealth capabilities on DOI factors

The dependent variable (mHealth capabilities acceptance) needs to be tested against the regression model assumptions before regression analysis can be carried out. These are the assumptions of homogeneity of variance and normality of the response variable.

Table 6. 14. Tests for regression model assumptions

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
M-Health Capabilities	0.078	191	0.006	0.975	191	0.001

a. Lilliefors Significance Correction

The results in table 6.14 show that there is significant departure from normality (sig. or p value<0.05) of the dependent variable (Shapiro-Wilk's statistic=0.975, df =191, p-value=0.001). Regression analysis can still be carried out with the knowledge that the regression analysis, though informative, is not statistically sound.

Table 6. 15. Regression model for mHealth capabilities on DOI factors

Dependent Variable = M-Health Capabilities acceptance				
Independent variables	Unstandardized Coefficients		T-Tests	
	B	Std. Error	t-statistic	p-value
(Constant)	0.050	0.066	0.759	0.449
DOI_Complexity	-0.012	0.068	-0.173	0.863
DOI-Relative Advantage	0.387	0.076	5.078	0.000
DOI-Compatibility	0.154	0.081	1.902	0.059
DOI-Triability	0.009	0.076	0.115	0.909
DOI-Observability	0.173	0.075	2.298	0.023
Model Fit:	F	df1	df2	p-value
	13.334	5	157	0.000
Coefficient of Determination = 0.298				

The regression model of mHealth capabilities on DOI factors (table 6.15) indicates that, when the DOI factors are considered, then DOI-relative advantage (coefficient=0.387, t=5.078, p-value=0.000) and DOI-observability (coefficient=0.173, t=2.298, p-value=0.023) stand out as the most significant in the regression model. A one unit increase in relative advantage will trigger a 0.387 increase in mHealth capabilities acceptance while a one unit increase in mHealth observability will trigger a 0.173 increase in in mHealth capabilities acceptance. The coefficient of determination shows that the regression model only accounts for 29.8% of the total variation in the data (coefficient of determination =0.298). The two most significant factors (relative advantage and observability) and compatibility were singled out and a multiple linear regression model was tested in an attempt to extract a regression equation based on the three factors. Compatibility was included as the p value is slightly above 0.05 (see table 6.15). Table 6.16 depicts the multiple linear regression model.

Table 6. 16. Multiple linear regression model for mHealth capabilities on DOI-relative advantage, compatibility, and observability

Dependent Variable = M-Health Capabilities acceptance				
Independent variables	Unstandardized Coefficients		T-Tests	
	B	Std. Error	t-statistic	p-value
X_1=DOI-Relative Advantage	0.388	0.074	5.269	0.000
X_2=DOI-Compatibility	0.142	0.067	2.113	0.036
X_3=DOI-Observability	0.161	0.075	2.138	0.034
Model Fit:	F	df1	df2	p-value
	23.595	3	172	0.000
Coefficient of Determination = 0.292				

Based on the results from table 6.16, a multiple linear regression equation that can be used to predict mHealth capabilities acceptance based on the three variables can be calculated using the following formula: $Y = b\boldsymbol{X_1} + b\boldsymbol{X_2} + b\boldsymbol{X_3} + constant\ value\ (c)$, where Y is the dependent variable (mHealth capabilities), X the independent variable, and b is the regression coefficient value for each one of the three independent variables.

The regression equation is as follows: $Y = \mathbf{0.388}\boldsymbol{X_1} + \mathbf{0.142}\boldsymbol{X_2} + \mathbf{0.161}\boldsymbol{X_3} + \boldsymbol{c}$

6.8.10. Need for mHealth knowledge

Results from the analysis as depicted in table 6.17 indicate that 90.1% of primary healthcare professionals need to know how mHealth works before adopting it, only 40.6% would cope with using mHealth devices and only 37.4% would cope with using mHealth applications. Importantly, table 6.18 shows that there is a significant positive correlation between the need to know how mHealth works before adoption and the acceptance of each one of the mHealth capabilities. The correlation depicts that an increase in mHealth knowledge may lead to an increase in the acceptance of each one of the mHealth capabilities.

Table 6. 17. Frequency analysis of need for training

Variables	Strongly Disagree + Disagree	I am not sure	Agree + Strongly agree	Total
Q.12.13: Need to know how m-health works before adopting it	11 5.1%	10 4.8%	191 90.1%	212
Q.12.14: Not coping with using mHealth devices	84 40.6%	44 21.3%	79 38.1%	207
Q.12.15: Not coping with using mHealth applications	79 37.4%	48 22.8%	84 39.8%	211

Table 6. 18. Correlation between need for mHealth knowledge and mHealth capabilities

Variables		Sending SMS	Collecting medical health data	Monitoring and treating patients	Communication with fellow healthcare professionals	Training healthcare workers	Tracking diseases and epidemic outbreak	Diagnostic support	Treatment support
Need to know how mHealth works before adoption	Correlation coefficient	.218**	.254**	.265**	.180**	.222**	.271**	.251**	.206**
	Sig. (2-tailed)	.001	.000	.000	.009	.001	.000	.000	.003
Not coping with using mHealth devices	Correlation coefficient	.064	.610	.194**	-.017	.106	0.004	-0.48	-0.44
	Sig. (2-tailed)	3.610	.383	.006	.807	.131	.952	4.97	.532
Not coping with using mHealth applications	Correlation coefficient	.006	.058	.099	-0.11	.064	.068	0.18	0.007
	Sig. (2-tailed)	.927	.400	.158	.873	3.62	.335	.803	.922

6.8.11. Willingness to learn how to use mHealth applications and mobile devices

Results from the analysis as depicted in table 6.19 show a general willingness to learn how to use mobile devices to provide mHealth (80.6% of respondents, N= 171) and to learn how to use mHealth applications (73.6%, N=156). In addition, positive significant correlations were found between the two variables and the acceptance of most of mHealth capabilities (table 6.20). In fact, correlation between Question 12.11 (willingness to learn how to use mobile devices) and communication with fellow healthcare professionals is the only one that is not significant. This may be due to the fact that cellphones are currently frequently used for communication purposes. Thus, healthcare professionals' willingness to learn to use mobile devices or mHealth applications does not impact on communicating with fellow healthcare professionals as cellphones are commonly used for such purpose i.e. whether they are willing to adopt mHealth or not. In cases where the correlations are significant, the increase in the willingness to learn how to use mHealth applications and mobile devices may lead to an increase the mHealth capabilities acceptance.

Table 6. 19. Frequency: Willingness to learn how to use mHealth applications and mobile devices

Variables	Strongly Disagree+ Disagree	I am not sure	Agree+ Strongly agree	Total
12.11. I am willing to learn how to use mobile devices to provide m-health	18 8.5%	18 8.5%	171 80.6%	207
12.12. I am willing to learn how to use m-health applications	24 11.3%	16 7.5%	156 73.6%	196

Table 6. 20. Correlation between willingness to learn how to use mHealth applications/mobile devices and mHealth capabilities acceptance

Variables		**Sending SMS**	**Collecting medical health data**	**Monitoring and treating patients**	**Communication with fellow healthcare professionals**	**Training healthcare workers**	**Tracking diseases and epidemic outbreak**	**Diagnostic support**	**Treatment support**
12.11. I am willing to learn how to use mobile devices to provide m-health	Correlation coefficient	**.256****	**.249****	**.274****	.115	**.266****	**.298****	**.314****	**.316****
	Sig. (2-tailed)	**.000**	**.000**	**.000**	.102	**.000**	**.000**	**.000**	**.000**
12.12. I am willing to learn how to use m-health applications	Correlation coefficient	**.263****	**.289****	**.379****	**.158***	**.264****	**.370****	**.423****	**.396****
	Sig. (2-tailed)	**.000**	**.000**	**.000**	**.028**	**.000**	**.000**	**.000**	**.000**

6.9. mHealth and disease prevention and management, and quality of healthcare provision

The role of mHealth in the fight against diseases is summarised in table 6.21. Communication with health field workers using mobile devices was highlighted as the most important aspect of fighting diseases (89.4% agreed or strongly agreed) while the diagnosis of diseases using mobile devices being the least appraised mHealth functionality (60.8% agreed or strongly agreed).

Table 6. 21. mHealth and fight against diseases in Burundi

Fighting Diseases	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Variation**
Disease Prevention									
13.1: Sending customized SMS's about disease prevention methods to mobile phone subscribers would contribute positively to disease prevention in Burundi	22 10.6%	9 4.3%	46 22.1%	94 45.2%	37 17.8%	**63.0%**		N/A	N/A
Disease Management									**Percentage of total variation = 50.36%**
13.2: Collecting patients 'medical/health data using smart mobile devices would contribute positively to disease management in Burundi	8 3.8%	7 3.3%	34 16.2%	115 54.8%	46 21.9%	**76.7%**	**2**	0.395	
13.3: Communicating with health field workers using mobile devices would enhance disease management processes in Burundi	3 1.4%	1 0.5%	18 8.7%	117 56.3%	69 33.2%	**89.4%**	**1**	0.718	
13.5: Tracking epidemic and disease outbreaks using mobile devices would enhance disease management processes in Burundi	11 5.2%	8 3.8%	51 24.2%	89 42.2%	52 24.6%	**66.8%**	**3**	0.842	
13.6: Diagnosis of diseases using mobile devices would enhance disease management in Burundi	16 7.7%	13 6.2%	53 25.4%	82 39.2%	45 21.5%	**60.8%**	**4**	0.796	
Quality of healthcare provision									
13.4: Training of health workers using mobile devices would enhance the quality of healthcare service provision in Burundi	13 6.2%	13 6.2%	37 17.5%	88 41.7%	60 28.4%	**70.1%**	**2**	0.500	
13.7: Treatment support using mobile devices would enhance the quality of healthcare service provision in Burundi	13 6.2%	15 7.1%	34 16.2%	102 48.6%	46 21.9%	**70.5%**	**1**	0.500	

6.9.1. Correlation between mHealth capabilities acceptance and fight against diseases

Table 6.22 shows that the three aspects of fighting diseases in Burundi (disease prevention, disease management, and quality of healthcare provision) are positively correlated with mHealth capabilities acceptance. Quality of healthcare provision is positively correlated with disease prevention and disease management while disease management is positively correlated with disease prevention.

Table 6. 22. Correlation between mHealth capabilities acceptance and fight against diseases

	Pearson Correlations		M-Health Capabilities	Disease Prevention factors	
				13.1: Disease prevention	Disease Management
Disease Prevention factors	Disease prevention	Correlation	0.392**		
		p-value	0.000		
		N	188		
	Disease Management	Correlation	0.518**	.413**	
		p-value	0.000	0.000	
		N	187	204	
	Quality of Healthcare Provision	Correlation	0.470**	.371**	.669**
		p-value	0.000	0.000	0.000
		N	190	208	205

**. Correlation is significant at the 0.01 level (2-tailed).

6.9.2. Regression of mHealth capabilities on fighting diseases (factors)

Table 6.23 indicates that the three aspects of fighting diseases are significant in the regression model. A one-unit increase in the perceptions of mHealth as a tool for disease prevention would trigger 15.3% increase in mHealth capabilities acceptance, one-unit increase in the perceptions of mHealth as a tool for disease management would trigger 32.2% increase in mHealth capabilities acceptance while one-unit increase in the perceptions of mHealth as a tool to enhance the quality of healthcare provision will trigger a 16.4% increase in mHealth capabilities acceptance. A multiple linear regression equation can be deduced as follows:

$$\boldsymbol{Y = -0.528 + 0.153X_1 + 0.322X_2 + 0.164X_3} + \mathbf{c}$$

Table 6. 23.Regression of mHealth capabilities on fighting disease variables

Dependent Variable = M-Health Capabilities				
Independent variables	Unstandardized Coefficients		T-Tests	
	B	Std. Error	t-statistic	p-value
(Constant)	-0.528	0.214	-2.468	0.014
X1=Disease prevention	0.153	0.058	2.648	0.009
X2=Disease Management	0.322	0.084	3.839	0.000
X3=Quality of Healthcare Provision	0.164	0.082	1.993	0.048
Model Fit:	F	df1	df2	p-value
	27.982	3	182	0.000
Coefficient of Determination =	0.316			

6.10. Influence of determinants of mHealth adoption (UTAUT variables) on mHealth capabilities acceptance

Determinants (UTAUT-related) of mHealth adoption were addressed by 14 questions that fell under section E of the questionnaire. These determinants were categorised as: facilitating conditions which are summarised in table 6.24, Performance Expectancy (P.E.) and Effort Expectancy (E.E.) summarised in Table 6.25.

Table 6.24 indicates that confidentiality of information (80.2%) is the most agreed upon factor that would be considered before adopting mHealth while reliability of mobile technology infrastructure (61.4%) is the least agreed upon factor that would be considered before adopting mHealth.

Table 6. 24. UTAUT factors/facilitating conditions

UTAUT factors/Facilitating conditions	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Reliability statistics**
14.1: Affordability of mobile devices is a factor that I would consider before adopting mHealth	11	17	34	125	25	**70.8 %**	**6**	0.492	**Percentage of total var =43.76%**
	5.2%	8.0%	16.0%	59.0%	11.8%				
14.4: Reliability of mobile technology infrastructure is a factor that I would consider before adopting mHealth	10	34	37	94	35	**61.4 %**	**7**	0.734	
	4.8%	16.2%	17.6%	44.8%	16.7%				
14.5: Free access to mHealth via SMS is a factor that I would consider before adopting mHealth	5	32	24	101	48	**71.0 %**	**5**	0.704	
	2.4%	15.2%	11.4%	48.1%	22.9%				
14.6: Affordability of sending SMS is a factor that I would consider before adopting mHealth	2	17	33	104	42	**73.7 %**	**2**	0.769	
	1.0%	8.6%	16.7%	52.5%	21.2%				
14.7: Affordability of making calls using a mobile phone is a factor that I would consider before adopting mHealth	10	22	25	111	42	**72.9 %**	**3**	0.770	
	4.8%	10.5%	11.9%	52.9%	20.0%				
14.8: Content of mHealth message/service in local language is a factor that I would consider before adopting mHealth	10	24	23	117	35	**72.7 %**	**4**	0.497	
	4.8%	11.5%	11.0%	56.0%	16.7%				
	2.4%	5.7%	15.8%	56.9%	19.1%				
14.9: Compatibility of mHealth service with my duties is a factor that I would consider before adopting mHealth	8	15	19	98	72	**80.2 %**	**1**	0.707	
	3.8%	7.1%	9.0%	46.2%	34.0%				
14.10: Confidentiality of information sent via mobile devices is a factor that I would consider before adopting mHealth	8	15	19	98	72	80.2%	1	0.707	0.707

Table 6.25 indicates that ease of use of mobile device (83.7%) is the most agreed upon factor that would be considered before adopting mHealth. This corroborates the findings in section 6.8.2 (i.e. difficulty of usage of mHealth is the least concern for most respondents). Expansion of healthcare access (70.0%) is the least agreed upon factor that would be considered before adopting mHealth. In terms of performance expectancy, convenience was the most agreed upon factor (80.9%) while expansion of healthcare access was the least agreed upon (70.0%).

Table 6. 25. UTAUT/performance expectancy and effort expectancy

UTAUT/PE, E.E.	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Reliability statistics**
Performance Expectancy (PE)									**Percentage of total var =74.23%**
14.2: Expansion of healthcare access is a factor that I would consider before adopting mHealth	9 4.3%	13 6.2%	41 19.5%	122 58.1%	25 11.9%	**70.0%**	**2**	0.500	
14.3: Convenience is a factor that I would consider before adopting mHealth	5 2.4%	12 5.7%	23 11.0%	133 63.6%	36 17.2%	**80.9%**	**1**	0.500	
Effort Expectancy (E.E.)									**Percentage of total var = 79.83**
14.11: Ease of use of mobile device is a factor that I would consider before adopting mHealth	7 3.3%	10 4.8%	17 8.1%	135 64.6%	40 19.1%	**83.7%**	**1**	0.500	
14.12: Ease of use of mobile health application is a factor that I would consider before adopting mHealth	6 2.9%	14 6.7%	28 13.4%	121 57.9%	40 19.1%	**77.0%**	**2**	0.500	

6.10.1. Correlation between mHealth capabilities acceptance and UTAUT variables

Table 6.26 indicates that the three UTAUT constructs are positively correlated with mHealth capabilities acceptance. In addition, effort expectancy is positively correlated with facilitating conditions and performance expectancy while performance expectancy is positively correlated with facilitating conditions.

Table 6. 26.Correlation between mHealth capabilities and UTAUT variables.

	Pearson Correlations		M-Health Capabilities	UTAUT variables: Facilitating Conditions	UTAUT variables: Performance Expectancy
mHealth adoption	Facilitating Conditions	Correlation	0.300**		
		p-value	0.000		
		N	175		
	Performance Expectancy	Correlation	0.191**	0.459**	
		p-value	0.009	0.000	
		N	188	186	
	Effort Expectancy	Correlation	0.314**	0.734**	0.359**
		p-value	0.000	0.000	0.000
		N	187	184	203

6.10.2. Regression of mHealth capabilities on UTAUT variables

Table 6.27 indicates that the p value of the t-tests for each construct is not significant. Thus, the regression model is not significant for the three variables combined.

Table 6. 27.Regression of mHealth capabilities acceptance on UTAUT variables

Dependent Variable = M-Health Capabilities acceptance				
Independent variables	Unstandardized Coefficients		T-Tests	
	B	Std. Error	t-statistic	p-value
(Constant)	0.025	0.074	0.331	0.741
Facilitating Condition	0.115	0.116	0.989	0.324
Performance Expectancy	0.042	0.080	0.524	0.601
Effort Expectancy	0.230	0.120	1.925	0.056
Model Fit:	F	df1	df2	p-value
	6.963	3	167	0.000
Coefficient of Determination =	0.111			

Effort expectancy was then singled out, as its p value is closer to 0.05, to test whether as a single variable it can predict mHealth capabilities acceptance. Table 6.28 shows that the regression model is significant (p value=0.000). Thus, a one unit increase in effort expectancy (ease of use of mobile devices and ease of use of mobile health applications) would trigger 0.327 increase in mHealth capabilities acceptance. Hence, a regression equation can be deduced as follows: $\boldsymbol{Y = 0.327X + c}$

Table 6. 28. Regression of mHealth capabilities acceptance on effort expectancy

Dependent Variable = M-Health Capabilities acceptance				
Independent variable	Unstandardized Coefficients		T-Tests	
	B	Std. Error	t-statistic	p-value
X =Effort Expectancy	0.327	0.072	4.513	0.000
Model Fit:	F	df1	df2	p-value
	20.371	1	186	0.000
Coefficient of Determination =	0.099			

6.11. Influence of impediments of mHealth on mHealth capabilities acceptance

Although more than 75% of respondents agreed that the factors listed in table 6.29 are healthcare impediments, unreliability of network coverage in rural areas was the most agreed upon factor at 86.3% while low rate of cellphone penetration is the least agreed upon (75.5%).

In table 6.29, items related specifically to the affordability factor (question 15.6: High cost of network connection and question 15.7: high cost of mobile Internet bundles) were identified as hindrance to mHealth adoption. Additionally, table 6.24 identified that affordability (question 14.1) is a factor that would be considered before adoption mHealth. Thus, affordability is a very important aspect of mHealth adoption as it was acknowledged both as a determinant to mHelath adoption and as a challenge within the Burundi's context. Reliability of mobile network is another important factor as it was perceived by healthcare professionals as both a determinant (question 14.4 in table 6.24) and a hindrance to mHealth adoption in Burundi (question 15.5 in table 6.29).

Table 6. 29. Impediments of mHealth capabilities acceptance

Healthcare Impediments	**Frequencies**							**Main Principal Component**	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Reliability statistics**
15.1: Lack of skills to develop mHealth applications	5	13	17	101	76	**83.5 %**	**4**	0.628	Percentage of total variation =48.29% Cronbach's Alpha Statistic = 0.816
	2.4 %	6.1 %	8.0%	47.6 %	35.8 %				
15.2: High cost of mobile devices	5	11	22	94	78	**81.9 %**	**6**	0.585	
	2.4 %	5.2 %	10.5 %	44.8 %	37.1 %				
15.3: Low rate of cellphone penetration	7	17	28	96	64	**75.5 %**	**2**	0.657	
	3.3 %	8.0 %	13.2 %	45.3 %	30.2 %				

Healthcare Impediments	Frequencies							Main Principal Component	
	Strongly disagree	Disagree	Not sure	Agree	Strongly Agree	**Agree+ strongly agree**	**Rank**	**Loading**	**Reliability statistics**
15.4: Low rate of other mobile devices (excluding cellphones) penetration	3	7	22	87	91	**84.8 %**	**3**	0.702	
	1.4 %	3.3 %	10.5 %	41.4 %	43.3 %				
15.5: Unreliable network coverage in rural areas	4	9	16	92	90	**86.3 %**	**1**	0.761	
	1.9 %	4.3 %	7.6%	43.6 %	42.7 %				
15.6: High cost of network connection	3	8	27	91	83	**82.1 %**	**5**	0.764	
	1.4 %	3.8 %	12.7 %	42.9 %	39.2 %				
15.7: High cost of mobile Internet bundles	1	10	21	69	111	**84.9 %**	**2**	0.747	
	0.5 %	4.7 %	9.9%	32.5 %	52.4 %				

6.11.1. Correlation between mHealth capabilities acceptance and impediments to mHealth adoption

Table 6.30 indicates that lack of skills, low rate of cellphone penetration, unreliable network coverage and high cost of network connection are significantly correlated with mHealth capabilities acceptance with a small effect size (correlation coefficient less than 0.30). This means that there is a weak association between these impediments and mHealth capabilities acceptance. As far as cost is concerned, the researcher investigated the influence of three types of costs (High cost of mobile devices, high cost of network connection and high cost of mobile Internet bundles) on mHealth adoption. Out of the three, only one, i.e. high cost of network connection is significantly correlated to mhealth adoption. The measurement of the three variables was deemed better than one generic single cost variable as it allowed the distinction (amongst the three variables) of specific cost factor that is essential to the adoption of mHealth in Burundi.

Table 6. 30. Correlation between mHealth capabilities acceptance and impediments of mHealth

	Pearson Correlations		***mHealth Capabilities acceptance***
Impediments	Q.15.1: Lack of skills to develop mHealth applications	Correlation	0.238**
		p-value	0.001
		N	191
	Q.15.2: High cost of mobile devices	Correlation	0.042
		p-value	0.569
		N	189
	Q.15.3: Low rate of cellphone penetration	Correlation	0.177*
		p-value	0.014
		N	191

	Pearson Correlations		*mHealth Capabilities acceptance*
	Q.15.4: Low rate of other mobile devices penetration	Correlation	0.124
		p-value	0.088
		N	190
	Q.15.5: Unreliable network coverage	Correlation	0.202**
		p-value	0.005
		N	190
	Q.15.6: High cost of network connection	Correlation	0.167*
		p-value	0.021
		N	191
	Q.15.7: High cost of mobile Internet bundles	Correlation	0.095
		p-value	0.191
		N	191

6.11.2. Multiple linear regression between mHealth capabilities acceptance and impediments of mHealth

Table 6.31 shows that the regression model is not significant (p values>0.05). Lack of skills to develop mHealth applications was singled out, as its p value is closer to the required 0.05. Then a regression analysis was performed between the variable and mHealth capabilities acceptance (table 6.32). The results indicate that the regression model is significant. Thus, a regression equation was generated as follows: $Y = 0.208\mathrm{X} + \mathrm{c}$

Table 6. 31.Regression between mHealth capabilities acceptance and mHealth impediments

Dependent Variable = M-Health Capabilities acceptance				
Independent variables	Unstandardized Coefficients		T-Tests	
	B	Std. Error	t-statistic	p-value
Lack of skills to develop mHealth applications	0.168	0.088	1.902	0.059
High cost of mobile devices	-0.154	0.091	-1.696	0.092
Low rate of cellphone penetration	0.060	0.084	0.715	0.476
Low rate of other mobile devices	-0.029	0.101	-0.289	0.773
Unreliable network coverage	0.096	0.114	0.845	0.399
High cost of network connection	0.032	0.116	0.276	0.783
High cost of mobile Internet bundles	-0.154	0.116	-1.329	0.185
Model Fit:	F	df1	df2	p-value
	1.398	7	180	0.000
Coefficient of Determination =	0.052			

Table 6. 32.Regression of mHealth capabilities acceptance on lack of skills

Dependent Variable = M-Health Capabilities acceptance				
Independent variable	Unstandardized Coefficients		T-Tests	
	B	Std. Error	t-statistic	p-value
X=Lack of skills to develop mHealth applications	0.208	0.062	3.351	0.001
Model Fit:	F	df1	df2	p-value
	11.226	1	190	0.001
Coefficient of Determination =	0.056			

SECTION B: DATA ANALYSIS FROM INTERVIEWS

Interviews were conducted with the Ministry of Health, Ministry of Communication and 4 telecommunications services providers. These interviews were conducted in the capital city Bujumbura. Using a deductive approach for qualitative data analysis, data were grouped according to themes related to the research questions. Then the Nvivo software was used to classify these themes into Nvivo nodes and interviewees' responses were coded into these nodes. Additional themes drawn from the interviewees' responses were included in the analysis to provide more clarity on the extent and potential of mHealth adoption in Burundi. This section starts with a description of the demographics of the interviewees followed by the presentation of data pertaining to the extent of and potential for mHealth adoption in Burundi. The last section deals with the analysis of data related to the research questions.

6.12. Demographics

Table 6. 33. Demographics of interviewees

Interviewee designation	Gender	Number of years of service	Name/type of organisation
ICT manager	Female	Less than 3 years	Ministry of Health and Fight Against AIDS
Communications officer	Male	More than 10 years	Ministry of Health and Fight Against AIDS
Director of Information, Education and Communication Centre for Development	Male	Between 3 and 5 years	Ministry of Communication

Public relations officer	Male	Between 3 and 5 years	Telecommunications company A
Sales manager	Male	More than 10 years	Telecommunications company B
Chief commercial business manager	Male	More than 10 years	Telecommunications company C
Chief of staff	Male	Less than 3 years	Telecommunications Company D

At the Ministry of Health, the interviews were held with two officials from the Directorate for Health Information Systems (DSNIS). The first interviewee was an ICT manager while the second was a communications officer. The former was referred to by the Director General of DSNIS while the latter was referred by the first interviewee. The second interviewee was particularly relevant because of his vast experience in dealing with Health Information Systems within the Ministry (10 years work experience).

At the Ministry of Communication, the interview was conducted with the director of CIEP (Information, Education, and Communication Centre for the Population and Development). CIEP is a department within the Ministry of Communication that devises strategies to disseminate health-related information for awareness and educational purposes to Burundi’s population. The strategies include health awareness programs through television, radio broadcasts and CBHWs. The department focuses on the following themes: Breastfeeding, good hygiene, infants’ homecare (including treatment) to mothers.

Four out of the six mobile telecommunications companies operating in the country (at the time when data was collected) were interviewed. The names of the companies are purposely omitted for confidentiality reasons. In each company, an employee was assigned to be interviewed, thus the researcher had no control over whom to interview.

6.13. Link between research questions and interview themes

The link between research questions/objectives and interview themes are summarised in table 6.34.

Table 6. 34. Link between research questions and interview themes.

Interviewees	Themes		
	Facilitating conditions for the adoption of mHealth in Burundi (Research objective 1/Research question 2)	**Impediments to mHealth adoption (Research objective 4/research question 4)**	**Role of mHealth in achieving country's broad goals in the health sector (Research objective 3/ research question 3)**
Ministry of Health and Fight Against AIDS	**Sub theme 1**: Existence of a long term plan for ICT adoption in the health sector **Sub theme 2**: Existence of strategy to secure long term sustainability of ICT in the health sector **Sub theme 3**: Role played by the Ministry of Health and Government in funding ICT initiatives in the health sector **Sub theme 4**: Facilitating conditions for mHealth adoption by health workers **Sub theme 5**: Role played by the Ministry of Health and government in promoting ICT adoption and use in the health sector: Initiatives in place to promote ICT and/or mobile health	**Sub theme 1:** Obstacles to using mobile devices to provide healthcare services **Sub theme 2:** Impediments to ICT adoption	**Sub theme 1:** Advantages of adopting mHealth
Ministry of Communication	**Sub theme 1:** Influence of the National ICT strategy on ICT adoption **Sub theme 2:** ICT implementation strategy to secure long term sustainability of ICT **Sub theme 3:** Facilitating conditions for mHealth adoption by healthcare professionals	**Sub theme 1:** Obstacles to mHealth adoption	
Mobile telecommunications operators	**Sub theme 1:** Effect of the National ICT Policy on mobile telecommunications service delivery **Sub theme 2:** Effect of the National Telecommunications	**Sub theme 1:** Obstacles to m-health adoption	

Interviewees	Themes		
	Facilitating conditions for the adoption of mHealth in Burundi (Research objective 1/Research question 2)	**Impediments to mHealth adoption (Research objective 4/research question 4)**	**Role of mHealth in achieving country's broad goals in the health sector (Research objective 3/ research question 3)**
	Regulatory Authority on mobile telecommunications service delivery **Sub theme 3:** Mobile telecommunications' infrastructure adequacy to launch mHealth initiatives **Sub theme 4:** Mobile telecommunications' infrastructure adequacy to disseminate mHealth initiatives **Sub theme 5:** Network generation supported by company **Sub theme 6:** Sustainability of mHealth initiatives **Sub theme 7:** Scalability of mHealth initiatives		

6.14. Existence of and potential for mHealth adoption in Burundi

This section discusses the types of ICTs currently in use within the public healthcare sector. The ultimate aim is to identify whether there are any mobile-enabled interventions currently run by the Ministry of Health and Fight Against Aids (MoH&A) in the following areas: health-related data collection, recording diseases, tracking disease outbreaks, education and awareness programs, remote patients' treatment and monitoring, communication with fellow health professionals, training health workers and diagnostic support according to the Wave Vital Consultant (2009) classification of mHealth capabilities (discussed in the literature) .

From the interviewees' responses, ICTs used in the public sector in Burundi can be grouped into 6 categories: 1) data collection, dissemination of healthcare-related information, tracking diseases outbreaks/spread and coordination of countrywide interventions, 2) education and awareness programs, 3) remote patients' treatment and monitoring, 4) communication with fellow healthcare professionals, 5) training health workers and 6) diagnostic support.

6.14.1. Data collection, dissemination of healthcare related information, tracking disease outbreaks/spread and coordination of countrywide interventions.

According to the interviewees from the Ministry of Health and Fight Against Aids, generally field healthcare data related to the outbreak of diseases, demographic data, and others are collected using a paper-based system. However, the current manual data collection system delays the transfer of information across various departments within the ministry. Respondent 1 said: "*currently, there is a delay in transmitting information. The different departments within the ministry get data earliest on the 15th of every month*" (MoH&A_1, interview, 2014). Once collected, data is captured into and analysed through the Health Information Management System (GESIS system). GESIS system is also used for the coordination of countrywide interventions and mapping of diseases. Currently, once data is captured into the GESIS system it is analysed and then the information generated is disseminated to the health department in charge of surveillance of the spread of diseases. Then the department uses the information to devise adequate strategies to tackle new diseases and/or epidemic outbreaks.

Respondent 2 stated:

> "*Field data is collected using paper-based system and captured through the GESIS system. Data is then analysed using GESIS. Currently the mapping of diseases is done using information generated by the system. However, a countrywide electronic health map is being drawn. This will allow mapping of diseases outbreak. GESIS data analysis is sent to the department in charge of surveillance of spread of diseases. Then the department devises adequate strategies to tackle new diseases (countrywide interventions coordination) based on data generated by GESIS. Emails, telephone calls and couriers are frequently used for countrywide interventions coordination*" (MoH&A_2, interview, 2014).

Moreover, respondents alluded to the fact that GESIS is only operational at the district or provincial level. This is may be the reason why the GESIS system was never mentioned by primary healthcare professionals in section A of this chapter. There was a plan to replace the GESIS system in 2016 by $DHIS_2$, which is a flexible, web-based open-source information system with visualisation features such as GIS, charts and pivot tables. $DHIS_2$ is meant to operate at district or provincial level.

However, there are also plans to implement two SMS-based systems for data collection purposes. These systems are the Rapid SMS[20] and Commcare-ODK[21] systems. Data collected from the two systems will be used for the coordination of countrywide interventions, recording the outbreak and spread of diseases, educational and awareness programs and for sharing information amongst various stakeholders (Appendix A).

The Rapid SMS system is at the testing stage within the maternal health program while the Commcare system is being tested within the maternal and infants' treatment programme:

Respondent 1 stated:

> "*Currently, Rapid SMS is at an experimental stage. Rapid SMS is an SMS system used as a communication medium between health workers and central decision-making body (district level, provincial level or national level). The pilot phases target maternal health specifically (expectant mothers). After the pilot phase the program is meant to be rolled up for the entire country ... [Commcare] it is a combination of rapid SMS features with extra features for sending collected information. It is currently being piloted for follow up on health conditions of expectant mothers infected by the HIV. It is designed to collect information about expectant mothers and transmit such data to a centralised database*" ($MoH\&A_1$, interview, 2014).

However, so far, emails, telephone calls, and couriers are still the dominant means of communication for countrywide interventions coordination (see Appendix A). The GESIS system only becomes useful for countrywide coordination once data collected is captured into the system.

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[20] An SMS system used as a communication medium between health workers and the central decision-making body (district, provincial, or national).

[21] A combination of rapid SMS features and extra features for sending collected information

Primary healthcare respondents confirmed (through the survey responses) that telephone calls (via mobile phones) are mainly used for communicating with fellow healthcare professionals, remote medical or health data collection, patients' treatment and monitoring and tracking diseases and epidemic outbreak. Odigie, *et al*. (2012) identified familiarity with the use of mobile phones to be a determinant of mHealth adoption. Hence, in the case of Burundi, mobile-enabled healthcare interventions (through the Rapid SMS for instance) could be attractive to PHCs as the medical personnel is used to some of the features of cellphones (such as sending and receiving SMSes).

6.14.2. Education and awareness programs

Radio and television are the most frequently used media for healthcare education and awareness programs (see Appendix A). According to respondents from the Ministry of Health and Fight and Against Aids, there is a promise that, once the Rapid SMS system is implemented, it will be used to send SMSes for healthcare education and diseases prevention purposes (respondent 1) (MoH&A_1, interview, 2014).

Primary healthcare professionals did not mention radio and television as part of the tools used for disseminating healthcare information. This stems from the fact that educational and awareness programs are generally broadcasted nationally. In addition, such programs are broadcasted only if the content is intended for a larger portion of the population beyond the areas covered by the PHCs.

6.14.3. Remote patients' treatment and monitoring

Only two hospitals use telemedicine: The private CMCK (Centre for Medical Surgery of Kinindo) hospital and the King Khaled Hospital (Public University Hospital). However, generally there is no remote treatment/follow up on patients through ICT. Respondent 2 said: "*Generally, there is no ICT used for remote treatment of or follow up on patients except the use of telemedecine by the CMCK and King Khaled hospitals. The two hospitals use telemedicine to connect with doctors from India for remote patients' treatment*" (MoH&A_2, interview, 2014). The lack of extensive use of telemedicine is not surprising. As Nyssen *et al* (2015) indicated, ICT within the health sector is hampered by lack of logistics such as lack of or poor internet connectivity and inadequate Internet bandwidth.

6.14.4. Communication with fellow healthcare professionals

The major means of communication used in this regard are cellphones and landline phones, which further supports the views of primary healthcare professionals pertaining to the extensive use of telephone calls at the primary healthcare level. However, Respondent 2 stated "*the Military Hospital of Kamenge is equipped with the Open clinic software which enables the sharing of information within the hospital"* (MoH&A$_2$, interview, 2014).

6.14.5. Training of health workers

Respondent 2 said: "*There are workshops/conferences held via teleconference. Also, there are the two hospitals that use telemedicine*." (MoH&A$_2$, interview, 2014).

6.14.6. Diagnostic support

Respondent 2 stated *"Generally, there is no ICT used for diagnostic support except in the two hospitals where telemedicine is used. In case healthcare professionals cannot diagnose a disease, they refer the patient to the district hospital or provincial hospital. They provide an ambulance. No specific ICT is used for booking or referral."* (MoH&A$_2$, interview, 2014).

6.15. Facilitating conditions for the adoption of mHealth in Burundi (Research objective 2/Research question 2)

6.15.1. Interviewee responses from the Ministry of Health and Fight Against AIDS

Figure 6.4 depicts a hierarchical model (generated from Nvivo software) based on the interviewees responses in regard to the following themes (facilitating conditions): *existence of a long term plan for ICT adoption in the health sector, existence of a strategy to secure long term sustainability of ICT in the health sector and the role played by the Ministry of Health and Government in funding ICT initiatives in the health sector.*

Respondent 1 from MoH&A indicated that there is a long term plan stipulated in the National ICT policy, although it does not address ICT needs within the health sector in detail. Thus, there is a need for a policy document that is specifically tailored to ICT needs within the health sector. In addition, there is a national strategy and planning committee that looks into the long-term sustainability of eHealth pilot projects. The national ICT policy serves as a guiding document for financing ICT initiatives. The funding model for ICT projects in the health sector is based on 20% funding from the government while 80% is mobilised through funding from various donors. This supports Nyssen *et al*. (2015) claim that ICT projects within the Burundi's health sector heavily rely on donors' funding.

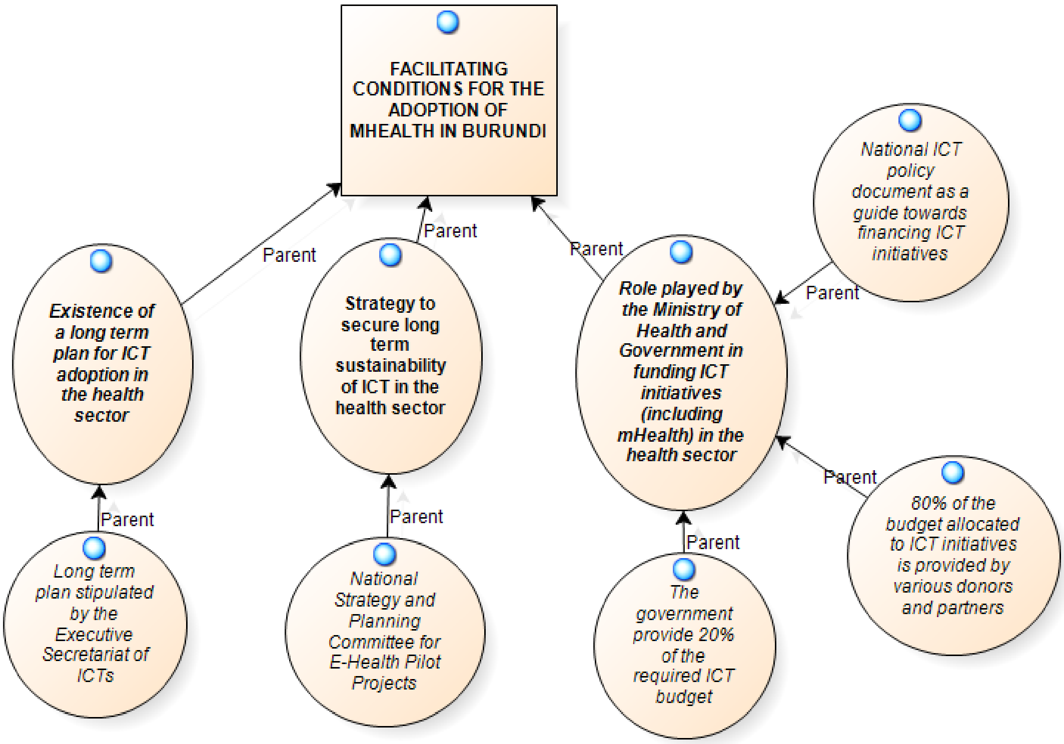

Figure 6. 3. Nvivo generated Hierarchical Model -Facilitating conditions for the adoption of mHealth in Burundi-MoH (1)

Respondent 1 indicated that that there is a need to train healthcare workers in ICT and mHealth applications use:

> *"Training of healthcare workers in ICT and mHealth applications is crucial. Many people do not even know what advanced options a cellphone can provide. ICT is a new thing for them. They do not know how to operate ICT tools (such as computer software), thus cannot figure out what additional benefits they may bring forth. Even civil servants in higher government positions do not know how to operate ICT tools"* (respondent 1) (MoH&A$_1$, interview, 2014).

In addition, respondents from the MoH&A mentioned that there is need for mHealth education and awareness programs targeted at healthcare professionals, training for mHealth devices and applications use, and making mobile devices and applications available as depicted in figure 6.4. This corroborates the fact that the researcher had to explain the concept of mHealth to respondents, as most of them were not aware of it. They also mentioned that there are initiatives in place to promote ICT and/or mHealth:

> *"There are also government-led initiatives to encourage ICT adoption nationwide: The Government of Burundi is really committed to ICT adoption. There are various ICT awareness programs such as public workshops, meetings, radio programs destined for the public sector and civil society, and information sharing workshops organised by SETIC (ICT Executive Secretariat). It has awareness programs destined also for business people. ICT adoption has become one of the main government's agenda/vision. All other sectors follow that vision which is also one of the main visions of the East African Community* (respondent 1) (MoH&A_1, interview, 2014). *The ministry in particular, sends healthcare professionals overseas for training to equip them with healthcare-related ICTs knowledge and skills"* (respondent 2) (MoH&A_2, interview, 2014).

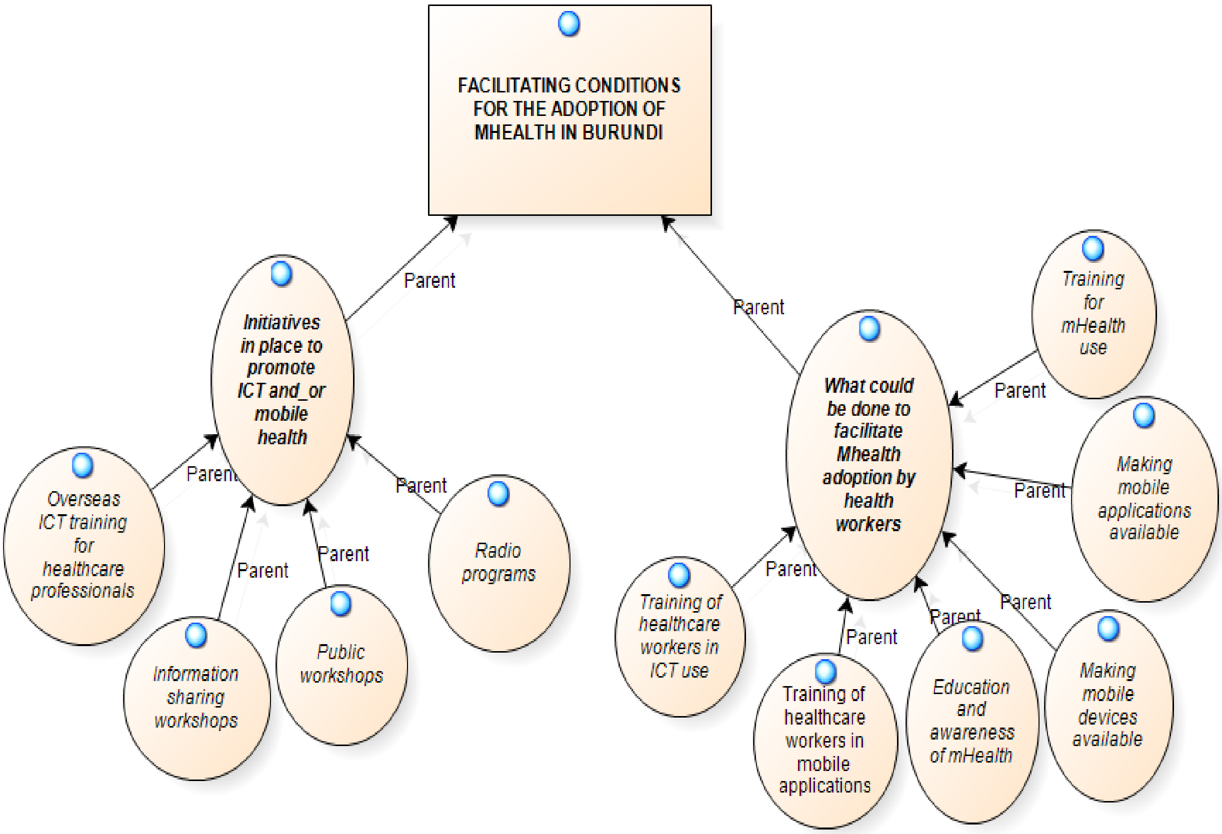

Figure 6. 3.Hierarchical Model -facilitating conditions for the adoption of mHealth in Burundi-MoH (2)

6.15.2. Interviewee responses from the Ministry of Communication

In one of its healthcare related initiatives, the Ministry of Communication through CIEP wanted to use SMS-based systems (U-report and Rapid SMS[22]) that would allow the department to get diverse health-related information (from the population) for each of their focus themes. Such information would determine the need for population training that could be devised (Ministry of Communication, interview, 2014). Thus, U-report and Rapid SMS would have helped to reveal what knowledge the population has about each theme. The themes are centred on child and maternal health. The first theme aims at disseminating information about breastfeeding; the second theme is reproduction including contraception, birth limitation; the third theme is the use of mosquito nets as prevention mechanisms against Malaria; the fourth theme is related to adherence to

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[22] **These two systems were attempts to introduce mHealth with the Ministry of Communication, however, they failed.**

good hygiene (washing hands); and the fifth one relates to infants' homecare (including treatment) (Ministry of Communication, interview, 2014). The implementation of such SMS-based systems would also enable the detection of any health-related problems within the community. Based on such information the department would then devise awareness programs. Such information would also guide the ministry on preventive and curative measures to be taken (Ministry of Communication, interview, 2014).

6.15.2.1. Influence of the National ICT strategy on ICT adoption

According to the director of CIEP, the national ICT strategy does not have an impact on the decisions taken by the Ministry of Communication. The Ministry of Communication, through CIEP, adopts adhoc strategies depending on current needs and such strategies do not need to be derived from the national ICT strategy. In addition, the Ministry of Communication does not have a specific strategy to secure the long-term sustainability of ICT and mHealth projects.

The interviewee said:

> *"For instance, the need for a timely management of healthcare-related problems triggered the need of an SMS based system (U report and Rapid SMS) for educational and awareness purposes which was meant to speed up data collection directly from the community in order to have a timely response to identified health-related problems. The traditional method of data collection is survey based. However, it is inefficient as results from surveys are only available a long time after data collection, sometimes additional problems may have occurred, thus making it difficult to devise effective strategies to counter healthcare related problems as they arise…. the Ministry does not have a strategy for sustainability of ICT led projects" (Ministry of Communication, in-depth interview, 2014)*

6.15.2.2. What could be done to make it easier for health professionals to adopt mHealth? (Facilitating conditions for mHealth adoption by healthcare professionals)

The interviewee said:

> *"There is a need for a multisectoral approach towards mHealth adoption. Such approach should be defined in a policy that includes all stakeholders including the Ministry of Health, Ministry of Communication, districts administration, and central administration."* (Ministry of Communication, interview, 2014). The quest for a multisectoral approach to mHealth adoption in Burundi is a very important point, as mHealth implementation has proved to succeed through partnerships (VanderKop, et al., 2012; Chang, et al., 2011).

The facilitating conditions from the Ministry of Communication point of view are summarised in figure 6.4.

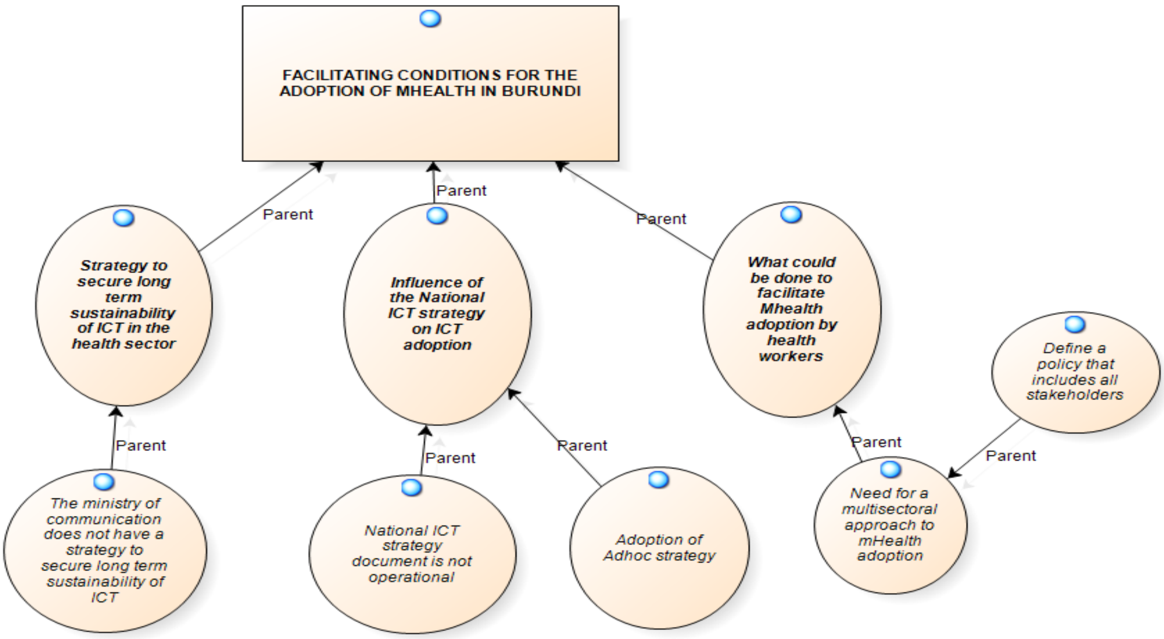

Figure 6. 4. Facilitating conditions-Ministry of Communication

6.15.3. Interviewee responses from mobile telecommunications operators

6.15.3.1. Effect of the national ICT Policy on mobile telecommunications service delivery

Mobile telecommunications operators indicated that the national ICT policy has a positive influence on mobile telecommunications service delivery in the following areas: quality of services provided, number of services provided, tariff and cost of mobile communication and conception of technological innovations as depicted in figure 6.5. None of the respondents mentioned any negative impact.

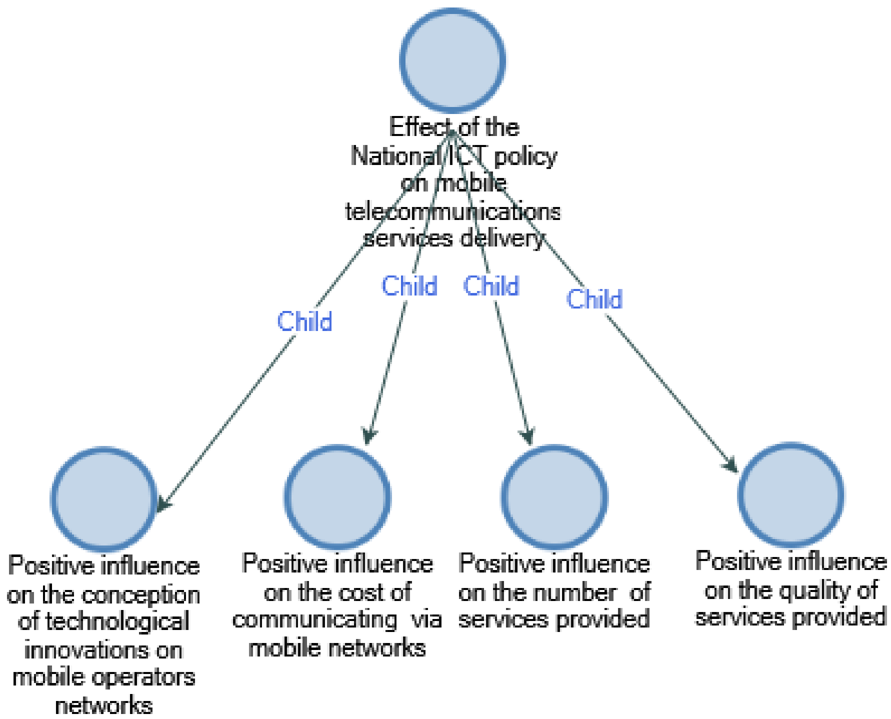

Figure 6. 5. Effect of the National ICT policy on mobile telecommunications service delivery

6.15.3.2. Effect of the National Telecommunications Regulatory Authority (ARCT) on mobile telecommunications service delivery

Generally, the effect of the National ICT Regulatory Authority on mobile telecommunications services delivery was assessed to be negative as depicted in figure 6.6 Mobile telecommunications services delivery is negatively influenced by the National ICT Regulatory Authority in terms of conception of technological innovations on the company's network. In this regard, respondent B mentioned: "*the National ICT Regulatory Authority directives have a negative influence on the conception of technological innovations on the company's network due to license fees that need to be paid*" (mobile telecommunications operator B, interview, 2014). As alluded to by Piper

(2016), in Burundi, licence fees are generally determined based on the services provided by the mobile operator. Therefore, this could hinder efforts towards the operators' innovations' expansions. The national ICT Regulatory Authority directives have a negative influence on the quality of services provided as *"quotas and taxes are imposed on services provided"* (mobile telecommunications operator B, interview, 2014). In addition, the directives have a negative effect on the number of telecommunications services provided to the public (mobile telecommunications operator B and mobile telecommunications operator C, interview, 2014), cost of mobile communication charges (mobile telecommunications operator D, interview, 2014) and on the dissemination of technological innovations on the company's network (mobile telecommunications operator B and Mobile telecommunications operator C, interview, 2014). Particularly, the negative perception of the cost of mobile communication charges may be due to the fact that mobile telecommunications have to pay numerous taxes (Piper, 2016), which then spills over to mobile cellphone users. Hence, potential mobile cellphone users may not be able to afford the costs associated with owning a phone (such as making calls), thus limiting the number of mobile network subscribers. Moreover, frequent policy changes within the Regulator makes the telecommunications industry unstable (Mobile telecommunications operator A, interview, 2014). However, contrary to mobile telecommunications operator D, the directives have a positive effect on the cost of mobile communication as "*prices charged by telecommunications companies are regulated by the regulator which ensures that citizens are not overcharged*" (mobile telecommunications operator A, interview, 2014). The regulator also limits unfair competition practices: *"because the ARCT regulates the cost of mobile communication charges, it ensures that there is no unfair competition practices from existing and upcoming mobile telecommunications operators"* (Mobile telecommunications operator B, interview, 2014).

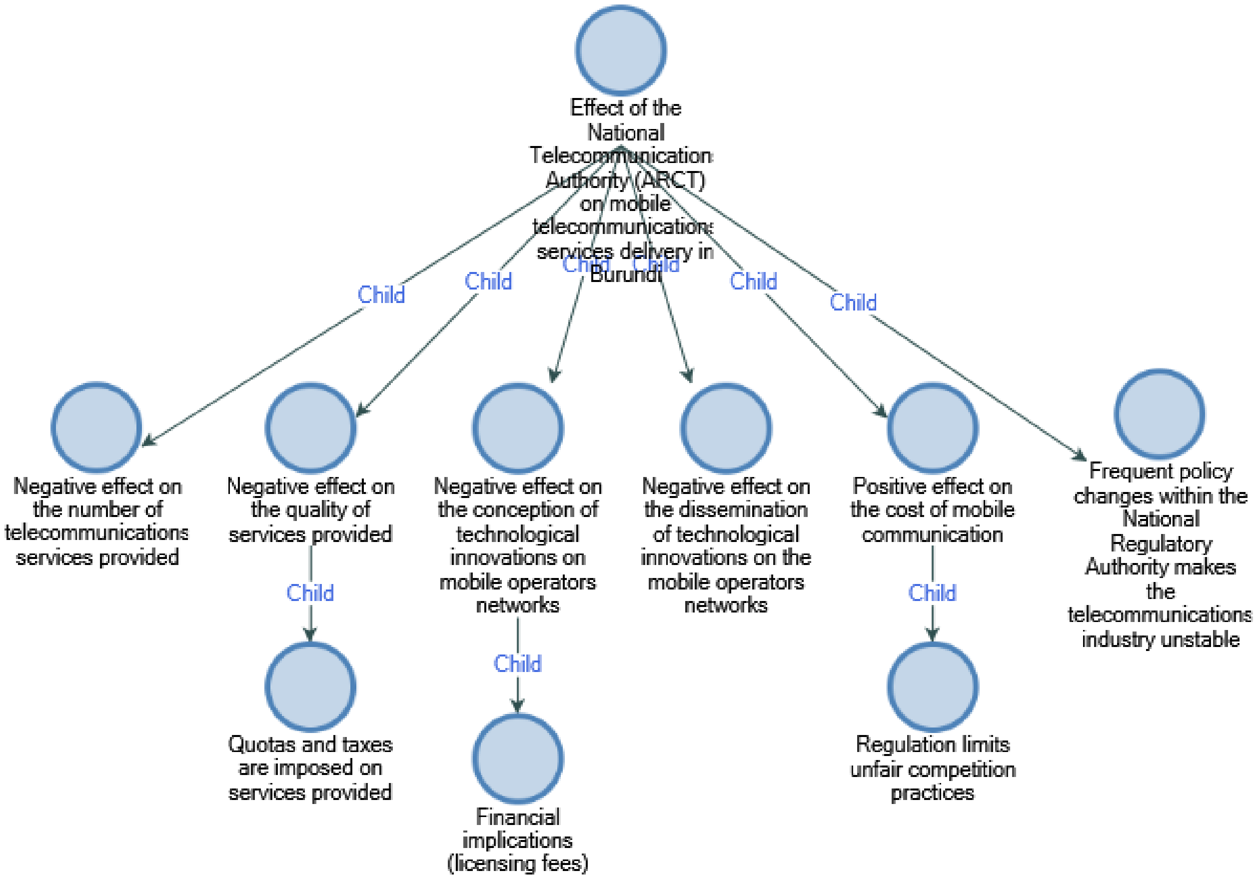

Figure 6. 6. Effect of the National Telecommunications Regulatory Authority on mobile telecommunications service delivery

6.15.3.3. Mobile telecommunications' infrastructure adequacy to launch and disseminate mHealth initiatives

Most of the respondents (3 out of the 4 respondents) indicated that their companies have adequate infrastructure to launch mHealth initiatives[23]. However, only 2 out the 3 indicated that their company's infrastructure is sufficiently adequate to disseminate mHealth initiatives[24]. Respondent A mentioned: "*Our Company's infrastructure is adequate enough to disseminate mHealth initiatives throughout the whole country. Our company's telecommunications network covers three quarter of Burundi's territory.*" (Mobile telecommunications Operator A, interview, 2014) while respondent D

[23] In this case, launching mHealth depicts a short-term dispensation of mHealth initiatives just like in the case of a pilot project.
[24] Disseminating mHealth initiatives imply scaling mobile health interventions, which largely depends on how far (the country's area/territory) the company's network covers and how reliable it is.

mentioned: "*Our Company's infrastructure is adequate enough to disseminate mHealth initiatives throughout the whole country*"

However, only one telecommunications company supports the fourth generation of mobile Internet broadband (4G). Two other mobile telecommunications company indicated that their networks support up to the second generation of mobile Internet broadband (2G). The remaining company supports up to the third generation of mobile Internet broadband (3G). The two mobile telecommunications companies whose networks support up to the second generation (2G) are operating on a narrow band digital network (Univercell, 2012). Hence, video transmission over their networks is very limited. This further reduces their capabilities to provide real time, video-supported mHealth interventions.

6.15.3.4. Sustainability of mHealth initiatives

Similar to the MOH&A$_1$ interviewee response, the need for mHealth awareness programs was mentioned by mobile telecommunications operators. Mobile telecommunications operator C said: *"there is need to make people aware of mobile phone-led innovations and other data-related innovations through various educational programs"* (mobile telecommunications operator C, interview, 2014). The inclusion of the Ministry of Communication in the initiation of mHealth initiatives was also expressed: *"as part of the Ministry of Health and AIDS sectorial policies, mHealth initiatives should be initiated and supported by the Government in conjunction with the Ministry of Information, Communication, and Technology"* (Mobile telecommunications operator D, interview, 2014). Furthermore, active participation of mobile telecommunications operators in mHealth initiatives was also suggested: *"Mobile telecommunications operators should be urged to include mHealth initiatives as part of their social/community initiatives"* (Mobile telecommunications operator D, interview, 2014). This further re-emphasizes the need for a multiskateholder approach to mHealth adoption in Burundi.

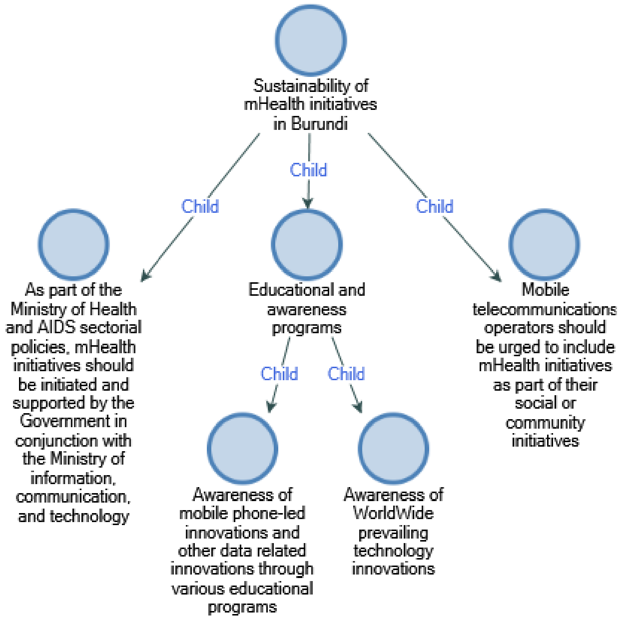

Figure 6. 7.Sustainability of mHealth initiatives in Burundi

6.15.3.5. Scalability of mHealth initiatives

To ensure the scalability of mHealth initiatives, mobile operators mentioned the need for audio and visual programs:

> "*There is need for audio and visual awareness campaigns because most of the time third world population lacks knowledge and information* (mobile telecommunications operator C, in-depth interview, 2014)*. Awareness campaigns should be spearheaded by the government in conjunction with Mobile telecommunications operators. Such campaigns should emphasize the need and benefits of mHealth within the Burundi's context* (mobile telecommunications operator D, in-depth interview, 2014). *Radio programs should be initiated to make people aware of the need to have a cellphone and the benefits or receiving healthcare related SMSs notifications*" (mobile telecommunications operator D, interview, 2014). Outreach through radio broadcasting is a good suggestion as most of Burundians consider it as their major source of information (IMS, 2015).

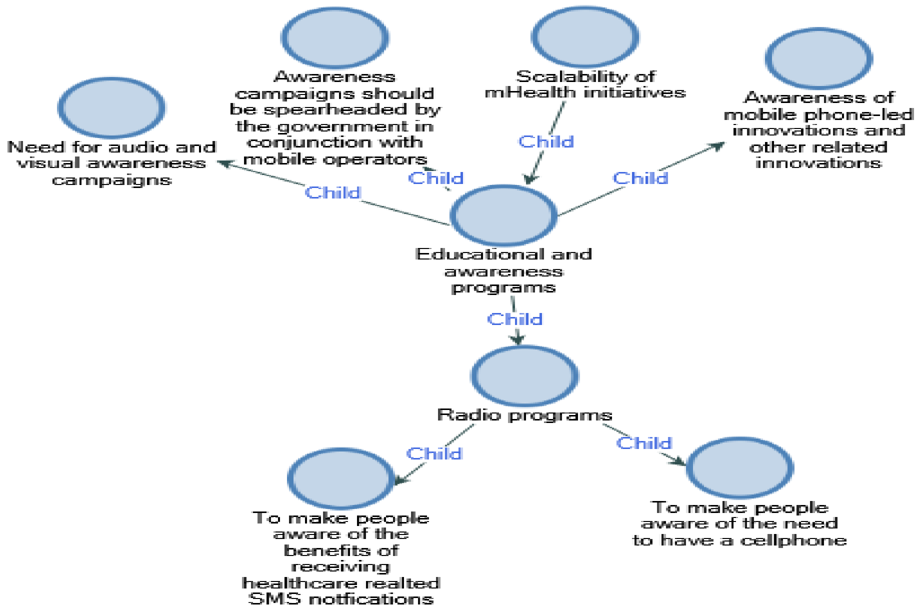

Figure 6. 8. Scalability of mHealth initiatives in Burundi

6.16. Role of mHealth in achieving country's broad goals in the health sector (Research objective 3/research question 3)

6.16.1. Advantages of adopting mHealth (Ministry of Health and Fight Against AIDS)

According to respondent 1 from MoH&A, the Ministry of Health currently experiences a delay in the flow of information across various departments. In addition, real time access to data is an issue. Thus, it is perceived that mHealth would help alleviate such shortfalls. Real time access to data will allow the ministry to respondent quickly to emergencies. MHealth also presents an opportunity for remote medical treatment. Respondent 1 said:

> "*There are a lot of advantages. Currently, there is a delay in transmitting information. The different departments within the ministry get data earliest on the 15th of every month. There will be a speed of health-related data transmission and perhaps reliability of data should the SMS based system be implemented. In addition, such system will enable speedy response to emergencies. Also there would be online training through sharing of information, medical treatment can be provided via mhealth, thus saving lives. The country will also be known globally as the system extends to sharing information with outsiders. MHealth also makes it easier to disseminate information, send online reports, online*

> *funds management, and online management. For instance, in 2014 there was a shortage of blood containers (which made it impossible to collect and transfuse blood). If we had an online management system, every stakeholder in blood transfusion would be aware of the stock levels and perhaps such problem would have been averted. The problem occurred due to lack of shared information. Vital information (such as the stock levels) was kept by a single department, thus other stakeholders were not aware of such problem which ended in such a situation (*MoH&A, interview, 2014*).* Although mHealth has proved to enhance real time access to information, long-term sustainability of such a system needs to be addressed. In the Burundi's case, as Nyssen (2015) mentioned, ICT deployment in the health sector heavily relies on donor funding. There is a need for funding mechanisms (for example through partnerships) at the local level that will guarantee the long-term sustainability of mHealth interventions. Such funding should address maintenance issues to avoid the same prevailing scenario of underperforming systems in the Burundi's healthcare sector (Nyssen *et. al*., 2015).

Respondent 2 alluded to the fact that wide accessibility of mobile cellphones compared to computers and other media is one of the advantages of mHealth:

> *"One of the advantages of mHealth is that it uses cellphones which are widely accessible compared to computers and other media*" (MoH&A, interview, 2014). However, the costs of maintain a cellphone network subscription (such as buying airtime and data) needs to be determined. The aim should be to find ways mHealth could have a wider impact with minimal costs or no costs to the beneficiary.

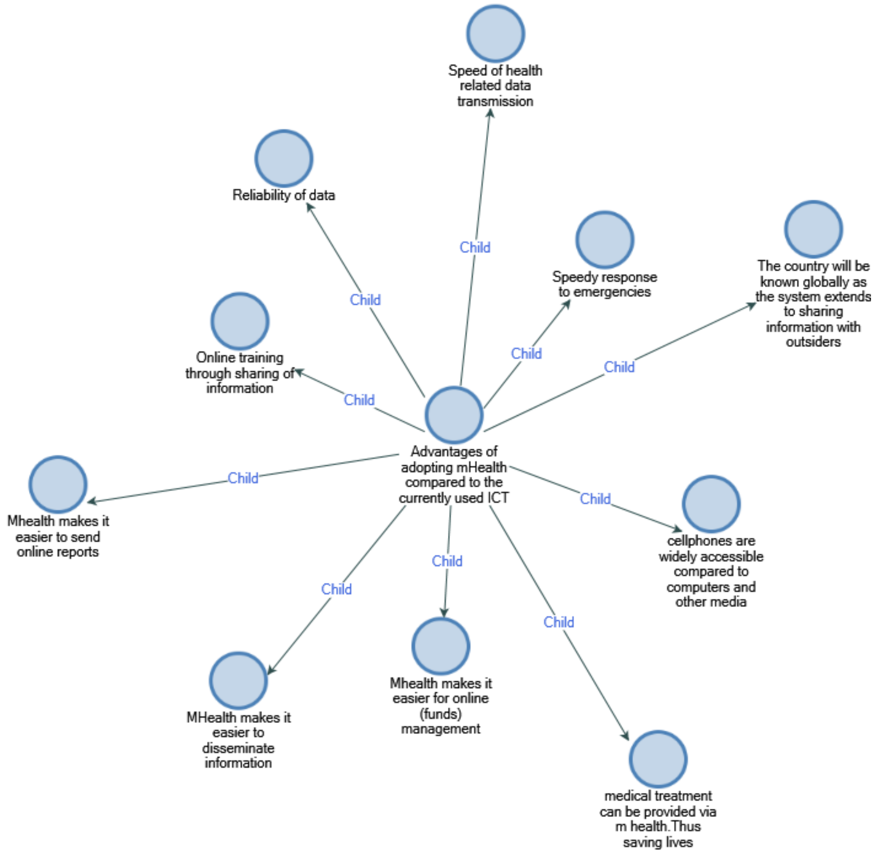

Figure 6. 9. Advantages of adopting mHealth (Ministry of Health and Fight against AIDS)

6.17. Impediments to ICT and mHealth adoption (Research objective 4/research question 4)

6.17.1. Ministry of Health and Fight Against AIDS

From the Ministry of Health, respondent 1 mentioned the following as impediments to ICT and mHealth adoption in Burundi: lack of nationwide common standards, low level of ICT expertise from the CBHWs, lack of clear ICT policy within the Ministry of Health, donor funding issues, a need for additional funding to overcome new obstacles that are likely to emerge during the pilot phases as impediments to mHealth adoption (MoH&A, interview, 2014). In addition, a scarcity of ICT skills, expensive ICT equipment, the unreliable electricity supply and Internet connection were cited as impediments to ICT adoption in Burundi.

> *"There is scarcity of ICT skills in the country and ICT equipment is currently expensive. There are also issues pertaining to budget and donors/partners funding. There are donors but they have their own pre-conceived objectives that they want to achieve and own perspectives on how ICT should be*

implemented in Burundi. Also, there is no clear ICT policy within the Ministry of Health (there is only one national ICT policy document which does not address fully the needs within the Ministry of Health). However, the ICT policy for the Ministry of Health is being drafted which will give a clear direction as to how ICT would support the implementation of healthcare related initiatives (MoH&A, respondent 1, interview, 2014). Similarly, Nyssen *et al*. (2015) also identified lack of ICT skills as one of the causes of underperforming healthcare systems in Burundi. Donors' funding issues maybe due to the fact that, as alluded to by respondent 1 in section 6.15.1, ICT implementation in the health sector rely heavily on donors funding (up to 80%), which may explain donors' tight control over how ICT-led interventions should be implemented.

In addition, respondent 1 indicated that*: "concerning mHealth projects implementation, the start-up phase is always difficult. For instance, concerning rapid SMS, many donors had agreed to sponsor the project but still the start was delayed notwithstanding many meetings that they had with the health ministry personnel. Although they (donors) understood the value of such system, they seemed hesitant to inject their monies, as this kind of ICT is a new approach for many stakeholders. It seems as if donors were seeking expert advice on how to invest their monies wisely into the venture. All these initiatives are at the testing or discussion stage"* (MoH&A, respondent 1, interview, 2014). The cautious approach towards mHealth funding is not surprising. As mHealth is a new concept within the Burundi's healthcare system, investors would want to ensure that the Return on Investment (monetary and otherwise) is worth the efforts towards the investment. Kochi (2013) argues that an impact evaluation of mHealth projects is an avenue for further funding for the projects. It is anticipated that an evaluation of the success and/or failure of currently piloted mHealth systems will inform better, improved ways of mHealth systems implementation in the country. This in turn will inform which areas of mHealth implementation investments should prioritize.

The respondent further said: *"Obstacles are being discovered as meetings are being held with various stakeholders. For instance, in one of the workshops that were held, it was discovered that there is a need for nationwide common standards (for e.g. "appellation" or naming conventions). Thus, it was discovered there is a need for more workshops in order to reach common standards. This delays the process of implementing ICT and further necessitates additional budget (which has to be renegotiated) and materials (as it is a new field within the Burundi's health sector). This makes room for slow adoption of ICT. MHealth is a new field within the Burundi's health sector. Thus, as Burundi moves gradually towards the implementation it is only then that obstacles are discovered. However, such obstacles can be overcome but this implies additional funds have to be sought and approved by potential donors. Unreliable electricity supply and Internet connection are additional impediments to ICT implementation in Burundi"* (MoH&A, respondent 1, interview, 2014). This further validates the need to invest in mHealth projects' evaluation to identify and address the obstacles towards effective and efficient use of mobile health interventions.

Moreover, respondent 1 indicated: *"in addition, one of the obstacles is the level of ICT expertise from the Community-Based Health Workers (CBHWs). These are the agents that the ministry wants to target in terms of mHealth adoption. Thus, they have to be given some training. In addition, electricity connection is unreliable. Thus, there is no guarantee that cellphones batteries will be charged at the desired time. There is a possibility that data may not reach its destination timeously if cellphones batteries are empty and not charged"* (MoH&A, respondent 1, interview, 2014). This corroborates Nyssen *et al*. (2015) argument of prevalence of electricity supply shortage throughout the whole country.

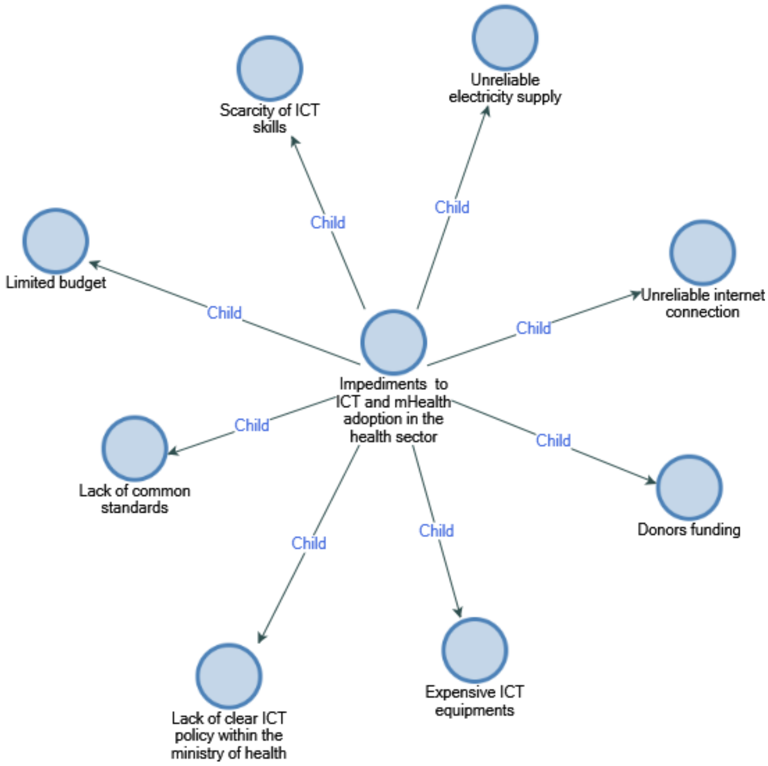

Figure 6. 10. Impediments to ICT and mHealth adoption in Burundi (MoH&A)

6.17.2. Ministry of Communication

At the Ministry of Communication, the respondent mentioned the lack of funds, lack of political will, fear that mHealth could be used for political propaganda and negligence from respondents to pilot phases as impediments to mHealth adoption in Burundi (Ministry of Communication respondent, interview, 2014).

> *"At some point, the ministry was involved in the feasibility analysis of implementing U report and Rapid SMS systems. The systems were designed to send health-related information by SMS and collect information from the community, then analyse (or treat) the information and to make it available to the relevant people. Rapid SMS was actually copied from Rwanda. Rapid SMS is actually designed for Health workers. However, U-report interacts with people within the community. The reasons for the failure of U report and Rapid SMS implementation were lack of funds and also lack of political will to further such venture. There was also fear that such system could be used to advance political agendas or political propaganda especially in the period of pre-elections. Thus, there was fear that such system could be used for mass*

mobilisation not for health-related initiatives but for political purposes" (Ministry of Communication respondent, interview, 2014). In the context of Burundi, the fear that mHealth interventions could be used for something else rather than its intended purpose further highlight the need for partnerships with the local or national government in the design and implementation of mHealth systems. Collaborating with the local administration is an avenue to collectively address any concerns in order to build trust between the beneficiaries of the system and the system functionality.

"In addition, donors had their own ways of thinking in terms of how the system will be designed which was in contradiction with the local Ministry of Communication. This generated a sort of apathy towards the systems. The project was initially sponsored by UNICEF. UNICEF is still experimenting possible ways to use such system for sanitation programs" (Ministry of Communication respondent, interview, 2014). Similarly, the clash between donors and the local administration was highlighted in section 6.17.1 by respondent 1 from the Ministry of Health.

"One of the obstacles is that the respondents to the mHealth based SMSs are not truthful or do not take their responses seriously (i.e. are negligent). Thus, some data that were collected during the testing of the U report and Rapid SMS systems were erroneous. There is a need to inform and train people (especially those susceptible to respond). However, the department is limited by lack of budget for such initiatives. There is also a need to identify serious people that will identify community problems and report them as they are. There is a need to explain to the community (potential respondents) of the advantages and opportunities that such system will present. Sometimes respondents are youth. Thus, there is a need to educate and make them aware of the goodness of such as system." (Ministry of Communication respondent, interview, 2014). This further emphasizes the need for awareness programs (that includes training on mHealth capabilities) as alluded by

previous respondents. The need for training was also mentioned by the respondents from the Primary Healthcare Centres.

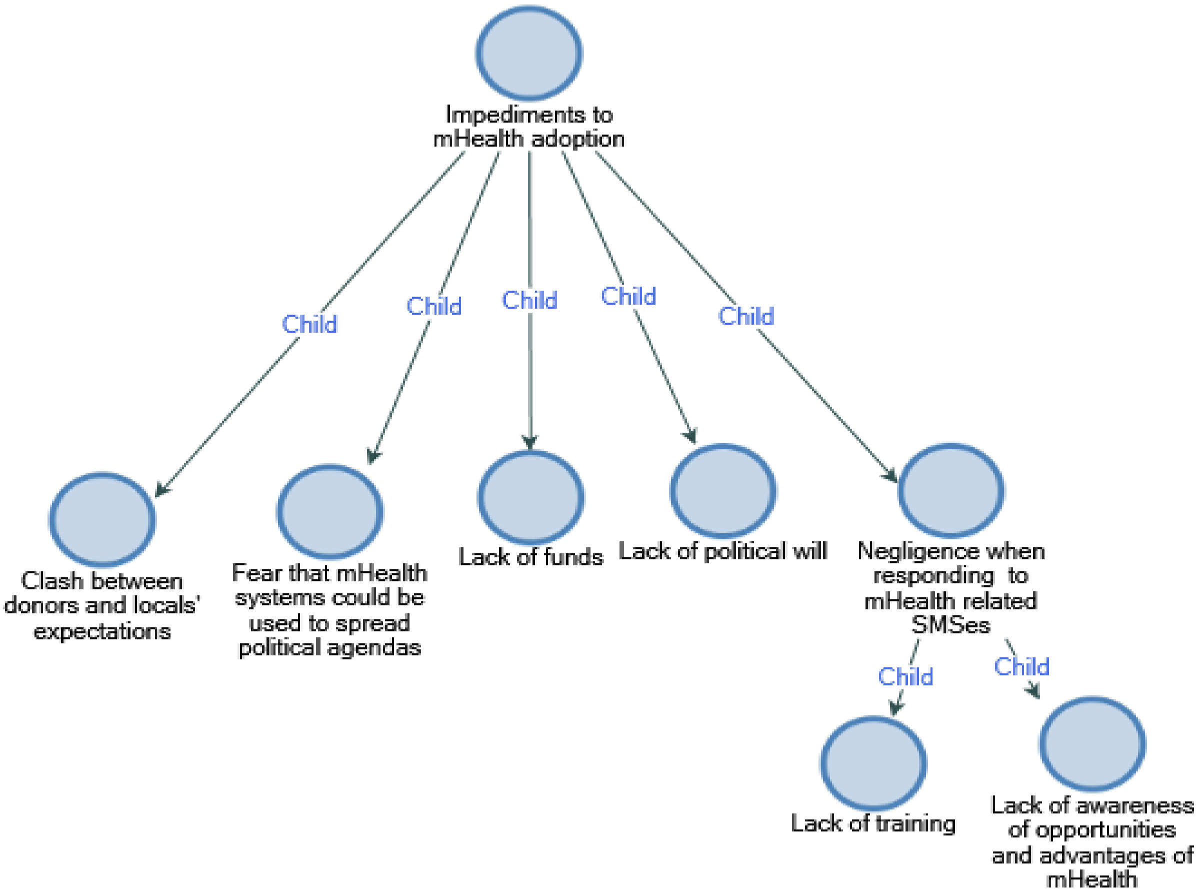

Figure 6. 11. Impediments of mHealth adoption in Burundi (Ministry of Communication)

6.17.3. Mobile telecommunications operators

As depicted is figure 6.12, low electricity penetration, resistance to learning, lack of skills to develop mHealth applications, low disposable income, high cost of mobile Internet bundles, low rate of cellphone penetration, low rate of other mobile devices (excluding cellphones) penetration, unreliable network coverage in rural areas, high cost of network connection airtime, resistance to change, the economic environment, unfamiliarity with ICT innovations, illiteracy rate are impediments that were mentioned by mobile operators.

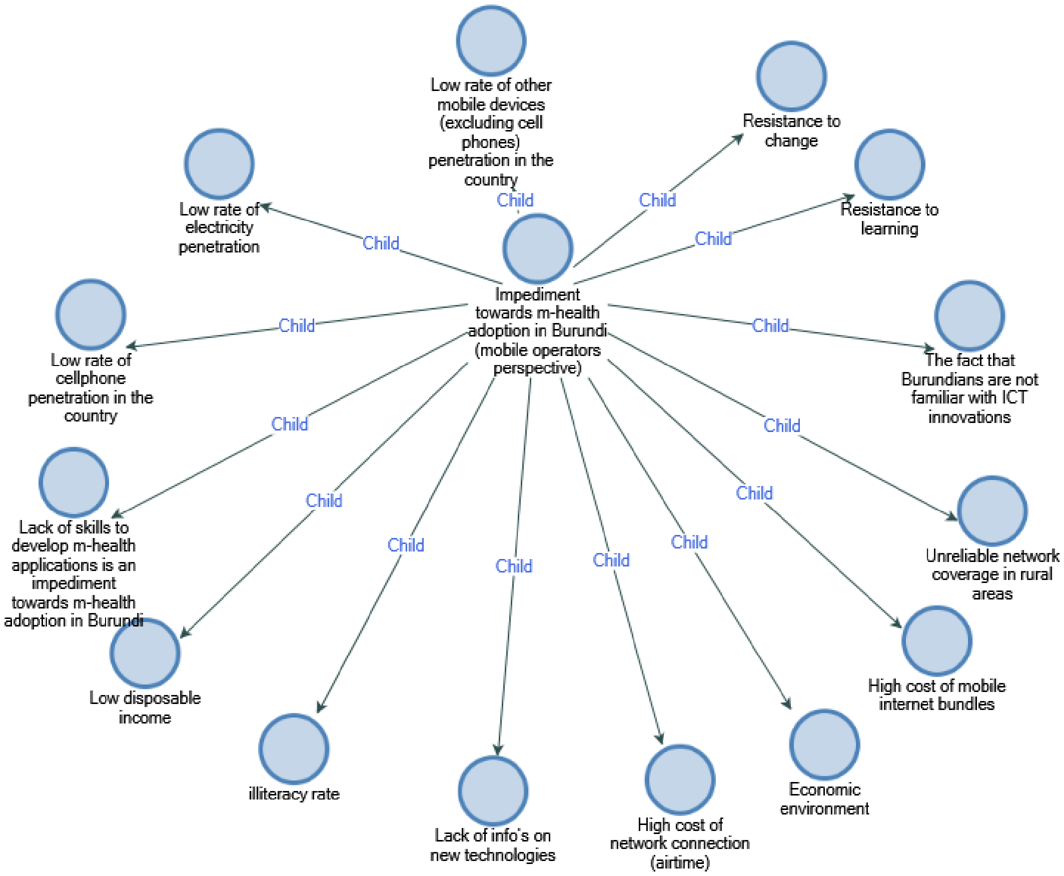

Figure 6. 12. Impediments to mHealth adoption in Burundi (Mobile operators)

Some of these impediments were already identified in the literature. Regarding the low electricity penetration, even in places where there is electricity supply in the country, frequent power outages were mentioned by Nyssen *et al* (2015) while Ngabo et al., (2012) argue that reliable electricity supply is an important determinant to mHealth adoption. The Executive Secretary of SETIC (mentioned earlier in the literature), identified low purchasing power, illiteracy rate and the recurring electricity shortage as a hindrance to regular access, availability and continuity of ICT services in Burundi (Iwacu, 2014). However, the current government's efforts to eradicate illiteracy are positive signs that, in the future more Burundians will be equipped with basic reading and writing skills, hence benefit from text-based mHealth interventions. The low rate of cellphone and other mobile devices penetration, the perceived high cost of mobile Internet bundles, the perceived high cost of network connection airtime and the perceived hindrances emanating from the economic environment may be due to the low purchasing power of most Burundians. This is quite understandable as the country heavily rely on foreign aid (CIA, 2016) and is one of the poorest in the world (AFP, 2016). Similar to mobile telecommunications operators' finding, primary healthcare professionals previously mentioned lack of skills to develop mHealth applications as a hindrance to mHealth adoption. As mHealth is a new concept in Burundi, resistance to change and learning towards adopting it is expected. Hence, change management programs need to be instigated to facilitate the transition from the traditional ways of healthcare delivery to mHealth-enabled interventions.

6.18. Summary of Chapter 6

The chapter reported the analysis and findings from data collected through the survey and interviews. Overall, the Cronbach's alpha coefficient revealed high internal consistency in the questionnaire items. Descriptive statistics reveal that male respondents were predominant in all designations (nurses, lab technicians, provincial health technicians and supervisors) across the five surveyed provinces. Interviewees were also predominantly male. The analysis portrayed that mobile phones are more used by healthcare professionals at work compared to other ICT tools such as computers and Internet. More specifically, cellphones are mainly used to make calls for the purpose of communicating with fellow healthcare professionals, remote medical or health data collection, patients' treatment and monitoring and tracking diseases and epidemic outbreak. The chapter also highlighted that at the primary healthcare level, paper forms are used for remote medical/health data collection and flowcharts are used for diagnostic and treatment support. The manual data collection was further confirmed by interviewees from the Ministry of Health who further indicated plans to implement two mHealth systems (Rapid SMS and Commcare) primarily for data collection purposes and subsequently for coordination of countrywide interventions, diseases monitoring, educational/awareness and sharing of information. The interviewee from the Ministry of Communication indicated that there was an attempt to implement a U report and a Rapid SMS system within the Ministry of Communication. However, such attempt failed for reasons pertaining to clash between donors' and locals' expectations and lack of trust in the system and who will control the system. It is proposed that the Ministry of Health learn from such failure so that the same scenario will not repeat itself for the proposed systems implementation within the ministry.

A small number of healthcare professionals use their cellphones for searching for medical information, booking an appointment with a patient, and sending medical information to patients via SMS. In addition, most of the healthcare professionals do not own any other mobile device except their cellphones. Inferential statistics reveal that complexity variables (taken as a whole) do not influence the adoption of mHealth in Burundi, while DOI-relative advantage, DOI-compatibility, DOI-trialability, DOI-observability, UTAUT-effort expectancy, UTAUT-performance expectancy and UTAUT-facilitating conditions are significant predictors of healthcare professionals' mHealth adoption. Additionally, interviewees from the Ministry of Health, Ministry of Communication and mobile telecommunications' companies highlighted the existing and required facilitating conditions for the adoption of mHealth in Burundi. While generally, healthcare professionals demonstrated willingness to learn how to use mobile devices and mHealth applications to provide healthcare services, the statistics revealed the importance for training in order to get acquainted with mHealth technologies. Moreover, it was established that mHealth can contribute to disease prevention, management and quality of healthcare services in Burundi (from healthcare professionals' point of view). Additionally, mHealth will make it easier to disseminate information, send online reports, and manage funds online (this is based on the interviewees responses). In addition, speedy response to emergencies, reliability of data, online training and making the country known through sharing of information with the rest of the world were further identified as potential benefits of mHealth within the context of the country (interviewees). Importantly, impediments to mHealth adoption such as lack of skills, high cost of mobile devices, low rate of cellphone penetration, unreliable network coverage and high cost of network connection do not negatively affect the adoption of mHealth. However, further impediments were identified through the interviews (Ministry of Health, Ministry of Communication and Mobile telecommunications) and reported in this chapter. These are lack of common standards, limited budget, scarcity of ICT skills, unreliable electricity supply, unreliable Internet connection, donor funding issues, expensive ICT equipment, and lack of clear ICT policy within the Ministry of Health (Ministry of Health). Additional impediments include clash between donors' and locals' expectations, fear that mHealth (i.e. the devices and networks through which mHealth interventions are carried) could be used to spread political agendas, lack of political will, negligence when responding to mHealth-related SMSes (Ministry of Communication). Furthermore, impediments from the mobile telecommunications' perspective are: illiteracy rate, low disposable income, lack of information on new technologies, unfamiliarity with ICT innovations, resistance to change, resistance to learning, low rate of electricity penetration, low rate of cellphone penetration, low rate of other mobile devices except cellphones, lack of skills to develop mHealth applications, high cost of network connection, economic environment, high costs of mobile bundles, unreliable network coverage in rural areas (mobile telecommunications companies).

The findings reported in this chapter are further discussed in Chapter 7.

CHAPTER 7: DISCUSSION

7.1. Introduction

Chapter 7 discusses the findings from the previous chapter. Firstly, a recap of findings pertaining to the state of ICT use for public healthcare in Burundi is presented. Then, a discussion of the study's findings that answer the research questions is presented including their interpretations and practical recommendations.

7.2. State of ICT use for public healthcare in Burundi

Nyssen, *et al*. (2015) state that paper-based instruments remain predominant in Burundi's health administration. Although the Ministry of Health and Fight Against AIDS (MoH&A) has a Health Information Management System (GESIS) installed at the district and provincial offices for data capture and analysis, field data collection is still done using paper forms ($MoH\&A_1$, interview, 2014)[25]. The output from GESIS is then transmitted to relevant departments through emails or couriers. The output is also used for tracking diseases outbreaks/spread and for countrywide interventions coordination ($MoH\&A_1$, interview, 2014). However, the current paper-based data collection is not efficient for disease prevention and management. Reports from health facilities at district and provincial level reach the central health administration in the capital city on the 15th of each month at the earliest ($MoH\&A_1$, interview, 2014). Thus, lack of real-time data collection and access hinders efforts to respond promptly to disease outbreaks and innate prevention. The 2014 case of a shortage of blood for urgent transfusion, as highlighted by one of the respondents, depicts an urgent need for devising systems that cater for timely access and sharing of data within the Ministry of Health in Burundi.

Radio and television are the main channels that the MoH&A uses for countrywide educational and awareness programs ($MoH\&A_1$, interview, 2014). This is quite understandable as radio broadcasting is the main source from which most of the Burundi's population (90%) draw information (IMS, 2015). The number of people getting news from the radio is increasing. There are a growing number of citizens who use their cellphones as Frequency Modulator (FM) receivers (IMS, 2015). However, television sets are not easily accessible to most of Burundi's population due to their

[25] MoH_1 refers to respondent 1 from the Ministry of Health and Fight against AIDS (MoH&A)

high cost (IMS, 2015). Hence, information transmitted through television broadcasting is mainly accessible to people in urban areas. At the primary healthcare level, 59.4% of healthcare professionals indicated that the image box is the main method that they use for educational and awareness programs at their respective primary healthcare centres (table 6.5 in the previous chapter). During educational sessions, an image box is used to display images illustrating the contents of the topic covered by the instructor.

Telemedicine is used by two hospitals, a private hospital (CMCK) and a public hospital (the Public University Hospital). In these two hospitals, telemedicine is used for remote patients' treatment, training of health workers and diagnostic support. In addition, there are workshops and conferences held via teleconferences for healthcare training purposes. Moreover, countrywide, cellphones and landline phones are the major means of communication amongst fellow healthcare professionals.

Table 6.5 in the previous chapter indicates that cellphones are mostly used at work by primary healthcare professionals to make calls for the purposes of communicating with fellow healthcare professionals (89.3%), remote medical, or health data collection (63.7%), patients' treatment and monitoring (42.5%) and tracking diseases and epidemic outbreaks (40.1%). Hence, mHealth applications are not used by primary healthcare professionals in the public sector to provide healthcare services in Burundi. This study confirms Nyssen's *et al.* (2015) assertion that the use of mHealth applications in the Burundi's sector is quasi non-existent with the exception of the Rapid SMS system and Commcare currently in pilot phase. In addition, as portrayed in figure 6.2 in the previous chapter, cellphones are seldom used to book an appointment with patients (22.5%) and SMSes are rarely used to sending medical information to patients (16.1%). Other ICT tools such as laptop, desktop computers, Internet, and wireless are seldom used at the primary healthcare level.

Cole-Lewis and Kershaw indicate that the ease of use of and the public interest in mobile text messaging, coupled with low cost of SMSes are reasons for the wide use of SMSes. Text messages delivered through mobile phones bridge the communication gap in the health sector between health workers and patients, different managerial levels, and between Ministry of Health and facilities in the peripheral areas (Hoffman, *et al*., 2010; Pop-Eleches, *et al*., 2011; Lester, *et al*., 2010). Vital Wave Consulting (2009) also argues that while radio and television can be used as a medium for public health education services, SMSes are better than these media, if one considers their cost effectiveness, scalability, and convenience (for mobile phone users). Thus, mHealth interventions that leverage the text messaging platform are more likely to reach a wider population base than other mobile-enabled capabilities (Marshall, *et al*., 2013). Radio and television offer a one-way channel to convey health-related information while cellphones are two-way communication media that enable people to inquire and make informed health-related decisions anonymously and/or in a manner that respects their privacy (Vital Wave Consulting, 2009). Anonymity and privacy are cited as key success factors for mobile-led interventions in cases where confidential health information such as one's HIV or TB status has to be revealed (Mukund and Murray, 2010; Bakshi, *et al*., 2011; Zurovac, *et al*., 2012). Countrywide, although the literacy rate is an important factor that needs to be considered in the adoption of text-based mobile-led interventions, text messaging still has the potential for broad reach. In developing countries, research has found that when an illiterate person receives a text message, he/she tends to seek help from family or friends in order to decode the message (Siedner, *et al*., 2012). In the context of text-based mHealth adoption in Burundi, this kind of message sharing may lead to the wider spread of educational and awareness messages. However, this can only be useful and safe in the context of broad, text-based awareness messages that do not divulge private information of the intended recipients.

Gagnon, *et al*. (2016) argue that the success of mHealth depends largely on its acceptance by healthcare professionals. The following sections discuss the findings from this research. An emphasis is placed on mHealth adoption by healthcare professionals in Burundi.

7.3.Problem statement, main research questions and sub questions

The problem statement that guides this study is formulated as follows: **The potential use of mobile communications for enhancing public healthcare in Burundi has not been investigated**. This statement leads to the following main research question: **What is needed to adopt mobile health (mHealth) for healthcare services delivery in Burundi?**

Subsequent research questions that derive from the main research question and their corresponding research objectives are as follows:

Research objective 1: To assess healthcare professionals' readiness to adopt mHealth

Research question 1: What are health professionals' perceptions of the use of mobile health to provide healthcare services?

- To what extent are healthcare professionals at the Primary Healthcare Centres (PHCs) willing to adopt mHealth? (1a)
- To what extent do healthcare professionals at the PHCs know about mHealth? (1b)

Research objective 2: To identify the determinants of mHealth adoption

Research question 2: What are the determining factors for mHealth adoption in Burundi?

Research objective 3: To identify potential contribution of mHealth interventions in achieving the country's broad goals in the health sector

Research question 3: What potential role can mHealth play in combating diseases in Burundi?

- What is the perceived mHealth contribution to disease prevention in Burundi? (3a)
- What is the perceived mHealth contribution to disease management in Burundi (3b)
- What is the perceived mHealth contribution to quality of healthcare services in Burundi? (3c)

Research objective 4: To identify obstacles to mHealth adoption in Burundi

Research question 4: What are the impediments to mHealth adoption in Burundi?

7.4. Research objective 1: Assessing healthcare professionals' readiness to adopt mHealth

7.4.1. Acceptance of mHealth capabilities

High acceptance of mobile phones and mobile technology amongst health professionals and their familiarity of the use of mobile phones have been often cited as drivers of mHealth initiatives in Africa (Rotheram-Borus, *et al*., 2011; Siedner, *et al*., 2012; Azfar, *et al*., 2011; Barrington, *et al*., 2010*;* Rajput, *et al*., 2012). In the context of this research, mHealth capabilities acceptance levels can be classified in three categories (see table 6.7 in the previous chapter). **High acceptance level (Acceptance >= 70%)**. This category encompasses most accepted mHealth capabilities (in descending order in table 6.7). These capabilities are communicating with fellow healthcare professionals using mobile devices (94.2%), collecting medical/health data by means of mobile devices (83.5%) and sending SMS to make people aware of different methods of disease prevention (70.6%). The second category depicts a **moderate mHealth acceptance level (Acceptance between 60% and 69%).** This category includes capabilities such as using mobile devices for tracking diseases and epidemic outbreaks (68%), use of mobile devices for diagnostic support (67%) and using mobile devices for treatment support (66.8%). The last category groups capabilities that scored the lowest acceptance level between 50% and 59 % (**Adequate acceptance level)**: This category includes capabilities such as training healthcare workers using mobile devices (57.9%) and monitoring and treating patients using mobile devices (51.2%). Although generally the acceptance of mHealth capabilities at the primary healthcare centres' level is above 50%, currently non-ICT methods are still the predominant methods for education and awareness programs, training healthcare professionals, diagnosis and treatment support at the primary healthcare centres (see table 6.5 in the previous chapter). Even in cases where mobile phones are used for mHealth purposes, mobile phone calls are used rather than any other mobile phone capabilities.

mHealth is a newly emerging concept within the primary healthcare centres and in the Burundi's context in general. There are efforts deployed to replace the current paper-based system with SMS based systems i.e. Rapid SMS[26] and Commcare-ODK[27] systems (MoH&A_1, interview, 2014). As mentioned by interviewees, current pilot tests of the SMS-based systems are being carried out within the maternal health program and maternal and infants treatment programme respectively. A report is yet to be published on the performance of the two systems. However, it is assumed that the 2015 pre-elections political instability and continued violence has halted efforts towards the continuation and evaluation of the piloted projects performance. So far, the Rapid SMS system in pilot phase (Burundi Ministry of Health, 2014) and the SIDA info (Nyssen, *et al*., 2015) interventions (a toll free based system) are the only reported systems in the

[26] An SMS system used as a communication medium between health workers and central decision-making body (district, provincial, or national).

[27] A combination of rapid SMS features and extra features for sending collected information

literature in the context of Burundi. In instances where these two systems are mentioned in the literature, they are generally described without mentioning their current performance status in the Burundi's context. Although SIDA info was reported in the literature, the interviewees never mentioned it.

Involving users in the development process of telehealth initiatives is critical (Wootton, *et al*., 2009). Gagnon, *et al*. (2004) advocate that the diffusion of telehealth and its application depends on its acceptance among healthcare practitioners. Thus, the participatory design approach is particularly suitable for mHealth adoption. Particularly the involvement of users in interface design plays a role in the successful adoption and usability of mobile devices (Graves, *et al.*, 1998). In Rwanda for instance, users' involvement during the Rapid SMS system design phase (as discussed in the literature review chapter) proved to be one of the key ingredients of its successful implementation to support maternal and infants' treatment interventions (Burundi Ministry of Health, 2014). In the case of Burundi, based on the findings from this study, there is a need for such involvement as there is limited knowledge of mHealth capabilities especially within the primary healthcare professionals (see section 7.4.3). Stakeholders' involvement should include training in the use of mHealth systems to ensure a high response rate to the mHealth projects (Pop-Eleches, *et al*., 2011). It is anticipated that such training will increase healthcare professionals' self-efficacy in terms of using mobile devices to provide healthcare. Self-efficacy has been identified as a determinant of perceived ease-of-use and perceived usability of a system (Davis, 1989). In addition, the perception of ease of use has been identified in many studies (such as Gagnon, *et al*., 2016; Kijsanayotin, *et al*., 2009; Moon and Kim, 2001) as a predictor of mHealth adoption. Thus, self-efficacy acquired through training has the potential to influence the adoption of mHealth. It is also anticipated that such training will increase awareness of the options that mobile phones can offer to support healthcare interventions. This awareness and the tangible results (when they are available) from the currently piloted Rapid SMS system may trigger a move from traditional means of communication (emails, telephone calls, and couriers) to more reliable mobile phone-enabled means of communications, such as SMS-based systems, for countrywide intervention coordination. The use of SMS-based data collection tools has proved to improve information quality and reduce data losses and reporting errors in various projects in

African countries (Chin, *et al*., 2013; Jian, *et al*., 2012; Seidenberg, *et al*., 2012; Blackenberg, Blackenberg, Worst and Scheffer, 2011; Tomlinson, *et al*., 2009).

7.4.2. Willingness to learn how to use mHealth applications and mobile devices

Willingness to adopt mHealth was assessed through the questionnaires by the following questions:

1. Q.12.11: I am willing to learn how to use mobile devices to provide mHealth
2. Q.12.12: I am willing to learn how to use mHealth applications

The results from the analysis (in table 6.19 in the previous chapter) show a general willingness to learn how to use mobile devices to provide mHealth (80.6% of respondents, N= 171) and to learn how to use mHealth applications (73.6%, N=156). In addition, positive significant correlations were found between the two variables and the acceptance of mHealth capabilities except for communication with fellow healthcare professionals' mHealth capability. Thus, strategies need to be put in place to stimulate mHealth capabilities acceptance by encouraging healthcare professionals to learn how to use mHealth devices and applications through various training opportunities. In the case of Burundi, the Ministry of Communication mentioned that obstacles to the implementation of mHealth include the fact that mHealth users were negligent, causing data collected through mHealth to be erroneous (Ministry of Communication, interview, 2014). This emphasizes the need for extensive training in mHealth. In addition, providing incentives to ensure a high response rate to mHealth projects is another strategy that can be used. In the Rwandan case of Rapid SMS adoption, performance- based incentives were put in place in order to increase CBHWs adoption and ownership of the system (Burundi Ministry of Health, 2014). In addition, CBHWs were empowered through training for greater commitment to the mHealth-based intervention. In the case of Burundi, It is imperative to provide incentives to ensure adoption of mHealth interventions especially because mHealth is a new concept within the country. Healthcare professionals might not be enthusiastic about learning and adopting it if they do not perceive any reward from using it. Incentives for the implementation of mHealth projects fall into three broad categories: cost savings, improved operational effectiveness, and revenue generation (Vodafone Group, 2012). In terms of revenue generation-based incentives (i.e. financial reward for end users), outcome-based incentives were found to be most effective. As discussed in chapter 2, a funding framework called Results Based Financing (RBF) is similar to the outcome-based framework which was introduced by the Government of Burundi (GoB) within the health sector. Such incentives could also be applied in the context of mHealth adoption in the country. For instance, CBHWs or other healthcare providers involved in mHealth interventions could be rewarded based on the increase of expectant mothers' visits to the clinics as a result of CBHWs' follow-up SMS messages.

7.4.3. Knowledge of mHealth

Results show that many primary healthcare centres' professionals had practiced mHealth at least once (although some might not been aware that they were practicing mHealth):

1. 72.2% (N=151) had, at least once, searched for medical information using cellphones
2. 67.9% (N=141) had, at least once, booked an appointment with a patient using cellphones
3. 52.3% had, at least once, sent medical information to their patients via SMS.
4. 51.66% had, at least once, received medical information on their phones via SMS

Furthermore, primary healthcare professionals had been involved more in mHealth activities compared to social network, Internet browsing, and cellphone banking activities:

1. Internet browsing: 69.7% never used their cellphones for Internet browsing
2. Connecting to Facebook: 66.8% never used their cellphones to connect to Facebook
3. Connecting to twitter: 91.5% never used their cellphones to connect to twitter
4. Cellphone banking: 61.3% never used their cellphones for banking.

However, concerning other mHealth capabilities where cellphones were used as depicted in table 6.5 in the previous chapter, they were mainly used to make calls.

Importantly, results from the analysis indicate that 90.1% of primary healthcare professionals need to know how mHealth works before adopting it (table 6.17 in the previous chapter). In addition, there is a significant positive correlation between the need to know how mHealth works before adoption and the acceptance of each one of the mHealth capabilities (table 6.18). The correlation depicts that an increase in mHealth knowledge would lead to an increase in the acceptance of each of the mHealth capabilities. The results diverge from Zhang, *et al*. (2010), who through analysis of mHealth adoption by nurses found that results demonstrability (observability) has no significant impact on mHealth adoption by nurses in Canada. However, the Canadian context is different from Burundi's as most nurses in Canada were already used to smartphones and their advanced capabilities. Prior exposure to mobile devices has been identified as an important contributing factor to rapid adoption of mHealth applications (Wootton, *et al.,* 2009). In Burundi, contrary to the Canadian case, results show that 93.40% of healthcare professionals do not own any other mobile device besides their cellphones. Thus, healthcare professionals may not be used to advanced mobile capabilities (such as mHealth applications). Hence, it is important for them to see how a mobile phone can be used to provide healthcare before adopting mHealth. Familiarity with mobile technologies was cited by Irwin, Nordstrom and Pyra (2012) as an important predictor of mHealth adoption within developing countries. This concurs with the expressed need in this study for observability by healthcare workers in Burundi. Venkatesh (2002) advocates that technology implementation should follow an incremental process. The aim of such a process is to detect existing adoption issues before embarking on large scale technology deployment. Thus, in the case of Burundi and in accordance with findings from this research, there is a need for education and awareness programs geared specifically towards mHealth adoption as part of mHealth advocacy, starting from the least sophisticated options (what healthcare professionals know already) to more complex mHealth options.

7.5. Research objective 2: To identify country specific factors that influence mHealth adoption

7.5.1. Determining factors for mHealth adoption in Burundi

mHealth adoption determinants were assessed from three perspectives: decision makers (Ministry of Health and Ministry of Communication), primary healthcare professionals and mobile telecommunications companies (in terms of the technical feasibility of mHealth adoption, prospects for sustainability and scalability of mHealth in Burundi).

7.5.1.1. Determining factors from the primary healthcare centres professionals' point of view

Diffusion of Innovation (DOI) theory factors

As outlined in Chapter four, the persuasion constructs from the Diffusion of Innovation (DOI) theory i.e. relative advantage, compatibility, complexity, trialability and observability were tested as possible determinants of mHealth acceptance within the primary healthcare context in Burundi. The relationship between the DOI persuasion constructs and mHealth capabilities acceptance are discussed in this section.

Relative advantage

Relative advantage of mHealth can be evaluated in terms of economic profitability, social benefits, time savings, and avoiding risks (Tornatzky and Klein, 1982), and perceived usefulness (PU) (Roberts and Pick, 2004). In this research, the assessed mHealth relative advantages can be grouped into two categories:

1. **Relative advantages to Primary healthcare professionals**: These include mHealth usefulness (question 12.7), making primary healthcare professionals job easier (question 12.8) and reducing the amount of effort spent on executing some tasks (question 12.9).
2. **Relative advantages to the population**: These include reaching a larger portion of the country's population, a larger portion of the population benefiting from healthcare services (question 12.21), an improvement in prevention and awareness of diseases (question 15.22).

Results from the analysis show that most respondents (above 70%) perceive the combined two sets of relative advantages as benefits that would derive from mHealth implementation in Burundi. Tornatzky and Klein (1982) found relative advantage to be an important factor in determining adoption of innovations. In line with Tornatzky and Kleine findings, a significantly strong positive correlation was found between the positive perceptions of these relative advantages as benefits of mHealth implementation in Burundi and mHealth capabilities' acceptance. Prior studies' findings indicate that technology usefulness is a significant and primary predictor of technology adoption (Chau and Hu, 2002). In addition, Kijsanayotin, *et al*. (2009) found that health IT adoption is a function of the perception that health IT is useful and easy to use. Generally, perceived relative advantage of an innovation is positively related to its rate of adoption (Rogers, 1983; Tan and Teo, 2000), and negatively related to potential adopters' resistance to technology (Dunphy and Herbig, 1995). Hence, based on the findings from this research, there is a need to devise strategies to increase the awareness of the benefits that derive from mHealth implementation in order to increase the acceptance of mHealth by healthcare professionals in Burundi.

Compatibility

The assessed compatibility variables can be grouped into three categories:

1. **Work related compatibility**: This includes compatibility with duties (question 12.23) and compatibility with what is needed to execute daily tasks (question 12.24).
2. **Organisational compatibility**: This includes compatibility with organisational working style (question 12.26) and compatibility with work ethics (question 12.27)
3. **Experiential compatibility**: This relates to the compatibility with one's experience with mobile devices (question 12.25).

Tornatzky and Klein (1982) argue that there are two sets of compatibility i.e. normative compatibility (based on the values and norms of potential adopters) and practical compatibility (based on the existing practices of the adopters). Based on the definition of the different types of compatibility above, experiential and work-related compatibility may be categorised under practical compatibility whilst organisational compatibility could refer to normative compatibility. Results from the analysis indicate that there is a positive but moderate correlation between the compatibility variables taken together and the mHealth capabilities acceptance. An increase in the perceptions of mHealth as being compatible with work-related duties, work daily requirements, working style, work ethics and one's experience with mobile devices will lead to an increase in mHealth capabilities acceptance. Tornatzky and Klein (1982) further claim that the potential adopter's perception of the innovation compatibility is positively related to adoption and implementation of the innovation. Dunphy and Herbig (1995) and Tan and Teo (2000) state that compatibility is positively related to the diffusion rate and negatively related to users' resistance to innovation. Ram (1987) also argues that individuals' psychological characteristics such as previous innovative experience play a role in the users' adoption of innovation. Thus, experiential compatibility as defined in this research is in accordance with Ram's findings. Hence, in the case of Burundi, it is imperative to introduce mHealth devices and applications that are in line with the three compatibility's categories identified in this research findings.

Complexity

The complexity variables can be grouped in two categories:

1. **Ease of use of mHealth devices and applications**: This was assessed through Q.12.9: I would not adopt mHealth because mobile devices are difficult to use; Q.12.14: I will not cope with using mHealth devices; Q.12.15: I will not cope with using mHealth applications; Q.12.16: I would adopt mHealth because mHealth devices are easier to use.
2. **Ease of learning mHealth applications**: This was assessed through question 12.10: I would not adopt mHealth if mHealth applications are difficult to learn.

Results from the analysis signify that most respondents perceive mHealth devices and applications as easy to use. In addition, primary healthcare professionals indicated that they will still adopt mHealth even if it may be difficult to learn. Although researchers (Dunphy and Herbig, 1995; Tornatzky and Klein, 1982) found that complexity is negatively related to innovation's adoption, results from this study suggest that complexity is not correlated with mHealth capabilities acceptance. Hence, mHealth complexity does not influence mHealth capabilities acceptance. Hu, *et al*. (1999) argue that in most cases, health professionals are generally competent enough to learn and use a new technology. Thus, technology complexity will not inhibit their technology acceptance. Similarly, this study's findings show that although primary healthcare professionals may not be acquainted with mHealth, they are eager to use mobile devices and applications for mHealth purposes no matter how difficult it may be in terms of learning how to use mHealth applications. Hence, this further validates healthcare professionals' claims of willing to learn how to use mHealth applications and mobile devices.

Trialability and observability

On one hand, trialability variables presented in this study can be classified in three categories:

1. **Testing**: This was assessed through Q.12.28: I would first test M-health before adopting it
2. **Evaluation of mHealth results**: This was assessed through Q.12.29: I would first adopt mHealth and then evaluate the results

3. **Unconditional adoption**: This was assessed through Q.12.30: I would adopt mHealth anyway because it has proven to work in other countries and Q.12.31: I am willing to adopt mHealth immediately without trying it.

In this study, trialability was found to be positively correlated with mHealth capabilities acceptance. An increase in the perceptions of mHealth as being trialable would lead to an increase in mHealth capabilities acceptance. The finding is in accordance with Ram's (1987) finding that the more the perceptions of an innovation as trialable, the less there is resistance to the innovation. He also points out that the more the perceptions that an innovation can be attempted in stages (divisibility factor), the less the innovation resistance. A way of increasing mHealth capabilities acceptance would be to run randomised mHealth trials where benefits of mHealth capabilities are demonstrated to the potential adopters.

On the other hand, the influence of observability variables on mHealth adoption was assessed through questions that assessed the need for healthcare professionals to see tangible results from mHealth adoption before adopting mHealth. These questions were: 'Q.12.32: I need to see tangible results of mHealth adoption before adopting it'; 'Q.12.33: I need to be shown where mHealth worked before adopting it'; 'Q.12.34: I do not need to see tangible results of mHealth. I will adopt it because I know it will work for me'. Only few respondents (26.9%) indicated that they do not need to see tangible results from mHealth implementation before adopting mHealth that further supports the significance of trialability on mHealth acceptance. A significant positive correlation was found between observability and mHealth acceptance. The more primary healthcare professionals are exposed to the concept of mHealth and its contribution towards achieving their organisational goals and their duties (compatibility variables) for instance, the more they would be willing to accept and adopt mHealth. One of the strategies that could be used is to tell potential users about recent case studies that depict where mHealth has been successfully implemented to achieve healthcare related goals in addition to the randomised trials. In the East African community (Rwanda, Tanzania, Uganda and Kenya), there are numerous cases of successful mHealth implementations. Partnerships could be forged between Burundi's Health ministry and stakeholders in the mHealth implementation within the rest of the East African community members. Such partnerships would bring on board experts in the field of mHealth to explain how mHealth has contributed to addressing healthcare related issues and to assist in the mHealth implementation in the country.

Unified Theory of Acceptance and Use of Technology (UTAUT) factors

The UTAUT model was adopted in the study to investigate performance and effort expectancy factors as well as facilitating conditions that influence the implementation of mHealth in Burundi. On one hand, facilitating conditions were assessed from primary healthcare professionals, decision makers within the ministries of health, communication and from the mobile telecommunications operators. Facilitating conditions were given much consideration because mHealth is a new concept in Burundi, hence there is need for much information on the pre-conditions (such as infrastructure and cost) for the adoption of mHealth within the context of the country from various stakeholders. On the other hand, performance and effort expectancy factors were assessed from the primary healthcare professionals' point of view.

Performance Expectancy (P.E.)

Performance Expectancy was assessed through the following variables:

a) Expansion of healthcare access: Q.14.2: Expansion of healthcare access (ability to reach larger portion of the population compared to other technologies) is a factor that I would consider before adopting mHealth

b) Convenience: Q.14.3: Convenience is a factor that I would consider before adopting mHealth

Results from the analysis show that performance expectancy is correlated with mHealth capabilities acceptance. An increase in the perceptions that mHealth is convenient and would contribute to the expansion of healthcare access would lead to an increase in the mHealth capabilities acceptance. Thus, there is a need to design mHealth solutions (mHealth devices and applications) in a way that is convenient to the users in order to minimise the prospects of non-adoption. In addition, mHealth solutions that would contribute directly to healthcare access (expansion of healthcare access) would be well accepted.

Effort expectancy (E.E.)

Effort expectancy was assessed through the following variables:

a) Ease of use of mobile devices: Q. 14.11: Ease of use of mobile devices is a factor that I would consider before adopting mHealth

b) Ease of use of mHealth applications: Q. 14.12: Ease of use of mHealth applications is a factor that I would consider before adopting mHealth

Effort expectancy is correlated with mHealth capabilities acceptance that means that the more mobile devices and mHealth applications become easier to use the more healthcare professionals would accept the mHealth capabilities. Thus, good interface designs need to be applied to maximise the potential of mHealth capabilities acceptance.

Facilitating conditions

From the primary healthcare professionals' perspectives, the variables that were used to assess facilitating conditions that may lead to mHealth acceptance can be grouped in 4 categories.

a) Affordability:

Q.14.1: Affordability of mobile devices is a factor that I would consider before adopting mHealth.

Q. 14.7: Affordability of making calls using a mobile phone is a factor that I would consider before adopting mHealth

Q. 14.5: Free access to mHealth via SMS is a factor that I would consider before adopting mHealth

Q. 14.6: Affordability of sending SMS is a factor that I would consider before adopting mHealth

b) Reliability

14.4: Reliability of mobile technology infrastructure is a factor that I would consider before adopting mHealth

c) Localised content

Q.14.8: Content of mHealth message/service in local language is a factor that I would consider before adopting mHealth

d) Confidentiality

Q.14.10. Confidentiality of information sent via mobile devices

A significant correlation was found between facilitating conditions and mHealth capabilities acceptance by primary healthcare professionals in Burundi. The positive correlation depicts that an increase in these facilitating conditions will lead to an increase in mHealth capabilities acceptance.

Government's influence through policies and regulations is a factor that affects mHealth adoption (Qiang, *et al.*, 2011). Particularly, regulation of mobile telecommunications service prices determines the extent to which mobile technology is used (Qiang, *et al*., 2011). In the case of Burundi, the Government has a significant influence on mobile telecommunications as operational telecommunications rates of fees and charges are set and revised by the government following recommendations from the National Regulator Authority (ARCT) (HIPSSA, 2013). It was predicted that due to the 2014 and the subsequent 2015 tax increase on mobile calls, many people living in Burundi would not be able to afford local and international calls (Siboniyo, 2015). Subsequently, the new enacted tax increase decree was predicted to reduce the traffic of mobile calls over the telecommunications networks (Siboniyo, 2015). Thus, in Burundi, an mHealth intervention that requires making calls at the caller's expenses might have very little impact due to the cost factor. Voice- based mHealth interventions such as the current running toll free-based "SIDA info" initiative, are encouraged as they will not be at the expenses of the users of mHealth services.

In addition, mHealth projects have proved to be successful when adapted to the local context and language. For instance, a mobile phone enabled initiative for cancer care in Nigeria showed that 72.5% of participants (who were mostly cancer patients) preferred to speak in the local language as this enhanced their ability to describe their health challenges clearly (Odigie, *et al*., 2012). In Burundi, designing SMS-based mHealth initiatives with contents in the local language, is a feasible option. Currently, the country has four prevailing languages (Kirundi, French, Swahili, and English). Kirundi is the native language which is spoken across the 18 provinces within the country. Thus, mHealth should be customised to accommodate the language in order to have a wider impact in the country. It is anticipated that when the technology is understood within their local language, potential adopters would be more open to adopt it compared to when the content of the mHealth program has to be translated for them into their native language. Thus, mHealth initiatives, if scaled, have the prospects of having a countrywide impact (taking into consideration that there is only one indigenous language spoken across the whole country).

Moreover, privacy has been recognised as one of the factors that triggers acceptance of mobile technology. In some instances, mHealth has been shown to be more acceptable in cases where people had to disclose private and sensitive information that they would not reveal through traditional face-to-face consultations with healthcare professionals (Zurovac, *et al*., 2012). Such has been the case of HIV patients that would prefer to disclose their sensitive information through mHealth interventions. It was perceived that mHealth-enabled interactions would keep their anonymity and the confidentiality of their information. Similarly, an intrusion in one's private life has also been cited as an impediment to mHealth adoption in one of the South African-led mHealth projects (Skinner, *et al*., 2007). Hence, there is a need to adapt mHealth to the countries' cultural contexts and specifically into Burundi's cultural context. The starting point would be to understand how privacy is understood and preserved within the Burundi's cultural context.

7.5.1.2. Need for a multi stakeholder approach to the adoption of mHealth in Burundi

Findings from the interviews further reveal that there is need for a multisector approach to mHealth adoption in Burundi (Ministry of Communication, interview, 2014). The mHealth ecosystem comprises a variety of stakeholders that play significant roles in the conception, implementation, or dissemination of mHealth interventions. Thus, a multisector approach to mHealth adoption that involves such key players is essential for the successful implementation of mHealth interventions. The success of mHealth projects has been linked to partnerships between public and private entities in terms of conception and implementation of mHealth interventions (Aranda-Jan, *et al*., 2014). Mechael (cited in Vital Wave Consulting, 2009) argues that forging strong partnerships with either a private organisation or government corporation is one of the factors that leads to mHealth implementation on a significant scale. Although most mobile telecommunications operators mentioned that they are able to provide mHealth, none of them indicated that they are able to disseminate mHealth interventions to the entire country. Hence, a partnership between the Government of Burundi through the ARCT and mobile telecommunications operators is essential in order to develop reliable and wide spread mobile technology infrastructure and mHealth services that yield substantial returns for both the providers (mobile telecommunications companies) and the beneficiary of mHealth services. Such a partnership could also address issues of subsidised or non-subsidised mobile network expansion. Vital Wave Consulting (2009) suggests driving innovation through incentives in the form of tax rebates for the telecommunications providers who are involved in the provision of mHealth services. In Burundi, the government, through ARCT, can offer discounts to telecommunications companies that incorporate mHealth services as part of their Corporate Social Responsibility (CSR).

Based on the above-discussed findings, the theoretical frameworks are adapted as depicted in figure 7.1 below:

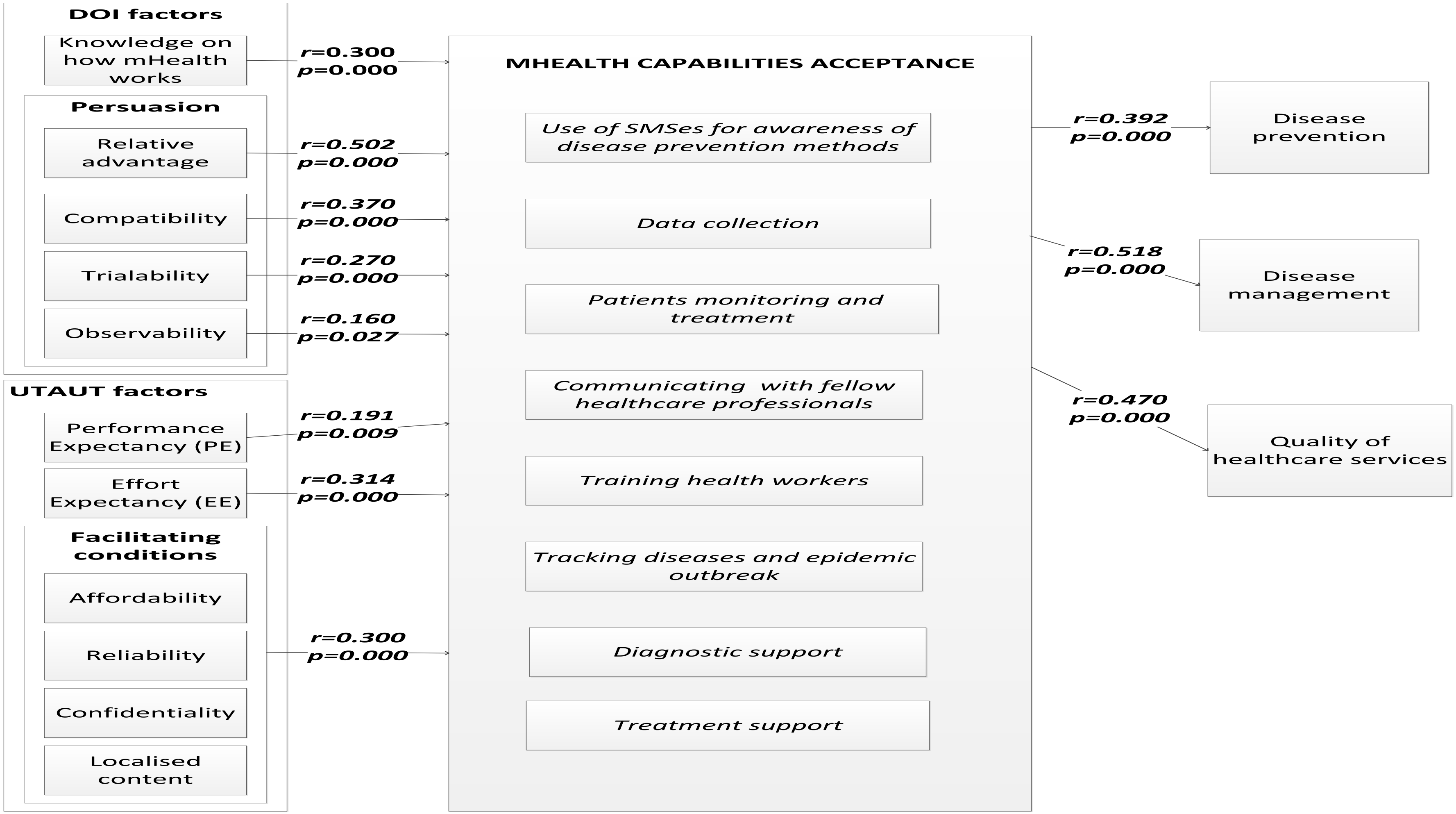

Figure 7. 1. Adapted theoretical framework

7.5.1.3. Existing and required facilitating conditions from the ministries and mobile operators' perspectives

From the interviews, respondents mentioned specific initiatives that have been put in place to promote ICT use within the public health sector. These include overseas ICT training for healthcare professionals, radio programs, information sharing workshops and public workshops. However, they further mentioned that there is a need for specific training on mHealth use and mobile applications use. There is also a need to make mobile devices and applications available within the Ministry in order to facilitate the adoption of mHealth within the public healthcare services in Burundi. The need for educational and awareness programs to stimulate enthusiasm towards mHealth adoption was also expressed. The Executive Secretariat of ICTs (SETIC) is in charge of coordinating and monitoring ICT projects to ensure that they are in line with the National ICT policy framework. There is also the planning committee for eHealth pilots' projects, which oversee the planning, and implementation of eHealth (including mHealth) pilot projects. However, it is unclear how the planning committee's duties is incorporated within the SETIC's mandate.

mHealth projects have proved to be successful when a country has a mHealth or eHealth strategy and when its government is willing to set up a system to integrate mHealth projects (Barrington, *et al*., 2010). The adoption of an eHealth strategy ensures that eHealth projects are aligned with the national health goals of a country. Lack thereof may lead to adhoc, pilot-only projects without the prospects of scalability, and sustainability. Lack of integrated health systems is one of the major impediments to healthcare services delivery in Burundi (GHI, 2011). Thus, the adoption of mHealth in Burundi needs to take an integrated approach in order to redress the shortcomings of previous systems. The aim should be to build integrated solutions that leverage the strength of existing (or upcoming) mHealth systems in order to avoid the 'pilotitis syndrome'[28] and costly duplication of efforts.

This research also found that when it comes to ICT-led initiatives with the Ministry of Health, the government provides 20% of the budget while the 80% is raised through donors' funding (MoH&A$_1$, interview, 2014). Iluyemi (quoted in Vital Wave

[28] Pilotitis in the context of mHealth adoption often refers to the implementation of various similar pilot systems that achieve almost the same purpose rather than just one integrated solution.

Consulting, 2009) indicates that ensuring the long term sustainability of mHealth programs in developing countries is a challenge. Vital Wave Consulting (2009) further argues that most of mHealth interventions in developing countries are initiated by seed funding from philanthropic organisations such as Non-Government Organisations (NGOs), or as part of a Corporate Social Responsibility (CSR) initiative of a for-profit business. However, once the seed funding is exhausted, most of the projects fail to be sustainable resulting in forced termination. Avgerou (2008) argues that western-driven mHealth solutions have been criticised for failing to recognise the unique contextual factors associated with developing regions. In the case of Burundi, the interviewee from the Ministry of Communication mentioned that a previous attempt to adopt a mobile-based intervention for an education and awareness program failed due to a clash between donors' expectations and reality/local expectations from the Ministry (Ministry of Communication, interview, 2014). Thus, there is a need to move from complete reliance to donors for funding mHealth projects to building up partnerships with local private entities in order to devise sustainable mHealth solutions that will supplement the donor-funding model. However, such a shift will require a business model that yields returns to both parties. In addition, harmonising mHealth funding with outcomes may attract more funding as a number of funding organisations (such as Global Fund, PEPFAR, and GAVI discussed in the literature) have embarked on the Results Based Funding (RBF) model. As the Burundi's government has embarked on the RBF based model within the health sector, it is expected that such a model would attract mHealth funding if extended to mHealth interventions.

Table 7.1 depicts the existing and required facilitating conditions (as identified from the respondents) for the adoption of mHealth in Burundi.

Table 7.1. Existing and required facilitating conditions to the adoption of mHealth in Burundi.

Themes	Existing facilitating conditions	Source	Comments (Burundi's context)	Required facilitating conditions	Source	Comments (Burundi's context)
Long term plan for ICT adoption in the health sector	National ICT policy	Respondent 1 (MoH&A)	***The policy does not address specific ICT needs within the health sector***	*eHealth strategy*	Barrington *et al*. (2010) Kochi, E. (2013)	***Not yet implemented. However, feasibility analysis of the implementation of an eHealth enterprise architecture has been commissioned (Nyssen et al., 2016).***
Strategy to secure long term sustainability of ICT in the health sector	Planning committee for eHealth pilot projects	Respondent 1 (MoH&A)	***No empirical evidence of its scope***	*Multi sectoral approach to mHealth adoption*	Respondent from the Ministry of Communication	***No empirical evidence in the context of Burundi***
				Collaboration with other stakeholders in the mHealth ecosystem	Wood T. (2013) Lemaire (2011) Cargo (2012) Nyssen et al. (2015)	***No empirical evidence in the context of Burundi***

Themes	**Existing facilitating conditions**	**Source**	**Comments (Burundi's context)**	**Required facilitating conditions**	**Source**	**Comments (Burundi's context)**
Funding mechanisms	20% funding from government; 80% from donor funding *Results Based Funding (RBF)*	Respondent 1 (MoH&A) Nyssen *et al*. (2015)	***Heavy reliance on donor funding*** ***RBF monitoring system ("Open RBF") has been implemented. RBF has been adopted as funding instrument for some projects within the Ministry of Health***	*Partnership between public and private sector* *Link RBF to mHealth interventions*	Qiang (2011) Van der Kop et al. (2012); Chang et al. (2011); Barrington et al., 2010 Africa Health Forum (2013)	***No empirical evidence in the context of Burundi*** ***RBF can be used as an evaluation tool to provide incentives. RBF can also attract further investment in mHealth***

Themes	**Existing facilitating conditions**	**Source**	**Comments (Burundi's context)**	**Required facilitating conditions**	**Source**	**Comments (Burundi's context)**
Initiatives in place to promote ICT	Overseas ICT training for healthcare workers	Respondent 2 (MoH&A)	***Relevance of such training in the context of mHealth adoption needs to be established.***	*Training of Healthcare workers in ICT use*	Respondent 1 (MoH&A)	***Training already exists but more needs to be done to bring an awareness of mHealth tools and their benefits***.
Initiatives in place to promote ICT	Information sharing workshops	Respondent 1 (MoH&A)	***Such media could be used emphasizing on mHealth adoption***	*Training in mHealth use (including mobile devices and applications use)*	Respondent 1 (MoH&A)	***A multi stakeholder approach is needed***
	Public workshops			*Availability of mobile devices*	Respondent 1 (MoH&A)	
	Radio programs			*Availability of mHealth applications*	Respondent 1 (MoH&A)	
				mHealth-related education and awareness programs	Respondent 1 (MoH&A)	

Themes	Existing facilitating conditions	Source	Comments (Burundi's context)	Required facilitating conditions	Source	Comments (Burundi's context)
National Telecommunications Regulatory Authority (ARCT)	Limits unfair competition practices Ensures that citizens are not over charged	Mobile Telecommunications operators	***Lack of price regulation within the telecommunication industry makes it difficult for the regulator to solve disputes***	*Consultation between the government and mobile telecommunications operators is needed to address root causes of the negative perceptions of mobile operators towards ARCT.*	Collaboration with other stakeholders in the mHealth ecosystem (Wood (2013); Lemaire (2011); Cargo (2012); Nyssen *et al*. (2015))	***A multi stakeholder approach is needed***
Mobile telecommunications infrastructure	Adequate to launch mHealth	Mobile telecommunications operators	***Not adequate to disseminate mHealth throughout the whole country.***	Adequate infrastructure to disseminate mHealth interventions	Mobile operators	***Need for partnership between government and mobile operators***

Themes	**Existing facilitating conditions**	**Source**	**Comments (Burundi's context)**	**Required facilitating conditions**	**Source**	**Comments (Burundi's context)**
				Sustainability of mHealth initiatives	Mobile telecommunications operators	***Mobile telecommunications operators should include mHealth as part of their social or community initiatives***
				Scalability of mHealth initiatives	Mobile telecommunications operators	***Awareness of mobile phone led and data innovations through various educational programs***

7.6. Research objective 3: To identify potential contribution of mHealth interventions in achieving the country's broad goals in the health sector

7.6.1. The role of mHealth in the fight against diseases.

Results from the analysis depict that primary healthcare workers would accept mHealth capabilities for disease prevention (by sending customised SMS's about disease prevention methods to mobile subscribers), disease management (using mobile devices to collect health-related data, communicate with health field workers, track epidemic and disease outbreaks, diagnose diseases) and to enhance the quality of healthcare provision (by using mobile devices to train health workers and for treatment support). Furthermore, qualitative findings reveal that in the context of the public healthcare system in Burundi, mHealth has the potential to address challenges that the system faces, such as a lack of real time access to data and unreliable paper-based data collection systems. It also has the potential to expand access to medical treatment, address the shortage of trained healthcare professionals and address the issue pertaining to fragmented access to data. Specifically, interviewees mentioned that mHealth will increase the speed of health-related data transmission which could lead to timely response to emergencies. They further mentioned that mHealth has the potential to increase data reliability (by replacing paper-based data collection instruments). Moreover, they highlighted that mHealth could also enable remote medical treatment, online training, and sharing of information amongst healthcare professionals ($MoH\&A_1$ and $MoH\&A_2$[29], in depth-interview, 2014). However, to achieve this, identified challenges need to be addressed. The following section discusses the challenges from the healthcare professionals, ministries and mobile operators' points of view.

[29] $MoH\&A_2$ refers to respondent 2 from the Ministry of health and Fight Against AIDS

7.7. Research objectives 4: To identify obstacles to mHealth adoption in Burundi

Obstacles to mHealth adoption in Burundi can be placed into six categories: Policy and regulations issues, socio-cultural issues, resistance to learning and change, economic issues, technical and ICT expertise issues, and political issues.

7.7.1. Policy and regulations issues

7.7.1.1. Lack of ICT policy that addresses the needs of the Ministry of Health

In this instance, there is a need for an eHealth strategy that aligns ICT interventions within the ministry to various other healthcare interventions. Having an mHealth or eHealth strategy and a system in place that integrates mHealth projects have been identified as drivers for successful mHealth projects (Barrington, *et al*., 2010). Although the country has an ICT policy in place, this research reveals that the policy does not address specific needs within the Ministry of Health (MoH&A_1, interview, 2014). However, the current commissioned study on the implementation of an eHealth enterprise architecture (Nyssen *et al*., 2016) is a positive move towards the implementation of a national eHealth strategy. Qiang *et al*. (2011) argue that mHealth is most effective when integrated in a comprehensive eHealth strategy. In addition, the adoption of an eHealth strategy ensures that eHealth projects are aligned with the national health goals of a country. Thus, in addition to the facilitating conditions identified through this study, the Ministry of Health needs not only to have an eHealth strategy but also should put in place mechanisms to ensure that various mHealth projects will be integrated for large scale impact.

In addition, from the interviews conducted with mobile telecommunications companies, within the scope of this study the influence of government-owned National Telecommunications Regulator’s (ARCT) regulations was assessed to be negative in the following areas: number of services provided, conception of technological innovations and dissemination of technological innovations. Qiang *et al*. (2011) argue that stability and consistency in the evolving policy environment make private actors more comfortable about investing in mHealth initiatives. However, this research indicates that the ARCT regulations change often thus making the telecommunications industry unstable (mobile telecommunications operator, interview, 2014).

7.7.1.2. Lack of work-related common standards that could be adopted for ministry-wide ICT adoption

Findings from the Ministry of Health reveal that similar work processes are called different names across various departments within the Ministry, thus making it difficult to adopt a common standardised system (MoH&A_1, interview, 2014). Thus, there is a need for multi-stakeholders' consultation to adopt standards that could be applied countrywide. As part of national strategies, governments may adopt regulations that support mHealth adoption (Qiang *et al*., 2011). For instance, in the case of Burundi, the government may intervene by creating regulatory framework that fosters the use of common standards for the transfer of information across mobile networks as suggested by Qiang *et al*. (2011). This will make it easier for the beneficiaries to switch between mHealth services providers. In addition, interoperability of mHealth services should be considered as it is crucial to ensure mHealth scalability. The Government of Burundi through its regulator (ARCT) may also set the standards for hardware and software platforms to ensure that mHealth applications can connect with each other and other mobile tools (Qiang *et al*., 2011).

7.7.2. Socio-cultural issues

7.7.2.1. Countrywide illiteracy rate

UNESCO (2013) projected that Burundi's overall adult literacy rate would reach about 85.4% in 2015. In order to ensure mHealth adoption in developing countries that includes even illiterate people, mHealth campaigns should be designed in a form of Interactive Voice Responses (IVRs) in addition to SMS messages (Maureen, 2014; Arora, 2015). This stems from the fact that IVR offers a voice-based, step-by-step, and easy to follow way of interaction that may be more appealing for illiterate people (Qiang *et al*., 2011). The IVR option can also be applied within the Burundi's context where some citizens living in the rural areas cannot read nor write. However, the current government's efforts to eradicate illiteracy such as free primary and basic adult education are signs that in the future, more of Burundi's population will be able to read and write and therefore benefit from text-based mHealth interventions. From 1990 to 2015, the percentage of youth (citizens between 15 and 24 years old) literacy rate increased from 44% to 87.6% (UNICEF, 2013). Hence, text-based mHealth interventions are particularly suited for the youth as a considerable number of them can read and write.

7.7.2.2. Resistance to learning and change

Resistance to change and resistance to learning were identified as individuals' characteristics that are likely to impede on the adoption of mHealth in Burundi (Mobile telecommunications operators, interview, 2014). As mHealth (especially the use of mobile phones applications to provide healthcare services) is a new concept within the Burundi's public healthcare system, it is highly likely that it will be resisted. The perceived relative advantage of a technology is positively related to its adoption (Tan and Teo, 2000; Rogers, 1983) and negatively related to potential adopters' resistance to its adoption (Dunphy and Herbig, 1995). In addition, practical compatibility (i.e. compatibility with people practices) has been found to be negatively related to potential adopters' resistance to technology adoption (Dunphy and Herbig, 1995; Tan and Teo, 2000). This research found that both relative advantage and compatibility are factors that are determinants of mHealth adoption from the primary healthcare professionals' point of view. Thus, as stated before, it is imperative to devise awareness campaigns that emphasize the relative advantage of mHealth as opposed to the current ways of providing public healthcare services. Particularly, an emphasis should be on the three categories of relative advantages as stated earlier in this chapter. Moreover, as per the findings from this research, the awareness programs should emphasize work- related compatibility, organisational compatibility and experiential compatibility in order to minimise the risk of healthcare professionals' resistance towards the adoption of mHealth.

Securing buy-in from stakeholders in the implementation of mHealth is key to the successful adoption of the technology. Lemaire (2011) suggests that educating and engaging end-users and target beneficiaries in building mHealth interventions is essential to the successful adoption of any mHealth intervention. This is particularly relevant within the context of Burundi as mHealth is a new concept. Thus, potential adopters need to be educated about mHealth and trained on how to use the technology within their relevant context. The emphasis should be on the usefulness and ease of use of the technology as these two factors have been identified (generally) through literature as the most key determinants of mHealth adoption (Zhang, *et al.*, 2010; Venkatesh, *et al.*, 2003; Moon and Kim, 2001; Gagnon, *et al.*, 2016). This will help build trust between the technology (and the information conveyed through the technology) and its potential users (Fabiano, 2013) and will minimise the risk of resistance towards the technology adoption. Fabiano (2013) further suggests that there is a need to collaborate with local partners to integrate local languages into the mHealth program.

7.7.3. Economic issues

a. ***Low disposable income***
b. ***Current economic environment***
c. ***High cost of mobile network connection***
d. ***High cost of Internet bundles***
e. ***Low rate of cellphones and other mobile devices penetration***

The economic issues delineated above need to be addressed through consultation between the public and private sectors. The aim is to bring on board investors to design an mHealth business model that would yield benefits to the public and private sectors and attract even further mHealth investments to the country. The government may also provide subsidies to make mobile device prices, making calls and sending SMS affordable. The government should also assist in developing a reliable mobile telecommunications infrastructure (which would cover the entire country) through consultation with mobile operators. Incentives may also be given to mobile operators who support mHealth initiatives as part of their Corporate Social Responsibility. There is also a need to stabilise the telecommunications industry through consistent and stable Telecommunications Agency Regulators' policies and regulations to attract more investors into the Burundi's mobile telecommunications industry.

7.7.4. Technical and ICT expertise issues

a. ***Unreliable network coverage in rural areas***
b. ***Lack of ICT knowledge***
c. ***Unfamiliarity with ICT innovations***
d. ***Unreliable electricity connection (frequent power shortages)***
e. ***Unreliable Internet connection***

As alluded to earlier in section 7.5.1.1, there is a need for a joint effort between the public and private sectors to develop sustainable mobile telecommunications network infrastructure that would provide reliable network coverage even to the remote areas of the country. However, the current more than 1000 km fibre optic project which is meant to cover the entire country with 3G access (ISTAfrica, 2014) coupled with ITU-sponsored Broadband Wireless Network Project (ITU, 2011) has raised high hopes of future reliable and affordable Internet connectivity throughout the country. In addition, the increase of higher learning institutions that offer ICT-related courses proves that the country is on the path to increasing ICT knowledge. There is also a need to keep the country on par with ICT innovations. The current EAC regional integration can help the country build ICT-related networks that will allow for sharing of ICT knowledge and innovations. This could be in the form of seminars, graduate workshops or EAC interuniversity exchange programs. In view of the current shortage of electricity supply, there is a need for alternative power sources that will keep information communication systems running in case of power outages. Moreover, there is a need to empower and incentivize communities to utilize renewable energy sources to keep their cellphones and other mobile devices charged. This would contribute in turn to mHealth interventions.

7.7.5. Political issues

a. ***Lack of political will***
b. ***Fear that SMS based systems could be used for political propaganda***

Aligning mHealth interventions with national health priorities is very important to secure buy-in from the government and the Ministry of Health (Kochi, 2013). In this case, key personalities within the government and the Ministry of Health must be enrolled as champions that will initiate mHealth adoption. Such buy-in will also establish the political will to promote mHealth as part of the government's national health interventions. However, there is a need to devise strategies to ensure transparency in the coordination and use of mHealth so that mHealth systems do not diverge from their intended purposes. Hence, this research advocates for a central coordinating organ that will coordinate, monitor, and evaluate mHealth projects to ensure that they do not stray from their intended goals.

Table 7.2 depicts the impediments to mHealth adoption in Burundi together with the identified solutions.

Figure 7. 2. Impediments to mHealth adoption and identified solutions

Impediments	**Identified solutions**
1. Policy and regulations issues	
Lack of ICT policy that addresses the needs of Ministry of Health	eHealth strategy (Barrington *et al.,* 2010; Qiang *et al.,* 2011)
Lack of work-related common standards that could be adopted for ministry-wide ICT adoption	Adoption of regulations that foster the use of common standards (Qiang *et al.,* 2011)
2. Socio-cultural issues	
Countrywide illiteracy rate	Design text-based mHealth interventions targeted to youth (15-24 years). Incorporate IVRs (Maureen, 2014; Arora, 2015) in addition to text-based messages in other age categories.

Impediments	Identified solutions
Resistance to learning and change	Devise awareness campaigns that emphasize on the relative advantage of mHealth, work-related compatibility, organisational compatibility and experiential compatibility (study findings). Educate and engage end-users and target beneficiaries in the development of mHealth interventions (Lemaire, 2011). Collaborate with local partners to integrate local languages into mHealth programs (Fabiano, 2016; Odigie *et al.*, 2012). Secure buy-in of the government and the Ministry of Health (Wood, T., 2013).
3. Economic issues	
Low disposable income Current economic environment High cost of mobile network connection High cost of Internet bundles Low rate of cellphones and other mobile device penetration	Consultation between the public and private sectors (recommendation). Ease of government regulations on mobile operators that support mHealth interventions (recommendation). Consistency in ARCT policies to attract more investors to the Burundi's mobile telecommunications industry (recommendation).
4. Technical issues and ICT expertise	
Unreliable network coverage in rural areas Lack of ICT knowledge Unfamiliarity with ICT innovations Unreliable electricity connection (frequent power shortages) Unreliable Internet connection	Public-private partnerships to develop sustainable mobile telecommunications networks infrastructure (recommendation). Use the EAC regional integration to build ICT-related networks for sharing ICT knowledge and innovations (recommendation). Develop and disseminate alternative power sources (recommendation).
5. Political issues	
Lack of political will Fear that SMS-based systems could be used for political propaganda	Secure buy-in of the government and the Ministry of Health by aligning mHealth interventions with national health priorities (Kochi, E., 2013). Need for a central monitoring, coordinating and evaluating body (recommendation)

7.8. Framework for the adoption of mHealth in Burundi

Based on the research findings and discussion thereof, a framework that may guide in devising mHealth interventions that are supported by various stakeholders within the mHealth ecosystem is presented in figure 7.2. Firstly, the framework advocates a national eHealth strategy as the starting point towards the implementation of sustainable mHealth interventions. The strategy would define the strategic aligning of mHealth in achieving the national health goals. In this case, mHealth is not viewed just as a facilitating tool but as part and parcel of the healthcare delivery system that requires careful planning, monitoring, and evaluation to ensure its sustainable implementation. The strategy should also define how mHealth systems will be integrated into the existing healthcare information systems. In addition, it is crucial to define hardware and software standards to be used to ensure systems interoperability. Secondly, collaboration amongst stakeholders within the mHealth ecosystem is suggested to address obstacles (impediments discussed above) to mHealth implementation. Such a collaboration will ensure buy-in by stakeholders within the mHealth ecosystem, which is an indispensable condition to successful mHealth implementation. For instance, as discussed above partnerships between mobile operators and the government could be forged for infrastructural development that caters for countrywide mobile-enabled mHealth interventions. In addition, mechanisms could be devised to provide incentives to healthcare workers. Moreover, funding mechanisms that yield returns to stakeholders within the mHealth ecosystem could be devised. Although dealing with the obstacles will create a conducive environment for mHealth adoption, there is also a need to take into cognisance factors (identified through the use of the DOI and UTAUT frameworks) that will influence healthcare professionals' adoption of mHealth for disease prevention and management and also for quality healthcare provision.

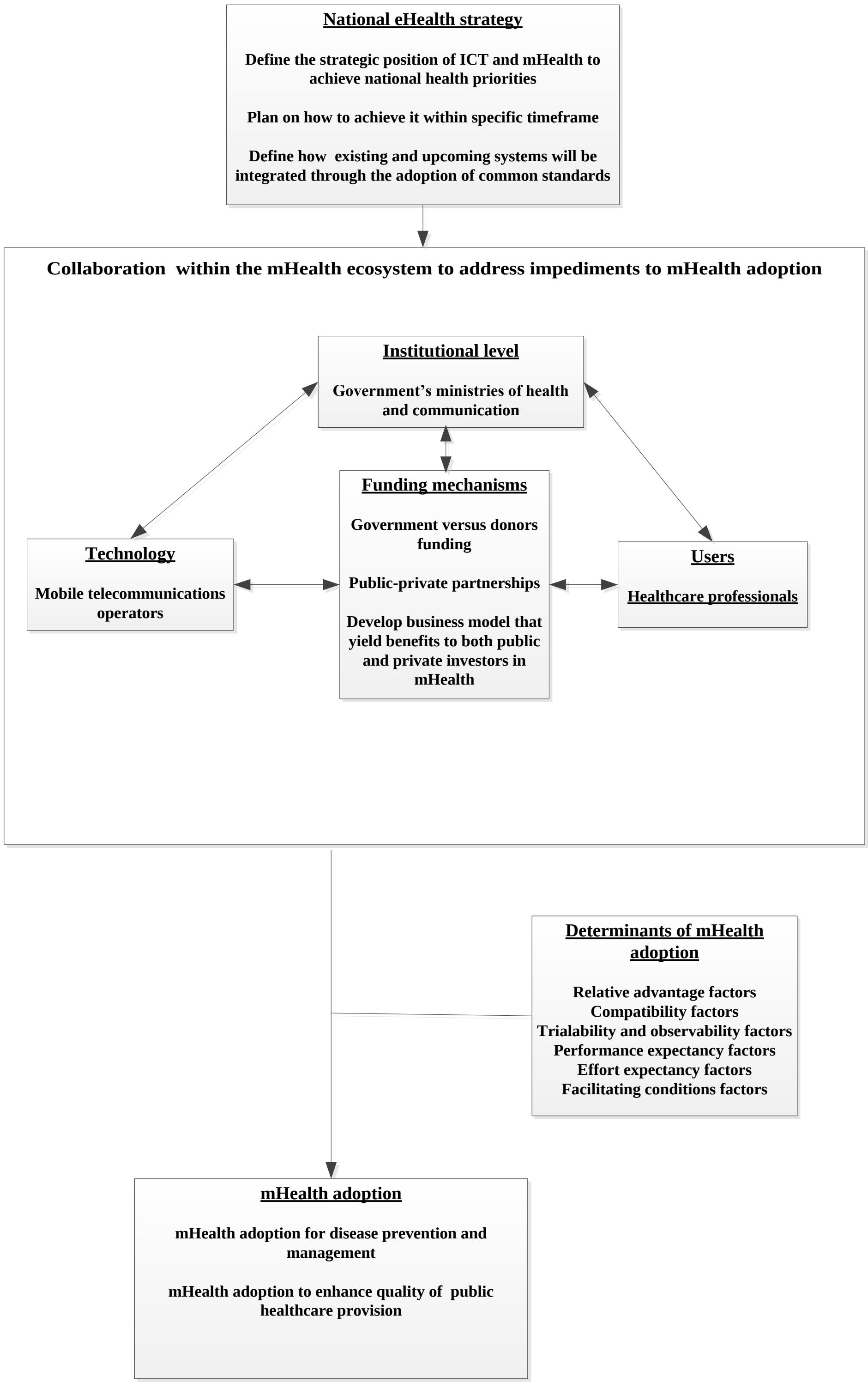

Figure 7. 3. Framework for the adoption of mHealth in Burundi13

7.9. Summary of chapter 7

This chapter elaborated on the findings from chapter 6. The chapter first presented the state of ICT utilization within the Burundi's public health sector. The public sector is currently dominated by paper-based data collection instruments which further poses issues of lack of real time access to data and lack of data reliability. In addition, mHealth applications are currently not used in the public sector with radio and television broadcast being the main channels for countrywide public health education programs. Cellphones are currently used by primary healthcare professionals to make calls. In answering the research questions, this chapter's discussion firstly pertained to healthcare professionals' willingness to adopt mHealth and their knowledge of mHealth. Although primary healthcare professionals are willing to adopt mHealth, their mHealth knowledge is limited. Hence, there is a need for mHealth education and awareness programs followed by an incremental process of adopting mHealth in Burundi. Secondly, factors that influence mHealth adoption (from the DOI and UTAUT models constructs) were discussed further. Healthcare professionals demonstrated self-efficacy toward using mHealth applications and mobile devices despite their limited knowledge of mHealth. Hence, complexity has no significant influence on mHealth adoption by primary healthcare professionals. However, relative advantage and compatibility factors have an influence on primary healthcare adoption of mHealth. Therefore, mHealth advocacy campaigns targeted to healthcare professionals in Burundi should emphasize work-related, organisational and experiential compatibility in addition to the two sets of relative advantages discussed in Chapter 6. Trialability and observability were also found to have a significant impact on the adoption of mHealth by healthcare professionals. In this chapter, it was argued that practical demonstration of mHealth capabilities to end users (through randomized trials and forging partnerships with other EAC countries that have adopted mHealth would increase mHealth adoption by healthcare professionals. In addition, mHealth solutions that contribute to the expansion of healthcare access, designed in a way that is convenient to users will be well accepted by primary healthcare professionals. Ease of use of mobile devices and mHealth applications (effort expectancy factors) were identified as determinants of mHealth adoption within the Burundi's context. Thus, good user interface design of mHealth applications is needed. Furthermore, existing and required facilitating conditions were discussed with an emphasis on building reliable mobile technology infrastructure, designing mHealth interventions in the local language and preserving privacy of mHealth users. The contribution of mHealth to the fight against diseases was also discussed. It was argued that in Burundi, mHealth has the potential to be used for disease prevention, management and also to ensure quality of healthcare provision. mHealth can enable real time access to data, expand access to medical treatment and address the shortage of trained healthcare professionals and fragmented access to data. Impediments to mHealth adoption in Burundi were classified into six categories i.e. policy and regulations issues, sociocultural issues, resistance to learning and change, economic issues, technical issues and ICT expertise, political issues. It was also argued that designing scalable and sustainable mHealth programs requires collaboration by various stakeholders. Thus, this research proposes an integrated, multi-stakeholders' framework that could address the identified impediments at the same time taking into cognisance the determinants of mHealth within the Burundi's context.

CHAPTER 8: CONCLUSIONS AND RECOMMENDATIONS

8.1. Introduction

This research investigated the potential use of mobile communications to enhance public healthcare in Burundi. It predominantly assessed primary healthcare professionals' knowledge of mHealth and their willingness to adopt mHealth; the determinants of mHealth adoption in Burundi; the potential role that mHealth can play in disease prevention, disease management and its contribution towards quality of healthcare services in Burundi; and impediments to mHealth adoption. The aim of this chapter is to recap the content of earlier chapters with an emphasis on the research findings and proposed solutions. It further outlines recommended suggestions for the implementation of mobile technologies as a tool to provide healthcare services in Burundi. The chapter further delineates the limitations of the study and suggestions for further research.

8.2. Recap of thesis chapters, research findings and proposed solutions

A literature survey revealed that mHealth research ranges from socio-economic factors that influence mHealth adoption to the evaluation of mHealth impact on people's health. However, Heerden, *et al*. (2012) argue that the use of theoretical frameworks within the mHealth study field is scarce. To address this gap, this study used three frameworks namely the Capability Approach, the Diffusion of Innovation (DOI) theory and the Unified Theory of Adoption and Use of Technology (UTAUT) to achieve its objectives. It further approached the issue of mHealth adoption in Burundi from three perspectives: the institutional perspective (government level), potential mHealth users' perspective (healthcare professionals) and the technology implementers' perspective. Hence, the study added a new integrated approach to the study of mHealth adoption. It is anticipated that findings that emanated from this research will not only address the gap within the mHealth research field but also will help Burundi's decision makers to make informed decisions in devising mHealth interventions to address some of the healthcare system's challenges.

The study adopted a methodological approach that firstly investigated literature on ICT4D research areas. The investigation led to the formulation of an initial conceptual framework on mHealth adoption in Burundi and potential research questions and objectives. Subsequently, a review of theoretical frameworks used in the study of ICT4 development was undertaken. This review led to the formulation of the final conceptual and theoretical frameworks to be used in the study, the updating of research questions and objectives, the formulation of survey questionnaire and interview questions. The survey instrument was subjected to expert scrutiny to test its validity before data collection commences. Collected data was analysed and discussed in the preceding chapters.

The literature review revealed that the use of mobile technologies to provide healthcare services presents several advantages compared to other ICT-enabled solutions for healthcare delivery such as telemedicine. Firstly, the number of mobile subscriptions worldwide is increasing exponentially. In 2013 for instance, the number of mobile subscriptions was equal to the global population (ITU, 2013). The expansion of mobile technology worldwide makes cellphones and mobile devices an ideal medium to reach a wider population especially in areas where the lack of Internet connection inhibits real time communication and access to resources (Lester, *et al*., 2006). Data transmission capabilities and portability are additional features that make mobile technology widely adopted compared to computers and the Internet (Mitchell, *et al*., 2011). Despite the large number of mobile phone subscribers in Burundi (which was estimated to be 2.247 million in 2012 (ISTAfrica, 2014)), mHealth adoption has lagged compared to its counterparts within the East African Community (EAC). A literature search found only two documented mHealth interventions in Burundi, the Rapid SMS (KIRAMAMA project) and the toll free SIDA info initiative (Nyssen, *et al*., 2015). On the contrary, the rest of the East African member states have had a number mHealth interventions (which were discussed in the literature review). In 2014 for instance, Kenya alone was ranked second for its innovative mHealth programs (Excelsior, 2014). Undoubtedly, Burundi can learn lessons from its counterparts that would assist in the implementation of mHealth projects.

This study took a positivist stance coupled with quantitative and qualitative data collection methods. On one hand, a questionnaire was used to conduct a survey with 212 healthcare professionals from 47 primary healthcare centres from 5 provinces using a cluster sampling method. The survey was designed to answer the research objective 1 (to assess health professionals' readiness to adopt mHealth); research objective 2 (to identify the determinants of mHealth adoption); research objective 3 (to identify potential contribution of mHealth interventions in achieving the country's broad goals in the health sector); and research objective 4 (to identify obstacles to mHealth adoption). On the other hand, interviews were conducted with two representative of the Ministry of Health, one representative of the Ministry of Communication and representatives of four mobile telecommunications companies. The interviews sought to identify additional determinants (research objective 2) and impediments (research objective 4) to mHealth adoption in Burundi and the potential role that mHealth can play in achieving the country's broad goals in the health sector (research objective 3).

The literature review identified positive GoB's efforts towards universal access to ICT throughout the country in an attempt to accelerate economic growth. These efforts are anchored in the country's 10 strategic goals of the national ICT development policy. These goals are developing ICT human resources, improving and adapting the regulatory, judicial and political landscape to include ICT as the cornerstone for economic development, improving ICT infrastructure, implementation of e-government and e-governance, developing ICT applications for economic development, and for social development, developing an ICT network to cater for rural network connectivity and universal access to communications via computer networks, to create and strengthen electronic transactions security mechanisms and lastly to develop national and regional contents. However, findings from this research reveal that ICT is seldom used to provide public healthcare services. Radio and television sets are the main links between the Ministry of Health and the recipients of health education and awareness messages. At the primary healthcare level, the image box is the main method for health education purposes. The use of telemedicine is demonstrated in two hospitals (one public hospital and one private hospital) for the sake of remote patients' treatment, training of health workers and diagnostic support. Nyssen, *et al*. (2015) established that paper-based instruments are still predominant in Burundi's health administration. Findings from this research found that field data collection is still done using paper forms. The Health Information System (GESIS) which is operational at the district and provincial offices becomes useful only once such data is captured into the system. GESIS then uses captured data for tracking diseases and to coordinate countrywide interventions. Nyssen, *et al*. (2015) identified shortfalls within ICT utilisation in the Burundi's public sector. These are donor-funded computer hardware for short span projects, a lack of ministry wide management of the distribution of computer equipment, a lack of knowledge on how to integrate computer equipment into healthcare professionals' activities, a low standard of hardware specifications, limited capacity of personal computers due to virus infections, a shortage of Hospital Information Systems (HIS), a lack of timely data transmission, a lack of adoption of ICT standards, data unavailability, poor quality of field data, a lack of effective data protection, a prevalence of defective computers, inadequate broadband Internet connectivity, an unregulated eHealth environment, a lack of health applications, insufficient human capacity. These shortfalls limit the prospects of using ICT as a strategic tool firstly to ensure universal access to healthcare services and secondly to assist the Burundi's Ministry of Health to achieve the set national health goals. Access to healthcare services is one of the pillars for a country's socio-economic development. Thus, a lack of strategic alignment of ICT within the Ministry of Health limits the prospects for the country's socio-economic development.

However, despite such challenges, the findings from this study reveal that healthcare professionals perceive mHealth as an ICT tool that can be adopted for disease prevention and management and for quality healthcare provision. Specifically, in the context of Burundi, it is perceived that customised SMS would contribute to disease prevention while the use of mobile devices for data collection, disease diagnosis and tracking, and for communication amongst healthcare workers would contribute to disease management. Additionally, using mobile devices to train healthcare workers and for treatment support would enhance the quality of healthcare provision in Burundi. Furthermore, at the macro level, replacing paper-based data collection instruments with mHealth tools would increase data reliability, increase timely response to emergencies, expand access to medical treatment and also address the issue of shortage of trained healthcare professionals. Figure 8.1 presents the current data collection and transmission procedures and depicts their major flaws. The narrative in section 8.1 is based on the interaction with healthcare workers at the Ministry's level and is further validated by referring to Nyssen, *et al*. (2015) in section 2.5.3 in chapter 2. Figure 8.2 depicts an illustrative scenario on how mHealth could be used for data collection and data sharing in the specific context of Burundi's public healthcare structures.

8.3. Current paper-based data collection from the community by Community-based Health Workers

The Community Based Health Worker (CBHW) collects data from the community and physically transports it to the Primary Healthcare Centres (PHCC). The PHCC then aggregates all the reports from the CBHWs and then physically transports an aggregate report to its district office (the district which the PHCC falls under). Each district then collects all the reports from its PHCCs, aggregates them and then sends them to the Provincial Health Department (BPS). The BPS captures all the districts' reports and then sends its report to the relevant department within the Ministry of Health (national level). The ministry's departments that normally receive reports from the BPS are: The Integrated National Programme against AIDS (PNILS), Integrated National Programme against Tuberculosis (PNILT), Integrated National Programme against neglected tropical diseases (PNIMTN), Integrated National Programme against Malaria (PNILP), and Integrated National Programme for Rural Peoples' Health (PNISR). It may take several weeks before each department receives needed information on disease outbreaks from the CBHWs. This has been identified as one of the major deficiencies within the Burundi health sector. Such a delay has been associated with the current inefficiency in dealing with preventable diseases and large scale occurrence of preventable deaths.

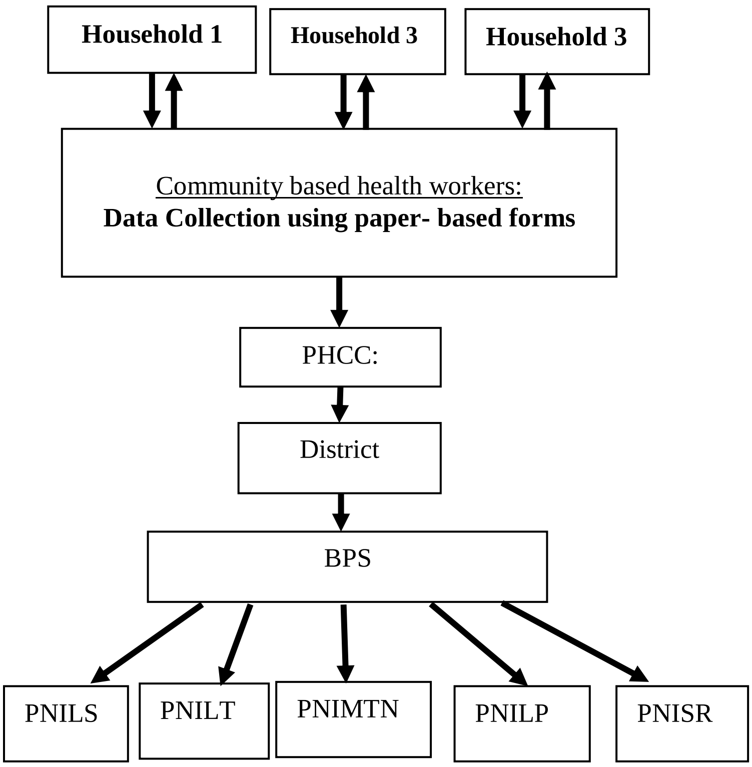

Figure 8. 1. Paper-based data collection from the CBHW

8.4. Proposed real time mobile-enabled data collection system from the community by Community-based Health Workers

The proposed mHealth-enabled data collection system uses mobile friendly electronic forms that can be downloaded onto mobile devices. Data collected from the community is captured through the mobile forms and are transmitted in real time to a central database that automatically aggregates the captured data into different categories. Health districts and provincial health departments have access to data while other departments at the national level have access to only a portion of information stored in the database based on their domain of specialisation. Such system speeds up information access and allows various departments to devise strategies to deal with any (potential) pandemic timeously.

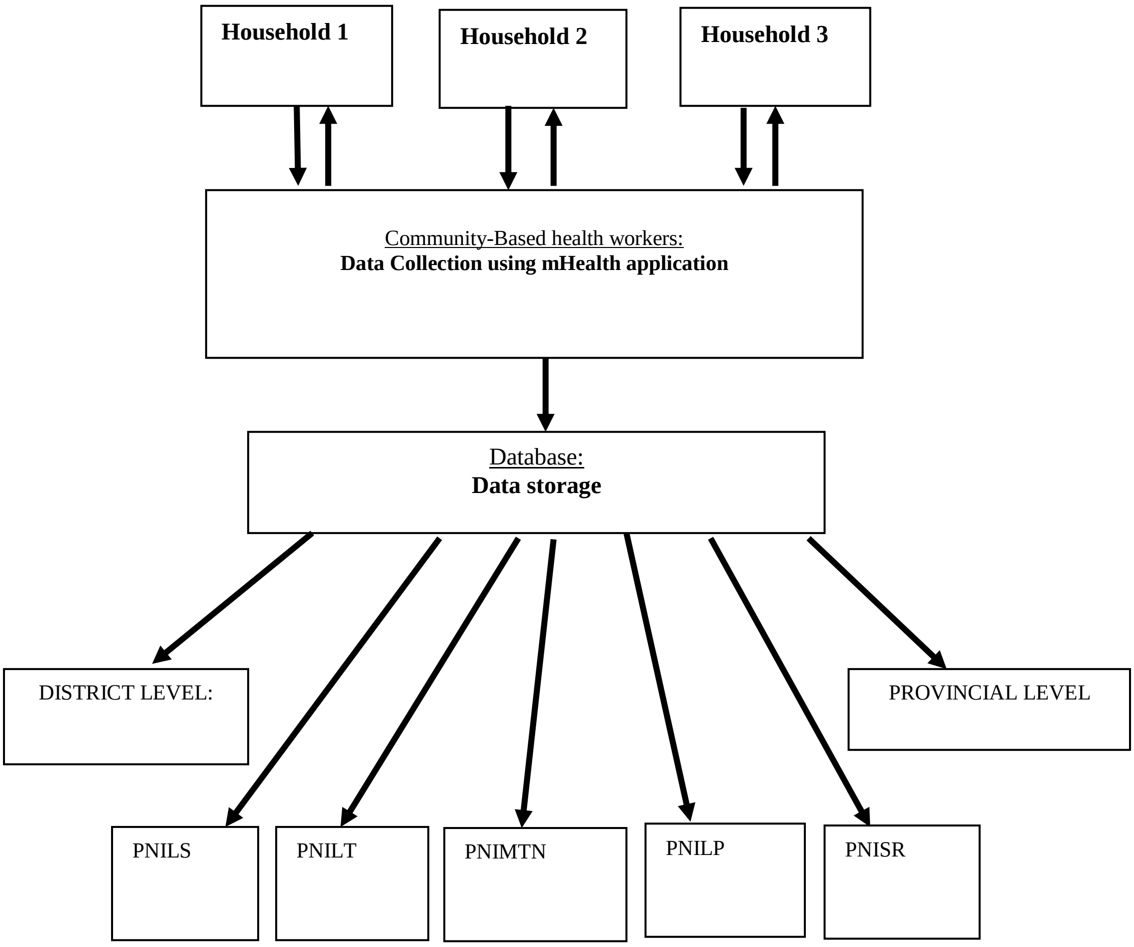

Figure 8. 2. Proposed Real Time Mobile enabled data collection

The success of mHealth as a tool to provide healthcare services largely depends on its acceptance by healthcare professionals (Gagnon, *et al*., 2016). This research established what is needed for Burundi's healthcare professionals to adopt mHealth based on the DOI and UTAUT constructs. Firstly, it was established that healthcare professionals' knowledge about mHealth capabilities is very limited. This is mostly due to the fact that healthcare professionals are not currently using mobile-enabled applications to provide healthcare services as phone calls are the most frequently used means of communication instead of mHealth applications. Furthermore, only a few healthcare professionals own additional mobile device besides their cellphones. Hence, additional options that other mobile devices such as tablets provide may be unknown to them. Although the need to know how mHealth works before adopting it was significantly correlated with mHealth adoption, not coping with using mHealth applications and mHealth services were not correlated with mHealth adoption except for monitoring and treating patients. In addition, complexity has no influence on mHealth adoption. Thus, one can deduce that healthcare professionals are willing to adopt mHealth despite the need to get acquainted with additional mobile devices and mHealth applications. However, due to the limited current knowledge of mHealth capabilities among healthcare professionals mHealth adoption needs to be introduced in a stepwise approach. The first approach is to bring more awareness of mobile technologies as a tool to provide healthcare services. The need for awareness was expressed through the interviews within the Ministry of Health, Ministry of Communication and the mobile technologies operators. In other words, this need was expressed by all the interviewees. Such awareness needs to be carried through the traditional methods that the Ministry of Health currently uses such radio and television broadcasting. It was established that the use of radio broadcasting has the potential to reach a large portion of the population, as it is the main source of information for most of Burundi's people (IMS, 2015). In addition, radio receivers are increasingly becoming portable as there are an increasing number of citizens that use their cellphone devices as Frequency Modulator (FM) receivers. Furthermore, awareness programs to promote the use of mHealth at the micro level (healthcare professionals' level) need to emphasize the identified determinants of mHealth (from a healthcare professional's point of view). It was established that there are DOI relative advantage factors, compatibility factors, trialability and observability factors that need to be considered for the successful adoption of mHealth by primary healthcare workers in Burundi. From the healthcare professional's point of view, mHealth will be adopted if it is perceived to be useful, makes one's job easier, reduces the amount of effort spent on executing some tasks, reaches a larger portion of the population, a larger portion of the population benefit from healthcare services and if it increases prevention and awareness of diseases. Statistically, it was deduced that these six relative advantages taken together influence healthcare professionals to adopt mHealth. By the same token, compatibility factors (taken together as a whole) such as compatibility with one's duties, what is needed to execute daily tasks, experience with mobile devices, organisational working style and work ethics influence healthcare professionals' mHealth adoption. Furthermore, mHealth may be adopted if it can be tried first, if its results can be evaluated, if it has proven to work elsewhere (trialability factors). Observability factors include the need to see tangible results before adopting mHealth. Variables within the UTAUT constructs i.e. performance expectancy, effort expectancy and facilitating conditions have an influence on the adoption of mHealth by healthcare professionals. Specifically, an expansion of healthcare access, convenience (performance expectancy factors), ease of use of mobile devices and ease of use of mHealth applications (effort expectancy factors) significantly influence healthcare professionals' adoption of mHealth. Significant facilitating conditions at the micro level include the affordability of mobile devices, the reliability of mobile technology infrastructure, free access to mHealth via SMS, the affordability of sending SMS, the affordability of making calls using a mobile phone, the content of mHealth message/service in local language and the confidentiality of information sent via mobile devices. Thus, mHealth awareness programs targeting healthcare professionals need to take into account these determinants in order to increase the prospects of mHealth acceptance by healthcare professionals. Although factors such as a lack of skills to develop mHealth applications, the high cost of mobile devices, low rate of cellphone penetration, unreliable network coverage and the high cost of network connection were identified by healthcare professionals as impediments to mHealth adoption, these factors do not negatively affect healthcare professionals' inclination to adopt mHealth.

At the macro level i.e. Health Ministry, Ministry of Communication and mobile technologies companies, gaps between the existing and required facilitating conditions were identified. Firstly, although there is a national ICT policy, findings reveal that the policy does not fully address ICT needs within the health sector. An eHealth strategy is needed instead. Secondly, although there is a planning committee for eHealth pilot projects, there is a need for a multi-sectoral approach to mHealth adoption to ensure its long term sustainability. Such a multi sectoral approach entails collaboration with other stakeholders in the mHealth ecosystem. Thirdly, this research established through literature review (for instance Nyssen, *et al*. (2015)) and from respondents that ICT funding in the health sector relies heavily on donor funding (80% of the budget). However, donor funding is frequently not reliable as donor-funded programs are experimental in nature without the prospects of scalability. Thus, once the donors' seed funding is exhausted, mHealth interventions associated with the funding are terminated (Vital Wave Consulting, 2009). Thus, additional sources of funding are needed to avoid sole reliance on donors' funding. Such other sources could emanate from partnerships between the public and private sectors. Additionally, Result Based Funding (already adopted by the Ministry of Health) could be adopted as a funding framework for mHealth initiatives and has the potential to attract additional funding from international sustainable healthcare promoting agencies (Qiang, *et al*., 2011). Fourthly, although the Ministry of Health has put in place initiatives to promote ICT (through information sharing workshops, public workshops and radio programs), there is a need for training in mobile device and applications use in the context of providing healthcare services. In addition, there is a need to make mobile devices available at affordable prices in the context of the current socio-economic state of the country. However, this needs a multi-stakeholder approach that involves the government, mobile telecommunications providers and other private entities that may want to venture into the mHealth industry. Furthermore, there is a need for a price regulation framework within the National Telecommunications Regulatory Authority (ARCT). Regulation will help stabilise the mobile telecommunications industry and will contribute to investor confidence in mHealth interventions. Subsequently, partnerships between the government and mobile operators are needed to build an adequate mobile telecommunications infrastructure that will ensure the wider dissemination of mHealth interventions through mobile telecommunications networks.

This research further established that impediments to mHealth adoption from macro (government's Ministry of Health, Ministry of Communication and mobile telecommunications providers') perspectives and micro (healthcare professionals') perspectives can be addressed through identified solutions (from literature) and recommended solutions. Firstly, an eHealth strategy is needed coupled with the adoption of regulations that foster the use of common standards within the Ministry of Health. These are essential components towards addressing policy and regulation issues that limit the adoption of mHealth within the Ministry of Health. Incorporating Interactive Voice Responses into mHealth programs, devising awareness programs that emphasize on the identified determinants of mHealth, educating and engaging end users in the development of mHealth interventions, collaborating with local partners to integrate local languages into mHealth programs and securing buy-in from the government and the Ministry of Health are the identified solutions that would address the socio-cultural impediments. The economic issues can be addressed through consultation between the public and private sectors, relaxing of government regulations on mobile operators, and consistency in the ARCT policies. Technical and ICT expertise issues could be solved through public and private partnerships, leveraging opportunities for collaboration within the East African Community, and developing and disseminating alternative power sources. Lastly, to address the political impediments, there is a need for a central coordinating department that will monitor and evaluate the use of mHealth for public healthcare in addition to securing buy-in of the government and the Ministry of Health (by aligning mHealth interventions with national health priorities).

8.5. Recommendations

1. ICT should be adopted within the public sector in Burundi taking a strategic approach. Specifically, there is a need of an eHealth strategy that will identify the strategic value of mHealth utilization within the health sector. The strategy should also clearly explain how mHealth interventions will be aligned with the national health priorities and how these interventions will help solve challenges that hinder the achievement of the national health goals. The strategy should also foster the use of common ICT standards and flexible processes to enable interoperability and scalability.
2. The mHealth ecosystem is made up of various actors that need to be considered for the successful implementation and adoption of mHealth interventions. Thus, an Open Innovation or collaborative approach is suggested. Such an approach would bring all stakeholders together to discuss and suggest best practices for mHealth adoption within the particular context of Burundi.

3. Telecommunications infrastructure expansion is required for mHealth to have a nationwide impact. Thus, the government of Burundi in consultation with the private sector needs to create a conducive environment to attract entrepreneurs into mobile technologies that can reach even remote areas of the country.
4. The East African Community (EAC) is a fertile ground for the exchange of knowledge pertaining to mHealth adoption. Forging partnership with other EAC member states that have already adopted sustainable mHealth interventions will enable the country to gain expert guidance into successfully adopting scalable mHealth solutions.
5. Private investment into mHealth ventures needs to be encouraged in order to avoid the sole reliance on donor funding. Hence, the formulation of a business model is required. The starting point should be investing in research that will identify a suitable business model within the country's socio-economic set up.
6. There is also need to have additional logistics (additional human resources and healthcare facilities) in place in order to deal with any possible increase in healthcare demands resulting from an increase in healthcare awareness due to mHealth-enabled interventions.
7. There is also need to develop an organisational culture within the Ministry of Health that supports mHealth adoption. Such a new organisation culture should emphasize the shift from ICT being viewed as a means to an end to ICT being a critical component in the attainment of countrywide goals.
8. In Burundi, research output is scarce. This poses an obstacle towards collaborative efforts to find sustainable solutions to socio-economic issues that the country currently faces. Thus, there is a need to invest more in ICT for development research to identify challenges to Burundi's socio-economic development and possible solutions.

8.6. Study's limitations and suggested future research

The study's scope is limited to the public sector. A further study is needed to incorporate the private healthcare sector. Such a study will assist in comparing perceptions from the two sectors' perspectives. Such a comparison will shed even more light onto the adoption of mHealth in Burundi. It will also assist in terms of assessing how prepared the private sector is to adopt mHealth compared to the public sector. It is anticipated that conclusions drawn from both perspectives will include additional factors that need to be considered in the context of mHealth adoption in Burundi.

The researcher acknowledges the low value of coefficients of determination for the regression analyses carried out in this research. Hence, the proposed regression models need to be tested and validated in real case scenario before being adopted. In addition, as mentioned in section 6.8, the researcher acknowledges that in terms of questionnaire wording, in some cases independent and dependent variables were conflated into one single item although this did not have any influence on the analysis nor the interpretation of results. It is suggested that future research could be more rigorously executed.

The researcher acknowledges that this study is nowhere exhaustive. For instance, the Capability Approach model was used in a specific and limited way mainly to identify potential mHealth capabilities in the Burundi's context. However, it is believed that the study generated knowledge on stakeholders' perceptions of local, economic, political and socio-cultural factors that may influence the adoption of mHealth in Burundi. The mHealth ecosystem is made up of a plethora of actors with sometimes-complex relationships. Thus, in addition to the stakeholders identified in this research, there is a need for an mHealth ecosystem environmental scan to identify all stakeholders and to devise strategies to include them in the planning, and implementation of mHealth projects. Moreover, future research should emphasize more on the indigenous Burundian features that may have theoretical implications.

8.7. Contribution of the study

This study is the first study that investigates the determinants of mHealth adoption within the public health sector in Burundi using primary data collection and a tripartite and integrated approach. The study adds a new, integrated perspective of mHealth adoption to the body of knowledge, focusing on end users, technology and the ministry level (decision makers). In view of the relevance and benefits of mHealth, it is anticipated that the framework that is derived from the findings of this study will enable the Burundi Ministry of health and other stakeholders to make informed decisions in disseminating healthcare services using mobile technology. Such an informed dissemination of mobile technology could have a wide impact on the population, thus enabling the country to address some pressing issues related to the management and prevention of diseases in Burundi. As mHealth research is evolving, there is a need for evidence of challenges and limitations to its adoption, particularly in developing countries. Thus, this research further contributes knowledge to this gap and could be used as a reference for future mHealth project implementations within a similar country set up.

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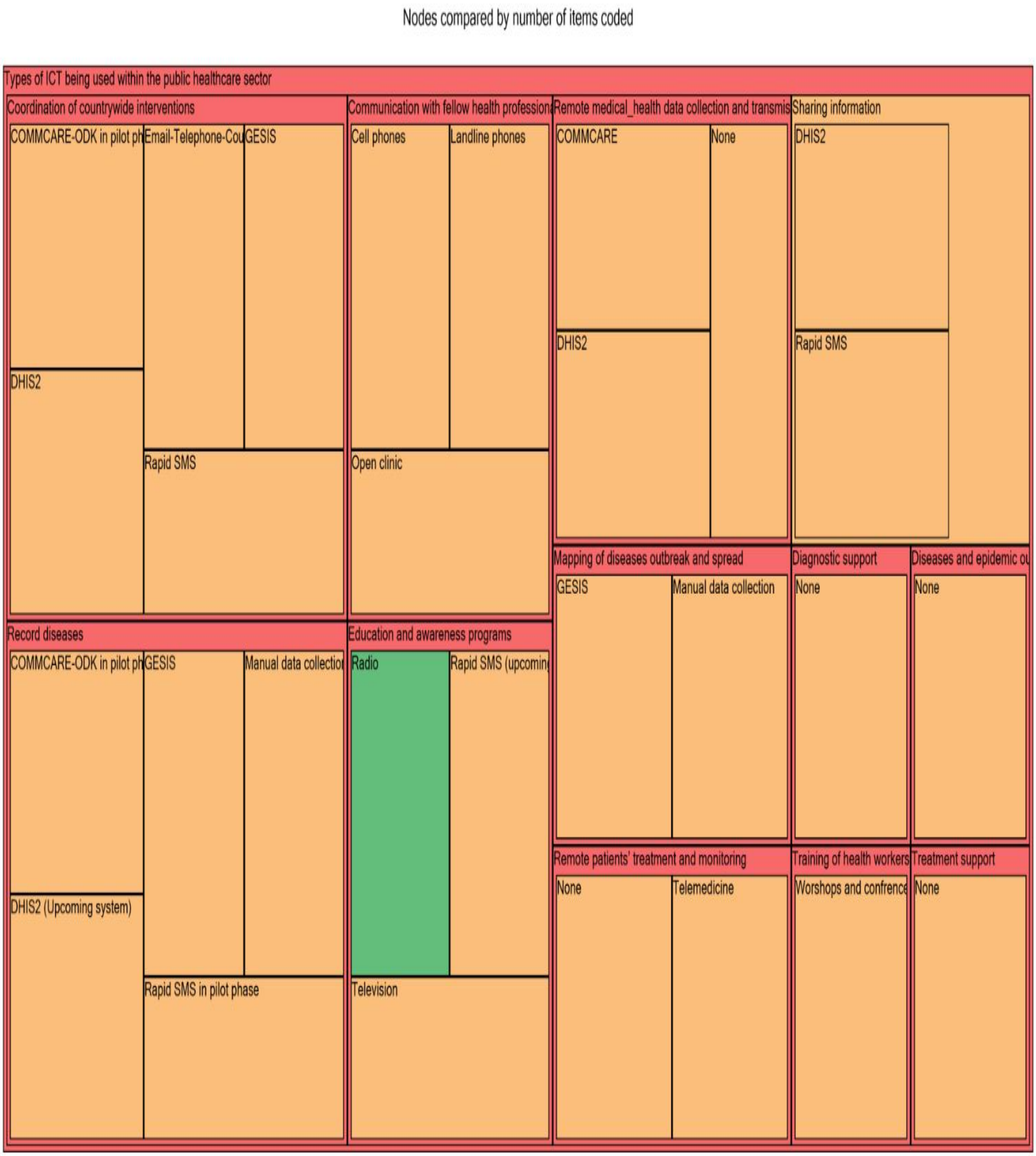
10. APPENDICES

10.1. Appendix A: Nvivo output



10.2. Appendix B: Questionnaires

QUESTIONNAIRE FOR HEALTHCARE PROFESSIONALS (English version)

SECTION A: GENERAL INFORMATION

1. Your age:

   Less than 18 years ☐ between 18 and 25 ☐ between 26 and 35 ☐ above 35 ☐

2. Your gender:

   Male ☐ Female ☐

3. In which health district and primary health care centres are you based?

   District: ____

   Primary health care centres___________________________________

4. What is your current designation:________________________________

5. Please provide a brief description of your current duties:_______________________________________

6. How often do you use the following ICTs to perform your duties at work? (Please tick wherever applicable). If there is any other ICT that you use to perform your duties but not listed below, please specify it and indicate how frequent you use it

	Never	Rarely	Sometimes	Often	Very often
6.1.Landline phones					
6.2.Cellphones					
6.3.Laptop					
6.4.Desktop computer					
6.5.Internet					
6.6.Wireless networks					
6.7.Other: Please specify___________					

SECTION B: CURRENT USE OF MOBILE HEALTH

7. For what work-related purpose (s) do you use the ICTs listed in the above table in question 4? (Please tick wherever applicable)

	ICTS							
Work-related purposes	Land line phones	Cellphones	Lap top	Desktop computer	Internet	Wireless networks	Other: Please specify:__________	Other: Please specify:__________
7.1.Education and awareness programs								
7.2.Remote medical/health data collection								
7.3.Remote patients' treatment and monitoring								
7.4.Communication with fellow health professional								
7.5.Training of health workers								
7.6.Diseases and epidemic outbreak tracking								
7.7.Diagnostic support								
7.8.Treatment support								
7.9.Other: please specify______								
7.10.Other: please specify______								

8. Please indicate how often you use your cellphone for the following services:

	Never	Rarely	Sometimes	Often	Very often
8.1.Internet browsing					
8.2.Facebook					
8.3.Twitter					
8.4.Cellphone banking					
8.5.Search for medical information					
8.6.Book an appointment with a patient					
8.7.Send medical information to your patient via SMS					

9. Have you ever received any medical information on your phone via SMS

Yes ☐ No ☐

10. Do you own any other mobile device except your cellphone?

No☐ Yes☐ : Please specify the type (s) of mobile device (s) that you have:

First mobile device: __________________

Second mobile device: ________________

Third mobile device: __________________

11. For what purposes do you use the mobile device (s) described in question 10? Please indicate how often you use the device for each purpose

11.1. First mobile device

	Very rarely	Rarely	Sometimes	Often	Very often
Purpose1: Please specify:_____________________					
Purpose2: Please specify:_____________________					
Purpose3: Please specify:_____________________					
Purpose4: Please specify:_____________________					
Purpose5: Please specify:_____________________					
Purpose6: Please specify:_____________________					
Purpose7: Please specify:_____________________					

11.2. Second mobile device

	Very rarely	Rarely	Sometimes	Often	Very often
Purpose1: Please specify:_____________________					
Purpose2: Please specify:_____________________					
Purpose3: Please specify:_____________________					
Purpose4: Please specify:_____________________					
Purpose5: Please specify:_____________________					
Purpose6: Please specify:_____________________					
Purpose7: Please specify:_____________________					

11.3. Mobile device

	Very rarely	Rarely	Sometimes	Often	Very often
Purpose1: Please specify:_____________________					
Purpose2: Please specify:_____________________					
Purpose3: Please specify:_____________________					
Purpose4: Please specify:_____________________					
Purpose5: Please specify:_____________________					
Purpose6: Please specify:_____________________					
Purpose7: Please specify:_____________________					

SECTION C: POTENTIAL ADOPTION OF MOBILE HEALTH

NOTE: ***MOBILE HEALTH REFERS TO THE USE OF MOBILE DEVICES (SUCH AS CELLPHONES) TO PROVIDE OR RECEIVE HEALTH CARE SERVICES***

12. Please indicate the extent to which you agree or disagree with the following statements

	Strongly Disagree	Disagree	I am not sure	Agree	Strongly Agree
12.1.I would accept to send SMS to make people aware of different methods of disease prevention					
12.2. I would accept to collect medical/health data by means of mobile devices					
12.3.I would accept to monitor and treat patients using mobile devices					
12.4.I would accept to communicate with fellow health professionals using mobile devices					
12.5.I would accept to train health workers using mobile devices					
12.6.I would accept to track diseases and epidemic outbreak using mobile devices					
12.7.I would accept to use mobile devices for diagnostic support					
12.8. I would accept to use mobile devices for treatment support					

	Strongly Disagree	Disagree	I am not sure	Agree	Strongly Agree
12.9.I would not adopt m-health because mobile devices are difficult to use					
12.10.I would not adopt m-health because m-health applications are difficult to learn					

12.11. I am willing to learn how to use mobile devices to provide m-health					
12.12. I am willing to learn how to use m-health applications					
12.13.I need to know how m-health works before adopting it					
12.14.I will not cope with using m-health devices					
12.15. I will not cope with using m-health applications					
12.16. I would adopt m-health because m-health devices are easier to use compared to other means of communication such as laptops or desktop computers.					
12.17.M-health is useful to me					
12.18. M-health will make my job easier					
12.19. M-heath will reduce the amount of effort spent on executing some tasks					
12.20. M-health would enable me to reach a larger portion of the country's population					
12.21. A larger portion of the population will benefit from health care services if m-health is implemented					
12.22.There will be an improvement in prevention and awareness of diseases should m-health be implemented					
12.23. M-health is compatible with my duties					
12.24. M-health is compatible with what I need to execute my daily tasks					
12.25.M-health is compatible with my experience with mobile devices					
12.26.M-health is compatible with my organisational working style					

12.27.M-health is compatible with my work ethics					
12.28. I would first test M-health before adopting it					
12.29. I would first adopt m-health and then evaluate the results					
12.30. I would adopt m-health anyway because it has proven to work in other countries					
12.31. I am willing to adopt m-health immediately without trying it					
12.32. I need to see tangible results of m-health adoption before adopting it.					
12.33. I need to be shown where m-health worked before adopting it					
12.34. I don't need to see tangible results of m-health. I will adopt it because I know it will work for me					

SECTION D: PERCEPTIONS OF THE ROLE OF M-HEALTH CAPABILITIES IN COMBATING HIV/AIDS, MALARIA AND OTHER DISEASES IN BURUNDI

NOTE: ***MOBILE HEALTH REFERS TO THE USE OF MOBILE DEVICES (SUCH AS CELLPHONES) TO PROVIDE OR RECEIVE HEALTH CARE SERVICES***

13. Please indicate the extent to which you agree/disagree with following statements

	Strongly Disagree	Disagree	I am not sure	Agree	Strongly Agree
13.1.Sending customized SMS's about disease prevention methods to mobile phone subscribers would contribute positively to disease prevention in Burundi					
13.2.Collecting patients 'medical/health data using smart mobile devices would contribute positively to disease management in Burundi					
13.3.Communicating with health field workers using mobile devices would enhance disease management processes in Burundi					
13.4.Training of health workers using mobile devices would enhance the quality of healthcare service provision in Burundi					

13.5.Tracking epidemic and disease outbreaks using mobile devices would enhance disease management processes in Burundi					
13.6.Diagnosis of diseases using mobile devices would enhance disease management in Burundi					
13.7.Treatment support using mobile devices would enhance the quality of healthcare service provision in Burundi					

SECTION E: DETERMINANTS OF M-HEALTH ADOPTON

14. To what extent do you agree/disagree with the following statements?

	Strongly Disagree	Disagree	I am not sure	Agree	Strongly Agree
14.1.Affordability of mobile devices is a factor that I would consider before adopting m-health					
14.2. Expansion of healthcare access (i.e. Ability to reach larger portion of the population compared to other technologies) is a factor that I would consider before adopting m-health					
14.3.Convenience is a factor that I would consider before adopting m-health					
14.4.Reliability of mobile technology infrastructure is a factor that I would consider before adopting m-health					
14.5.Free access to m-health via SMS is a factor that I would consider before adopting m-health					
14.6.Affordability of sending SMS is a factor that I would consider before adopting m-health					
14.7.Affordability of making calls using a mobile phone is a factor that I would consider before adopting m-health					
14.8.Content of m-health message/service in local language is a factor that I would consider before adopting m-health					
14.9.Compatibility of m-health service with my duties is a factor that I would consider before adopting m-health					
14.10.Confidentiality of information sent via mobile devices is a factor that I would consider before adopting m-health					

14.11.Ease of use of mobile device is a factor that I would consider before adopting m-health					
14.12.Ease of use of mobile health application is a factor that I would consider before adopting m-health					
14.13.Triability of m-health applications before implementation is a factor that I would consider before adopting m-health					
14.14.Tangible results from the trial period is a factor that I would consider before adopting m-health					

SECTION F: OBSTACLES TO M-HEALTH ADOPTION

15. To what extent do you agree/disagree with the following statements?

	Strongly Disagree	Disagree	I am not sure	Agree	Strongly Agree
15.1.Lack of skills to develop m-health applications is an impediment towards m-health adoption in Burundi					
15.2.High cost of mobile devices is an impediment towards m-health adoption in Burundi					
15.3.Low rate of cellphone penetration in the country is an impediment towards m-health adoption in Burundi					
15.4.Low rate of other mobile devices (excluding cellphones) penetration in the country is an impediment towards m-health adoption in Burundi					
15.5.Unreliable network coverage in rural areas is an impediment towards m-health adoption in Burundi					
15.6.High cost of network connection (airtime) is an impediment towards m-health adoption in Burundi					
15.7.High cost of mobile internet bundles is an impediment towards m-health adoption in Burundi					

THANK YOU FOR YOUR PARTICIPATION

QUESTIONNAIRE FOR HEALTHCARE PROFESSIONALS (FRENCH VERSION)

QUESTIONNAIRE POUR LES PROFESSIONNELS DE LA SANTÉ

SECTION A: INFORMATIONS GENERALES

1. Votre âge:

Moins de 18 ans ☐ Entre 18 et 25 ans ☐ Entre 26 et 35 ans ☐ Plus de 35 ans ☐

2. Votre sexe:

Homme ☐ Femme ☐

3. Dans quel district sanitaire et centre de santé de proximité êtes-vous basé?

District sanitaire: ____

Centre de santé de proximité : ______________________________________

4. Quelle est votre désignation professionnelle actuelle: ______________________

5. Veuillez fournir une brève description de votre tâche actuelle: ______________________
____

6. Avec quelle fréquence utilisez-vous les TIC suivantes pour effectuer votre tâche à votre lieu de travail? (Veuillez cocher la / les cases qui convient (-nent). S'il y a une autre TIC dont vous vous servez pour effectuer votre tâche, mais qui ne figure pas sur la liste ci-dessous, veuillez préciser laquelle et aussi à quelle fréquence vous l'utilisez.

	Jamais	Rarement	Quelquefois	Souvent	Très souvent
6.1.Téléphones fixes					
6.2. Téléphones cellulaires					
6.3.Ordinateur portable					
6.4. Ordinateur de table					
6.5.Internet					
6.6. Réseaux de connexion sans fil					
6.7.Autre: Veuillez préciser ______________					

SECTION B: UTILISATION ACTUELLE DU MOBILE POUR LA SANTÉ

7. Dans quel (s) but (s)lié(s) à l'accomplissement de votre tâche utilisez-vous les TIC telles que mentionnées plus haut au tableau de la 4e question? (Veuillez cocher la/les case (s) qui convient (-nent)).

	TIC					
Buts liés à votre travail	Téléphones fixes	Téléphones cellulaires	Ordinateur portable	Ordinateur de table	Internet	Réseaux de connexion sans fil	Autre: Veuillez préciser:______
7.1. Programmes d'Education et de sensibilisation							
7.2. Support de transmission après collecte de données médicales / sanitaires							
7.3. Support pour le traitement à distance et le suivi de l'état de santé des patients							
7.4. Communication avec d'autres professionnels de santé							
7.5. Support de formation du personnel de santé							
7.6. Suivi de l'émergence des maladies et épidémies							
7.7. Support d'Appui au diagnostic							
7.8. Support d'Appui au traitement des patients							
7.9.Autre:Veuillez préciser ___________________________							

8.Veuillez indiquer avec quelle fréquence vous utilisez votre téléphone cellulaire pour ces services:

	Jamais	Rarement	Quelquefois	Souvent	Très souvent
8.1Navigation sur Internet					
8.2. Réseau social Facebook					
8.3. Réseau social Twitter					
8.4. Services bancaires via la téléphonie cellulaire					
8.5.La recherche de l'information médicale					
8.6.Fixer un rendez-vous avec un médecin					
8.7. Envoyer par SMS des renseignements médicaux à votre médecin traitant					

9. Avez-vous déjà reçu une quelconque information médicale sur votre téléphone par SMS ?
Oui ☐ Non ☐

10. Possédez- vous l'un ou l'autre appareil mobile à part votre téléphone cellulaire?
Non ☐ Oui☐: Veuillez préciser le type(s) d'appareil mobile(s) que vous avez

Premier appareil : ___________________

Deuxième appareil : _________________

Troisième appareil : ___________________

11. À quelles fins utilisez-vous le / les appareil(s) mobile(s) décrits à la10e question ? Veuillez indiquer pour chacune de ces fins avec quelle fréquence vous utilisez cet/ ces appareil(s).

11.1. <u>Premier appareil</u>

	Très rarement	Rarement	Quelquefois	Souvent	Très souvent
1ère fin: Veuillez préciser:______________________					
2 e fin: Veuillez préciser:______________________					
3 e fin: Veuillez préciser:______________________					
4 e fin: Veuillez préciser:______________________					

5^{e} fin: Veuillez préciser:_____________________					
6^{e} fin: Veuillez préciser :______________________					
7^{e} fin: Veuillez préciser:_____________________					

11.2. Deuxième appareil

	Très rarement	Rarement	Quelquefois	Souvent	Très souvent
1èrefin: Veuillez préciser:_____________________					
2^{e}fin: Veuillez préciser:_____________________					
3^{e} fin: Veuillez préciser:_____________________					
4^{e} fin: Veuillez préciser:_____________________					
5^{e} fin: Veuillez préciser:_____________________					
6^{e} fin: Veuillez préciser :______________________					
7^{e} fin: Veuillez préciser:_____________________					

11.3. Troisième appareil

	Très rarement	Rarement	Quelquefois	Souvent	Très souvent
1ère fin: Veuillez préciser:_____________________					
2e fin: Veuillez préciser:_____________________					
3e fin: Veuillez préciser:_____________________					
4e fin: Veuillez préciser:_____________________					
5e fin: Veuillez préciser:_____________________					
6e fin: Veuillez préciser :_____________________					
7e fin: Veuillez préciser:_____________________					

SECTION C: ADOPTION POTENTIELLE DE LA SANTÉ VIA LE MOBILE

*REMARQUE**: LA** SANTÉ**VIA LE** MOBILEREFERE A L'UTILISATIONDES APPAREILS MOBILES(**TELS LES TELEPHONES CELLULAIRES) POUR DISPENSER** OU RECEVOIR DES SOINSDESANTÉ*

12. Veuillez indiquer dans quelle mesure vous êtes d'accord ou pas avec les énoncés suivants:

	Totalement Contre	Contre	Je ne suis pas sûr (e)	D'accord	Totalementd'accord
12.1. J'accepterais d'envoyer des SMS aux gens pour les conscientiser sur les différentes méthodes de prévenir les maladies					

12.2. J'accepterais de recueillir des données médicales/sanitai-res au moyen d'appareils mobiles					
12.3. J'accepterais de suivre et de traiter des patients en utilisant des appareils mobiles					
12.4. J'accepterais de communiquer avec d'autres professionnels de la santé en utilisant des appareils mobiles					
12.5. J'accepterais de former le personnel de santé en utilisant des appareils mobiles					
12.6. J'accepterais de suivre l'émergence des maladies/épidémies et leur évolution en utilisant des appareils mobiles					
12.7. J'accepterais d'utiliser des appareils mobiles comme supports d'appui au diagnostic					
12.8. J'accepterais d'utiliser les appareils mobiles comme supports d'appui au traitement des patients					

	Totalement Contre	Contre	Je ne suis pas sûr (e)	D'accord	Totalement d'accord
12.9. Je ne pratiquerai pas Ia santé via le mobile si les appareils mobiles sont difficiles à utiliser					
12.10. Je ne pratiquerai pas la santé via le mobile s'il s'avère difficile d'en apprendre les logiciels					
12.11. J'apprendrai volontiers comment utiliser les appareils mobiles en					

vue de pratiquer la santé via le mobile					
12.12. J'apprendrai volontiers comment utiliser les logiciels de la santé via le mobile					
12.13. J'ai besoin de savoir comment la santé via le mobile fonctionne avant de la pratiquer					
12.14. Je ne suis pas capable d'utiliser les appareils pour la santé via le mobile					
12.15 Je ne suis pas capable d'utiliser les logiciels de la santé via le mobile					
12.16. Je pratiquerais Ia santé via le mobile car les appareils mobiles sont plus faciles à utiliser par rapport à d'autres moyens de transmission de l'information tels que les ordinateurs de table ou portables					
12.17. La santé via le mobile m'est utile					
12.18. La santé via le mobile rendra mon travail plus facile					
12.19. La santé via le mobile réduira la quantité d'effort à fournir pour exécuter certaines tâches					
12.20. La santé via le mobile me permettra d'atteindre une plus grande partie de la population du pays					
12.21. Une grande partie de la population bénéficiera des soins de santé si la santé via le mobile est mise en œuvre					
12.22. La mise en œuvre de la santé via le mobile améliorera la prévention des maladies et la sensibilisation des gens sur ces dernières					

12.23. La santé via le mobile est compatible avec mon travail					
12.24. La santé via le mobile est compatible avec ce dont j'ai besoin pour accomplir de mes tâches quotidiennes					
12.25. La santé via le mobile est compatible avec mon expérience dans l'utilisation des appareils mobiles					
12.26. La santé via le mobile est compatible avec le style de travail dans votre structure de santé					
12.27. La santé via le mobile est compatible avec la déontologie de votre profession					
12.28. Je testerais d'abord la santé via le mobile avant de la pratiquer					
12.29. Je pratiquerais d'abord la santé via le mobile et en évaluerais ensuite les résultats					
12.30. Je pratiquerais quand même la santé via le mobile parce qu'elle a été expérimentée avec succès dans d'autres pays					
12.31. Je pratiquerai volontiers la santé via le mobile immédiatement sans l'essayer					
12.32. J'ai besoin de voir des résultats tangibles de la mise en œuvre de la santé via le mobile avant de la pratiquer.					
12.33. J'ai besoin de voir là où la santé via le mobile est effectivement mise en œuvre avant de la pratiquer					
12.34. Je n'ai pas besoin de voir des résultats tangibles de la mise en œuvre de la santé via le mobile. Je la pratiquerai parce que je sais que ça va marcher					

SECTION D : LES PERCEPTIONS SUR LE ROLE DES OPPORTUNITES OFFERTES PAR LA SANTÉ VIA LE MOBILE DANS LA LUTTE CONTRE VIH / SIDA, LE PALUDISME ET AUTRES MALADIES AU BURUNDI

REMARQUE : LA SANTÉ PAR LE MOBILEREFERE A L'UTILISATIONDES APPAREILS MOBILES (TELS LES TELEPHONES CELLULAIRES) POUR DISPENSER OU RECEVOIR DES SOINS DE SANTÉ

13. Veuillez indiquer dans quelle mesure vous êtes d'accord ou pas avec les énoncés suivants :

	Totalemen tcontre	Contre	Je ne suis pas sûr (e)	D'accor d	Totalement D'accord
13.1. Envoyer des SMS personnalisés sur les méthodes de prévention des maladies aux abonnés de la téléphonie mobile contribuerait sensiblement à la prévention des maladies au Burundi					
13.2. Collecter les données médicales /sanitaires des patients en utilisant des appareils mobiles intelligents contribuerait sensiblement à la gestion des maladies au Burundi					
13.3. Communiquer avec le personnel de santé travaillant sur terrain en utilisant des appareils mobiles améliorerait les processus de gestion de la maladie au Burundi					
13.4. Des formations pour le personnel de santé en utilisant des appareils mobiles amélioreraient la qualité des soins de santé au Burundi					
13.5. Suivre l'émergence des épidémies et maladies en utilisant des appareils mobiles améliorerait les processus de gestion de la maladie au Burundi					
13.6. Diagnostiquer les maladies en utilisant des appareils mobiles améliorerait la gestion des maladies au Burundi					
13.7. Utiliser des appareils mobiles comme supports d'appui au traitement des patients améliorerait la qualité des soins de santé au Burundi					

SECTION E : DETERMINANTS DE LA MISE EN ŒUVRE DE LA SANTÉ VIA LE MOBILE

14. Dans quelle mesure êtes- vous d'accord ou pas avec les énoncés suivants ?

	Totalement contre	Contre	Je ne suis pas sûr (e)	D'accord	Totalement d'accord
14.1. Le coût des appareils mobiles est un facteur que j'examinerais avant de pratiquer la santé via le mobile					
14.2. Le degré de couverture en termes d'accès aux soins de santé (soit la capacité d'atteindre une plus grande partie de la population par rapport aux autres technologies) est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.3. Le caractère pratique est un facteur que je considèrerais avant de mettre en œuvre la santé via le mobile					
14.4. La fiabilité des infrastructures de la technologie du mobile est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.5. L'accès gratuit à la santé via le mobile par SMS est un facteur que je considèrerais avant de la pratiquer					
14.6. Le coût de l'envoi de SMS est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.7. Le coût des appels par téléphone					

mobile est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.8. Le contenu du message/service de la santé via le mobile dans la langue locale est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.9. La compatibilité de la santé via le mobile avec mon travail un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.10. La confidentialité de l'information envoyée via les appareils mobiles est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.11. L'aisance à utiliser l'appareil mobile est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.12. L'aisance à utiliser le module de la santé via le mobile est un facteur que je considèrerais avant de pratiquer cette dernière					
14.13. L'essai des logiciels de la santé via le mobile avant sa mise en œuvre est un facteur que je considèrerais avant de pratiquer la santé via le mobile					
14.14. Des résultats tangibles à la fin de la période d'essai constituent un facteur que considèrerais					

avant de pratiquer la santé via le mobile					

SECTION F : **OBSTACLES A LA MISE EN ŒUVRE DE LA SANTÉ VIA LE MOBILE**

15. Dans quelle mesure êtes-vous d'accord ou pas avec les énoncés suivants ?

	Totalement contre	Contre	Je ne suis pas sûr (e)	D'accord	Totalement D'accord
15.1. Le manque de compétences pour répandre les logiciels de la santé via le mobile est un obstacle à sa mise en œuvre au Burundi					
15.2. Le coût élevé des appareils mobiles est un obstacle à la mise en œuvre de la santé via le mobile au Burundi					
15.3. Le faible niveau d'accès à la téléphonie cellulaire dans le pays est un obstacle à la mise en œuvre de la santé via le mobile au Burundi					
15.4. Le faible niveau d'accès aux autres appareils mobiles (à part les téléphones cellulaires) dans le pays est un obstacle à la mise en œuvre de la santé via le mobile au Burundi					
15.5. L'insuffisance de la couverture du réseau mobile dans les zones rurales est un obstacle à la mise en œuvre de la santé via le mobile au Burundi					
15.6. Le coût élevé de la connexion au réseau (cartes de recharge) est un obstacle à la mise en œuvre de la santé via le mobile au Burundi					
15.7. Le coût élevé de la connexion sur l'Internet mobile est un obstacle à la mise en œuvre de la santé via le mobile au Burundi					

MERCI POUR VOTRE PARTICIPATION

INTERVIEW QUESTIONNAIRE FOR THE MINISTRY OF HEALTH AND FIGHT AGAINST AIDS (English version)

SECTION A: BACKGROUND INFORMATION

1. Name of the Ministry:___________

2. Current official designation: ___________________________

3. Years of experience in current designation (in years)

    3.1. Less than 3 years ☐
    3.2. Between 3 and 5 years ☐
    3.3. Between 5 and 10 years ☐
    3.4. More than 10 years ☐

4. Date of interview: _________________________________

Section B: ICT IMPLEMENTATION IN THE MINISTRY

ICT IMPLEMENTATION STRATEGY

5. What are the ICTs used in the public healthcare sector
6. For what purpose (s) are these ICTs used?
7. What types of ICT (if any) being used to:
    a. Record diseases
    b. Map disease outbreak and spread
    c. Coordination of countrywide interventions
    d. Sharing information
    e. Education and awareness programs
    f. Remote medical/health data collection
    g. Remote patients' treatment and monitoring
    h. Communication with fellow health professionals
    i. Training of health workers
    j. Diseases and epidemic outbreak tracking
    k. Diagnostic support
    l. Treatment support
8. Are ICTs adopted on Adhoc basis or is there a long term plan for ICT adoption in the health sector?

9. Is there any current strategy to secure long term sustainability of ICT in the health sector

ALIGNMENT OF MULTISECTORAL INTERVENTIONS WITH ICT

10. How does ICT help achieve national health-related goals? Please give some examples

BENEFITS OF ICT USE IN THE HEALTH SECTOR

11. How is ICT use in the health sector beneficial to the 1.community and to 2.health workers?

IMPEDIMENTS OF ICT ADOPTION

12. What are the impediments of ICT adoption in the health sector

SECTION B: PERCEPTIONS OF MOBILE HEALTH ADOPTION

THE TERM MOBILE HEALTH REFER TO THE USE OF MOBILE DEVICES (SUCH AS CELLPHONES) TO PROVIDE OR RECEIVE HEALTH CARE SERVICES

13. Is there any m-health initiative in the country?

    Yes No: if yes please specify which one____________________

14. On a scale of 1 to 5 (1=Now: Already introduced, 2= in less than 1year, 3= in 3 years, 4=in more than 3 years' time,5=Never= It will never be introduced), please indicate when the ministry will introduce the use mobile technology to :
    a. Collect health-related data [ ]
    b. Facilitate communication amongst health workers [ ]
    c. Educate health workers [ ]
    d. Train health workers [ ]
    e. Diagnose diseases [ ]
    f. Treat diseases [ ]
    g. Monitor patients [ ]
    h. Track diseases and epidemic outbreak [ ]
15. What could be the advantages of adopting m-health?
16. Do you think m-health will be easier to use than the currently used ICTs
17. Do you think m-health would enable the dissemination of health care services to larger portion of the population than the currently used ICTs? How?
18. What could be/are obstacles for using mobile devices such as cellphones to provide health care services?
19. What could be done in order to facilitate m-health adoption by health workers?

20. What is the role of the Ministry of health and the government in:

1. Funding ICTs initiatives (including m-health) in the health sector. Is the government the primary source of funds or NGOs?
2. Promoting ICT adoption and use in the health sector. Are there any initiatives in place to promote ICT and/or mobile health? If there is any, please elaborate

INTERVIEW QUESTIONNAIRE WITH THE MINISTRY OF HEALTH AND MINISTRY OF AIDS (FRENCH VERSION)

QUESTIONNAIRE D'ENTREVUE AVEC LES GESTIONNAIRES NATIONAUX EN CHARGE DE CES ACTIVITES AU MINISTÈRE DE LA SANTÉ PUBLIQUE ET DE LA LUTTE CONTRE LE SIDA

SECTION A: INFORMATIONS SUR LE MINISTERE

1. Nom du ministère: ______________________________________

2. Désignation officielle actuelle: _____________________________

3. Années d'expérience dans la désignation actuelle (en années)

   3.1. Moins de 3 ans ☐

   3.2. Entre 3 et 5 ans ☐

   3.3. Entre 5 et 10 ans ☐

   3.4. Plus de 10 ans ☐

4. Date de l'entrevue: ______________________________________

SECTION B: MISE EN ŒUVRE DES TIC AUDIT MINISTERE

STRATÉGIE DE MISE EN ŒUVRE DES TIC

5. Quelles sont les TIC utilisées dans le domaine de la santé publique ?

6. Dans quel (s) but (s) ces TIC sont- elles utilisées?

7. Quels types de TIC (s'il y en a) sont utilisées pour :

   a. Répertorier les maladies

   b. Schématiser l'émergence des maladies et leur propagation

   c. Coordonner les interventions à l'échelle nationale

   d. Echanger les informations

   e. Programmes d'éducation et de sensibilisation

   f. Transmettre les données médicales / sanitaires collectées

   g. Support pour le traitement à distance et le suivi de l'état de santé des patients

   h. Communiquer avec les autres professionnels de la santé

   i. Former le personnel de santé

   j. Suivre l'émergence des maladies et épidémies

   k. Support d'appui au diagnostic

l. Support d’appui au traitement des maladies

8. Les TIC sont-elles mises en œuvres de manière circonstancielle ou cela fait partie d’un plan à long terme de mise œuvre des TIC dans le domaine de la santé?

9. Y a-t-il une stratégie en cours d’exécution en vue d’assurer la viabilité à long terme des TIC dans le domaine de la santé ?

HARMONISATION DES INTERVENTIONS MULTISECTORIELLES EN MATIERE DE TIC

10. Comment les TIC contribuent-elles à atteindre les objectifs sanitaires nationaux? Veuillez donner quelques exemples

AVANTAGES DE L'UTILISATION DES TIC DANS LE DOMAINE DE LA SANTÉ

11. Comment l'utilisation des TIC dans le secteur de la santé est-elle profitable pour la 1. Communauté et 2. le personnel de santé ?

OBSTACLES A LA MISE EN ŒUVRE DES TIC

12. Quels sont les obstacles à la mise en œuvre des TIC dans le domaine de la santé ?

a. Du point de vue de la communauté

b. Du point de vue des professionnels de la santé

SECTION B: LES PERCEPTIONS SUR LA MISE EN ŒUVRE DE LA SANTÉ VIA LE MOBILE

LA TERMINOLOGIE ‘ LA SANTÉ VIA LE MOBILE ’ *REFERE* A L'UTILISATION DES APPAREILS MOBILES (TELS LES TELEPHONES CELLULAIRES) *POUR DISPENSER O*U RECEVOIR DES SOINS DE SANTÉ

13. Existe-il une initiative ‘santé via le mobile’ dans le pays?

Oui ☐ **Non**☐

Si oui, veuillez préciser laquelle ____

14. Sur une échelle de 1 à 5,

(1 = Maintenant: Déjà en application

2 = D’ici quelques mois, dans moins d’ 1 année

3 = D’ici 3 ans

4 = D’ici 3 ans et plus

5 = Impossible = Elle ne sera jamais mise en œuvre)

veuillez indiquer quand est-ce que le ministère mettra en place l'utilisation de la technologie du mobile pour:

a. Recueillir des données sanitaires [ ]

b. Faciliter la communication parmi le personnel de santé [ ]

c. Former le personnel de santé [ ]

d. Offrir des formations au personnel de santé [ ]

e. Diagnostiquer des maladies [ ]

f. Traiter des maladies [ ]

g. Surveiller les patients [ ]

h. Suivre l'émergence des maladies et épidémies [ ]

15. Quels pourraient être les avantages de la mise en œuvre de la santé via le mobile comparativement aux TIC actuellement utilisées?

16. Pensez-vous que la santé via le mobile sera d'un usage plus facile que les TIC actuellement utilisées ?

17. Pensez-vous que la santé via le mobile permettrait d'étendre l'accès aux soins de santé à une plus grande partie de la population que les TIC actuellement utilisées? Comment?

18. Quels seraient / sont les obstacles à l'utilisation des appareils mobiles tels que les téléphones cellulaires en vue de dispenser des soins de santé?

19. Quelles actions pourraient être menées afin de faciliter la mise en œuvre de la santé via le mobile par le personnel de santé?

20. Quel est le rôle du ministère de la santé et du gouvernement dans:

1. Le financement des Initiatives sur les TIC (y compris la santé via le mobile) dans le domaine de la santé. Le gouvernement est-il la principale source de financement ou ce sont les ONG?
2. La promotion de l'utilisation des TIC dans le domaine de la santé. Y a-t-il des initiatives mises en place pour promouvoir les TIC et / ou la santé via le mobile? S'il y en a, veuillez expliciter.

INTERVIEW QUESTIONNAIRE FOR THE MINISTRY OF COMMUNICATION

SECTION A: BACKGROUND INFORMATION

1. Current official designation: ______________________________

2. Years of experience in current designation (in years)

   2.1. Less than 3 years ☐
   2.2. Between 3 and 5 years ☐
   2.3. Between 5 and 10 years ☐
   2.4. More than 10 years ☐

Date of interview: _____________________________

SECTION B: FACILITATING CONDITIONS FOR mHealth ADOPTION

3. How does the current National ICT strategy facilitate ICT adoption?
4. What are the mechanisms the ministry has in place to facilitate ICTs adoption
5. Is the ministry involved in the planning and/or implementation of any m-health initiatives? If yes, which m-health initiatives is the ministry involved in and how is the ministry involved?
6. What could the Ministry of communication do to make it easier for health professionals and the community to adopt m-health?
7. What is the current ICT implementation strategy to secure long term sustainability of ICT and m-health projects?

SECTION C: IMPEDIMENTS TO mHealth ADOPTION IN BURUNDI

8. From the Ministry of communication perspective, what do you see as obstacles to m-health adoption and how can the ministry contribute to removing these obstacles?
9. Are there any plans in place to address these obstacles? Does the ministry have specific timeframes to address these obstacles?

INTERVIEW QUESTIONNAIRE FOR THE MINISTRY OF COMMUNICATION (FRENCH VERSION)

QUESTIONNAIRE D'ENTREVUE AU MINISTERE EN CHARGE DE LA COMMUNICATION

SECTION A : INFORMATIONS GENERALES

1. Désignation officielle actuelle: ______________________________

2. Années d'expérience dans la désignation actuelle (en années)

   2.1. Moins de 3 an ☐
   2.2. Entre 3 et 5 anné ☐
   2.3. Entre 5 et 10 a ☐
   2.4. Plus de 10 ar ☐

Date de l'entrevue: ______________________________________

SECTION B : CONDITIONS QUI FACILITENT LA MISE EN ŒUVRE DE LA SANTÉ VIA LE MOBILE

3. De quelle manière l'actuelle stratégie nationale des TIC facilite-t-elle leur mise en œuvre ?

4. Quels sont les mécanismes que le ministère a mis en place pour faciliter la mise en œuvre des TIC ?

5. Est- ce que le ministère participe à la planification et / ou la mise en œuvre de l'une ou l'autre initiative concernant la santé via le mobile?
   Si oui, dans quelles initiatives sur la santé via le mobile le ministère est-il engagé et comment ?

6. Du point de vue du ministère en charge de la communication, quels sont d'après vous les obstacles à la mise en œuvre de la santé via le mobile et comment le ministère peut-il contribuer à les surmonter?

7. Y a-t-il des stratégies mises en place en vue de contourner ces obstacles?
   Pour ce faire, le ministère a-t- il des délais précis ?

8. Quelles actions le ministère en charge de la communication pourrait-il mener pour faciliter la mise en œuvre de la santé via le mobile par les professionnels de la santé et la communauté ?

9. Quelle est l'actuelle stratégie de mise en œuvre des TIC visant à garantir la viabilité à long terme des projets des TIC et de la santé via le mobile ?

INTERVIEW QUESTIONNAIRE FOR

MOBILE TELECOMMUNICATION OPERATORS

SECTION A: BACKGROUND INFORMATION

1. Current official designation: ____________________________

2. Years of experience in current designation (in years)

   2.1. Less than 3 years ☐
   2.2. Between 3 and 5 years ☐
   2.3. Between 5 and 10 years ☐
   2.4. More than 10 years ☐

3. Date of interview: __________________________________

4. Please discuss the m-health services, if any, that your company's networks support in Burundi

5. Please discuss the m-health services, if any, that your company's networks support in other parts of the world?

6. Please explain how the current National ICT policy affect your service delivery in Burundi

7. Please explain how the National ICT Regulatory authority affect your service delivery in Burundi

8. Is your current infrastructure adequate for the launch of m-health initiatives/wide dissemination of m-health initiatives in the country? Please explain_____________________________

9. In your opinion, what could be done to ensure the sustainability of m-health initiatives in Burundi?

10. In your opinion, what could be done to ensure the scalability of m-health initiatives in Burundi?

11. What are the obstacles to m-health adoption in Burundi?

QUESTIONNAIRE D'ENTREVUE AVEC LES OPERATEURS DE TELEPHONIE MOBILE (FRENCH VERSION)

SECTION A: INFORMATIONS GENERALES

1. Désignation officielle actuelle: ____________________________

2. Années d'expérience dans la désignation actuelle (en années)
   3.1. Moins de 3 ans ☐
   3.2. Entre 3 et 5 ans ☐
   3.3. Entre 5 et 10 ans ☐
   3.4. Plus de 10 ans ☐

3. Date de l'entrevue: ________________________________

4. Veuillez indiquer les services de la santé par le mobile qui sont supportés par votre réseau au Burundi

5. Veuillez indiquer les services de la santé par le mobile qui sont supportés par votre réseau dans d'autres pays

6. Dans quelle (s) mesure (s) la politique nationale des TIC a-t-elle une influence sur la prestation de vos services au public au Burundi ?

7. Dans quelle (s) mesure (s) les directives de l'Agence Nationale de Régulation des Communications (ARCT) ont-elles une influence sur la prestation de vos services au public au Burundi ?

8. Avez-vous des infrastructures adéquates pour lancer/disseminer des initiatives de santé par le mobile au Burundi ? Si Oui, Veuillez expliquer

9. A votre avis, qu'est ce qui pourrait être fait pour assurer la durabilité des initiatives de la santé par le mobile au Burundi ?

10. A votre avis, qu'est ce qui pourrait être fait pour assurer l'adoption à grande échelle des initiatives de la santé par le mobile au Burundi ?

11. A votre avis, quelles sont les obstacles à l'adoption de la sante par le mobile au Burundi ?

10.3. Appendix B: Informed Consent Documents

QUESTIONNAIRES

ENGLISH VERSION:

UNIVERSITY OF KWAZULU-NATAL
School of Management, IT and Governance

Dear Respondent,

PhD Research Project

Researcher: Patrick Ndayizigamiye (27 72 705 0950)

Supervisor: Prof Manoj Maharaj (27 31-260 7051)

Research Office: Ms P Ximba (27 31-260 3587)

I, Patrick Ndayizigamiye am a Ph.D. student in the School of Management, IT and Governance, at the University of KwaZulu-Natal. You are invited to participate in a research project entitled ***ADOPTION OF MOBILE HEALTH TECHNOLOGIES FOR PUBLIC HEALTHCARE IN BURUNDI***

The aim of this study is to: **ascertain the extent to which mobile health (m-health) can be used in the prevention and management of diseases in Burundi**.

Through your participation I hope to understand how mobile health can be used in the prevention and management of diseases in Burundi. The results of this survey are intended to contribute to the wide adoption of m-health within the public healthcare system in Burundi.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this research project. Confidentiality and anonymity of records identifying you as a participant will be maintained by the School of Management, IT and Governance, UKZN.

If you have any questions or concerns about participating in this study, please contact me or my supervisor at the numbers listed above.

It should take you about 20 minutes/s to complete the questionnaire. I hope you will take the time to complete the questionnaire.

Sincerely

Investigator's signature___________________________________
Date_________________

UNIVERSITY OF KWAZULU-NATAL
School of Management, IT and Governance

PhD Research Project

Researcher: Patrick Ndayizigamiye (27 72 705 0950)

Supervisor: Prof Manoj Maharaj (27 31-260 7051)

Research Office: Ms P Ximba (27 31-260 3587)

CONSENT

I____(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

_____________________ _____________________

Signature of Participant Date

FRENCH VERSION:

Université de Kwazulu-Natal
Faculté de Gestion, TIC et Gouvernance

Cher participant,

Project de recherche pour l'obtention du doctorat

Enquêteur : Patrick Ndayizigamiye (cell: 27 72 705 0950)

Superviseur: Prof Manoj Maharaj (cell: 27 31-260 7051)

Bureau de recherche: Ms P Ximba (27 31-260 3587)

Je, soussigné, Patrick Ndayizigamiye, suis étudiant dans la faculté de gestion, TIC et Gouvernance à l'Université de KwaZulu-Natal (Afrique du Sud). Je vous invite à participer dans le projet de recherche intitulé: « *Adoption de la santé par les technologies du mobile pour les services sanitaires publics au Burundi* »

Le but de ce projet est d'établir comment la santé par les technologies du mobile peut être utilisée dans le domaine de la prévention et la gestion des maladies au Burundi.

Votre participation me permettra de savoir comment la santé par les technologies du mobile peut être utilisée dans le domaine de la prévention et la gestion des maladies au Burundi. Les résultats de ce projet contribueront dans l'adoption à grande échelle de la santé par les technologies du mobile dans le domaine du système sanitaire publique au Burundi.

Votre participation dans ce projet est purement volontaire. Vous avez le droit de refuser de participer dans ce projet ou de se retirer de ce projet à n'importe quel moment sans aucune conséquence. Il n'y a aucun gain monétaire lié à la participation dans ce projet. La confidentialité et l'anonymat des vos réponses qui pourraient vous identifier en tant que participant dans ce projet seront maintenus par la Faculté de Gestion, TIC et Gouvernance de la dite Université.

Au cas où vous auriez des questions ou inquiétudes à propos de votre participation dans ce projet, veuillez me contacter ou contacter mon superviseur aux numéros mentionnés ci haut. Ça vous prendra 15 minutes pour compléter le questionnaire. J'espère que vous auriez du temps suffisant pour le compléter.

Sincèrement,

Signature de l'enquêteur_______________________ Date :
____

Université de Kwazulu-Natal

Faculté de Gestion, TIC et Gouvernance

Project de recherche pour l'obtention du doctorat

Enquêteur : Patrick Ndayizigamiye (cell: 76 621 035)

Superviseur: Prof Manoj Maharaj (cell: 27 31-260 7051)

Bureau de recherche: Ms P Ximba (27 31-260 3587)

Autorisation :

Je, soussigné, __________________________________ (Nom et prénom du participant), atteste que j'ai compris le contenu de ce document ainsi que la nature de ce projet et j'accèpte de participer dans ce projet de recherche. Je suis conscient que j'ai la liberté de me retirer de ce projet à n'importe quel moment désiré.

____________________   ____________________

Signature du Participant   Date

INTERVIEWS

ENGLISH VERSION:

UNIVERSITY OF KWAZULU-NATAL
School of Management, IT and Governance

Dear Respondent,

PhD Research Project

Researcher: Patrick Ndayizigamiye (27 72 705 0950)

Supervisor: Prof Manoj Maharaj (27 31-260 7051)

Research Office: Ms P Ximba (27 31-260 3587)

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The aim of this study is to: **ascertain the extent to which mobile health (m-health) can be used in the prevention and management of diseases in Burundi**.

Through your participation I hope to understand how mobile health can be used in the prevention and management of diseases in Burundi. The results of this survey are intended to contribute to the wide adoption of m-health within the public healthcare system in Burundi.

Your participation in this project is voluntary. You may refuse to participate or withdraw from the project at any time with no negative consequence. There will be no monetary gain from participating in this research project. Confidentiality and anonymity of records identifying you as a participant will be maintained by the School of Management, IT and Governance, UKZN.

If you have any questions or concerns about participating in this study, please contact me or my supervisor at the numbers listed above.

It should take you about thirty (30) minutes to answer one-to-one interview questions.

Sincerely

Investigator's signature____________________________________
Date_________________

UNIVERSITY OF KWAZULU-NATAL
School of Management, IT and Governance

PhD Research Project

Researcher: Patrick Ndayizigamiye (27 72 705 0950)

Supervisor: Prof Manoj Maharaj (27 31-260 7051)

Research Office: Ms P Ximba (27 31-260 3587)

CONSENT

I____(full names of participant) hereby confirm that I understand the contents of this document and the nature of the research project, and I consent to participating in the research project. I understand that I am at liberty to withdraw from the project at any time, should I so desire.

I consent/do not consent to having this interview audio- recorded.

____________________ ____________________

Signature of Participant Date

FRENCH VERSION:

Université de Kwazulu-Natal
Faculté de Gestion, TIC et Gouvernance

Cher participant,

Project de recherche pour l'obtention du doctorat

Enquêteur : Patrick Ndayizigamiye (cell: 27 72 705 0950)

Superviseur: Prof Manoj Maharaj (cell: 27 31-260 7051)

Bureau de recherche: Ms P Ximba (27 31-260 3587)

Je, soussigné, Patrick Ndayizigamiye, suis étudiant dans la faculté de gestion, TIC et Gouvernance à l'Université de KwaZulu-Natal (Afrique du Sud). Je vous invite à participer dans le projet de recherche intitulé: « *Adoption de la santé par les technologies du mobile pour les services sanitaires publics au Burundi* »

Le but de ce projet est d'établir comment la santé par les technologies du mobile peut être utilisée dans le domaine de la prévention et la gestion des maladies au Burundi.

Votre participation me permettra de savoir comment la santé par les technologies du mobile peut être utilisée dans le domaine de la prévention et la gestion des maladies au Burundi. Les résultats de ce projet contribueront dans l'adoption à grande échelle de la santé par les technologies du mobile dans le domaine du système sanitaire publique au Burundi.

Votre participation dans ce projet est purement volontaire. Vous avez le droit de refuser de participer dans ce projet ou de se retirer de ce projet à n'importe quel moment sans aucune conséquence. Il n'y a aucun gain monétaire lié à la participation dans ce projet. La confidentialité et l'anonymat de vos réponses qui pourraient vous identifier en tant que participant dans ce projet seront maintenus par la Faculté de Gestion, TIC et Gouvernance de la dite Université.

Au cas où vous auriez des questions ou inquiétudes à propos de votre participation dans ce projet, veuillez me contacter ou contacter mon superviseur aux numéros mentionnés ci haut.

Ça vous prendra trente (30) minutes pour répondre aux questions posées dans cette entrevue.

Sincèrement,

Signature de l'enquêteur________________________ Date : ___________________________

Université de Kwazulu-Natal

Faculté de Gestion, TIC et Gouvernance

Project de recherche pour l'obtention du doctorat

Enquêteur : Patrick Ndayizigamiye (cell: 76 621 035)

Superviseur: Prof Manoj Maharaj (cell: 27 31-260 7051)

Bureau de recherche: Ms P Ximba (27 31-260 3587)

Autorisation :

Je, soussigné, ___________________________________ (Nom et prénom du participant), atteste que j'ai compris le contenu de ce document ainsi que la nature de ce projet et j'accèpte de participer dans ce projet de recherche. Je suis conscient que j'ai la liberté de me retirer de ce projet à n'importe quel moment désiré.

J'autorise/je n'autorise pas l'enregistrement de cette entrevue

____________________   ____________________

Signature du Participant   Date

10.4. Appendix C : Gatekeepers Permission Letter

ENGLISH VERSION

March 22, 2017

To Whom It May Concern:

PERMISSION TO CONDUCT RESEARCH AS PART OF THE PhD QUALIFICATION

It is a requirement of our PhD qualification that the student completes a thesis based on research in a specific field of study. In this way students are given the opportunity to creatively link and discuss the theoretical aspects of the programme to the practical issues facing organisations in real life settings. Typically a thesis necessitates data gathering by the student by means of questionnaires and interviews.

Patrick Ndayizigamiye (Student No. 206510150) has chosen to do a research project entitled**:**

ADOPTION OF MOBILE HEALTH TECHNOLOGIES FOR PUBLIC HEALTHCARE IN BURUNDI

Your assistance in permitting access to your organisation for purposes of this research is most appreciated. Please be assured that all information gained from the research will be treated with the utmost confidentiality. Furthermore, should you wish any result/s or findings from the research "to be restricted" for an agreed period of time, this can be arranged. The confidentiality of information and anonymity of personnel will be strictly adhered to by the student.

I am available at any stage to answer any queries and/or to discuss any aspect of this research project.

If permission is granted, please sign the attached form.

Thank you for your assistance in this regard.

Yours sincerely

Prof. M S Maharaj
(Supervisor)

FRENCH VERSION

Logo Université du Kwazulu- Natal

8 mai 2014

A Qui De Droit:

DEMANDE D`AUTORISATION POUR UN TRAVAIL DE RECHERCHE EN VUE DE L`OBTENTION DU DIPLOME DE DOCTORAT

Parmi les exigences pour obtenir un diplôme de Doctorat à l'Université susmentionnée, figure celle que l'étudiant présente une thèse sur base de recherches dans un domaine d'études précis. De cette manière, les étudiants ont la possibilité d'établir un lien de façon créative et de discuter des aspects théoriques du programme en corrélation avec les problématiques réelles auxquelles les organisations font face dans leur gestion au quotidien. En général, une thèse nécessite la collecte de données par l'étudiant grâce aux questionnaires et interviews.

Patrick Ndayizigamiye (Numéro de la Carte d'Etudiant : 206510150) a choisi comme projet de recherche:

ANALYSE DE L'ACCEPTABILITE DE LA SANTÉ PAR LES TECHNOLOGIES DU MOBILE POUR LES SERVICES SANITAIRES PUBLICS AU BURUNDI

Votre assistance en permettant l'accès à votre organisation aux fins de cette recherche sera des plus utiles. Soyez assuré que toute information collectée à travers la présente recherche sera traitée avec toute la confidentialité requise. En outre, l'on pourra s'accorder sur les modalités en vue de garder hors publication pour un laps de temps convenu, certain(e)s résultat / s ou conclusions de ladite recherche, selon vos souhaits. La confidentialité des informations et l'anonymat du personnel sera strictement respectée par l'étudiant.

Je suis disponible à tout moment pour répondre à vos questions et / ou discuter de l'un ou l'autre aspect de ce projet de recherche .

Si l'autorisation est accordée, veuillez signer le formulaire ci-joint.

Je vous remercie pour votre assistance à cet égard.

Cordialement

Signature

____

Prof M S Maharaj
(Superviseur)

Gatekeeper's consent: Ministry of health and AIDS

Gatekeeper's Consent

I ...Dr. Dionis Nizigiyimana....... in my capacity as .Permanent Secretary.......hereby give permission to **Patrick Ndayizigamiye (Student No. 206510150)** to conduct research in my organization.

The student MAY/MAY NOT (delete whichever is not applicable) use the name of the organisation in the dissertation.

Signature of Manager/Owner/Gatekeeper:...

Company Stamp: REPUBLIQUE DU BURUNDI Cabinet du Ministre BUJUMBURA Ministère de la Santé Publique et de la Lutte Contre le SIDA

Date: ....11-06-2014..........

Gatekeeper’s consent: Ministry of communication

Gatekeeper’s Consent

I Sibebese Frédéric François.................. in my capacity as Permanent Secretary..........hereby give permission to**Patrick Ndayizigamiye (Student No. 206510150)**to conduct research in my organization.

The student MAY/MAY NOT (delete whichever is not applicable) use the name of the organisation in the dissertation.

Signature of Manager/Owner/Gatekeeper:...

Company Stamp:

REPUBLIQUE DU BURUNDI
CABINET DU MINISTRE
B.P 1080
Tél.22 25 34 72
Ministère des Télécommunications, de l'Information, de la Communication et des Relations avec le Parlement

Date: 31 July 2024

Gatekeepers consent : Mobile Operators-ONATEL (National Office of Telecomunications)

Gatekeeper's Consent

I MBAYAHAGA Isidore in my capacity as CCO (Chief Commercial officer hereby give permission to **Patrick Ndayizigamiye (Student No. 206510150)** to conduct research in my organization.

The student MAY/MAY NOT (delete whichever is not applicable) use the name of the organisation in the dissertation.

Signature of Manager/Owner/Gatekeeper:..

Company Stamp:

Date: le 04. 09. 2014

10.5. Appendix D: Ethical clearance letter

UNIVERSITY OF KWAZULU-NATAL™
INYUVESI YAKWAZULU-NATALI

4 December 2014

Mr Patrick Ndayizigamiye 206510150
School of Management, IT and Governance
Pietermaritzburg Campus

Dear Mr Ndayizigamiye

Protocol reference number: HSS/1560/014D
Project title: Adoption of Mobile Health Technologies for Public Healthcare in Burundi

Full Approval – Expedited Application

In response to your application received on 20 November 2014, the Humanities & Social Sciences Research Ethics Committee has considered the abovementioned application and the protocol have been granted **FULL APPROVAL.**

Any alteration/s to the approved research protocol i.e. Questionnaire/Interview Schedule, Informed Consent Form, Title of the Project, Location of the Study, Research Approach and Methods must be reviewed and approved through the amendment/modification prior to its implementation. In case you have further queries, please quote the above reference number.

PLEASE NOTE: Research data should be securely stored in the discipline/department for a period of 5 years.

The ethical clearance certificate is only valid for a period of 3 years from the date of issue. Thereafter Recertification must be applied for on an annual basis.

I take this opportunity of wishing you everything of the best with your study.

Yours faithfully

....

Dr Shenuka Singh (Chair)
Humanities & Social Sciences Research Ethics Committee

/pm

Cc Supervisorr: Professor Manoj Maharaj
Cc Academic Leader Research: Professor Brian McArthur
Cc School Administrator: Ms Debbie Cunynghame

Humanities & Social Sciences Research Ethics Committee
Dr Shenuka Singh (Chair)
Westville Campus, Govan Mbeki Building
Postal Address: Private Bag X54001, Durban 4000
Telephone: +27 (0) 31 260 3587/8350/4557 **Facsimile:** +27 (0) 31 260 4609 **Email:** ximbap@ukzn.ac.za / snymanm@ukzn.ac.za / mohunp@ukzn.ac.za
Website: www.ukzn.ac.za

1910 - 2010
100 YEARS OF ACADEMIC EXCELLENCE

Founding Campuses: Edgewood, Howard College, Medical School, Pietermaritzburg, Westville