UNIVERSITY OF GHANA

MHEALTH AS A VIABLE SOLUTION FOR THE PREVENTION AND MANAGEMENT OF CHOLERA IN THE GREATER ACCRA REGION OF GHANA - PERSPECTIVES OF PROVIDER-SIDE STAKEHOLDERS

BY

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THIS THESIS IS SUBMITTED TO THE UNIVERSITY OF GHANA, LEGON, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF DOCTOR OF PHILOSOPHY (Ph.D) DEGREE IN HEALTH POLICY AND MANAGEMENT

JULY 2020

DECLARATION

I, the undersigned, hereby declare that this thesis is the result of my own original work and that no part of it has been presented for another degree in this University or elsewhere. All references used have been duly cited.

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CERTIFICATION

We, the undersigned, hereby declare that this thesis was under our supervision and therefore consider it credible to enter the cannon of certified academic research through the award of a Doctor of Philosophy (Ph.D) in Health Policy and Management Degree.

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DEDICATION

This thesis is dedicated to my family in general, especially my wife (Mrs. Dora Hammond) and mother (Madam Veronica Efua Ankoh) for their special support and sacrifice which have brought me this far in my education.

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LIST OF ABBREVIATIONS

CHPS	Community-Based Health Planning and Services
eHealth	Electronic Health

mHealth	Mobile Health
FGD	Focus Group Discussion
GHS	Ghana Health Service
GSMA	Groupe Speciale Mobile Association
GAR	Greater Accra Region
ICT	Information Communication Technology
IDI	In-depth Interview
LMICs	Low-and-Middle-Income Countries
ITU	International Telecommunication Union
WHO	World Health Organization
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
SMS	Short Message Service
TAM	Technology Acceptance Model
TC & DL	Technological Capabilities and Level of Digital Literacy
TTF	Task-Technology Fit

ABSTRACT

This study explored public health services delivered through the mobile phone (mHealth), the challenges faced and enablers and facilitators leading to the overall impact on the viability for the prevention and management of cholera in the Greater Accra Region of Ghana. The World

Health Organization (WHO) identifies technological applications as one of the health system pillars to ensure access and quality of health services for which the universal mobile telephony is identified as a potential healthcare tool due to its high adoption and use by people, including health providers. Despite the foregoing, its use in healthcare has been described as slow due to safety, medico-legal, and cost concerns by healthcare providers. The Ghanaian public healthcare system has been challenged with access and quality of health services and cholera has been one of its major public health challenges, particularly for the GAR. The mobile phone as a technological tool could help in its prevention and management for which the study explored. The study was situated in an Intepretivist-Social Constructionist paradigm, with a qualitative research approach; and a phenomenological design that utilized purposive sampling techniques with sub-techniques such as maximum variation and snowball sampling. In-depth interviews and focus group discussions were used to collect data from participants and discussants of diverse backgrounds. Three study sites (Accra Metro, Ga West, Ada East) with varied characteristics were selected for the research. Qualitative data collected were transcribed and inductively coded using NVIVO (version 11) software package. The data analysis was based on the thematic content (network) technique. The major findings of the research showed a high technological capacity and digital literacy among healthcare providers who use the mobile phone to deliver aspects of healthcare for the management of cholera. The practice of mHealth by healthcare providers was found to be largely informal with some of the mHealth services comprising data collection, digital learning, health emergencies, management and logistics, disease surveillance, and telehealth. Overarching challenges encountered with the use of the mobile phones were Management and leadership, Finance, Access, Infrastructure, Technical and Human resources (MFAITH challenges). The study also showed that there were key enablers and facilitators which enhanced viability of using mobile phones for effective management of cholera such as financial and infrastructure provision, policy framework,

human resource development, and task-technology fit. The study concluded that there was high mobile phone adoption and use among healthcare providers for public health services; and that tasks of providers fit in well with the mobile phone. However, the practice was largely informal, without any overarching policy direction, and not aligned with organizational objectives. The health sector must engage the telecommunication companies (Telcos) to play a more active role in mHealth provision by presenting a viable business model for them. A policy framework should be developed to guide and give direction for mHealth design and implementation. Healthcare providers should be trained and motivated to effectively deliver mHealth services for a viable mHealth for the prevention and management of cholera.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

According to the World Health Organization (WHO), there are six health system building blocks for ensuring improved access and coverage of health services. One of these six blocks is the adoption and application of medical technologies (WHO, 2010), which help to improve the efficiency of healthcare delivery and offer opportunities for improvement in the quality and quantity of life (Levin-Scherz & Zimlichman, 2013). Information and Communications Technologies (ICT) have seen significant growth over the past decade, leading to socioeconomic development that serves as the foundation for the development of electronic health (eHealth) (ITU, 2015). Five billion people were connected to mobile services (including wireless networks) in 2017 and about 6 billion unique mobile subscribers predicted for the year 2025 worldwide (GSM Association, 2019).

Mobile technologies include other devices such as iPad (Intelligent Pad), iPod (Intelligent Pod), Cell Phone, and PDA (Personal Digital Assistant). However, for this study, mobile technology will be limited to only the mobile or cell phone. This is because of its ubiquity, universality, and successful application in other sectors such as finance and banking (ITU, 2015). The Canadian Medical Association (2014) suggests that mobile phone-based interventions have great appeal in developing countries due to resource constraints. Ehealth is an innovation comprising all technologically based platforms (e.g. telemedicine, telecare, telehealth, mHealth, etc.) used to enhance patient care, monitoring, and health services delivery remotely. Specifically, ehealth is the utilization of various ICT platforms for healthcare (Schweitzer & Synowiec, 2012) and is suggested as a catalyst for overhauling healthcare delivery from manual to the electronic platform which could help bridge the digital divide (Quarshie, 2016). One of

the fastest-growing offshoots of eHealth is mobile health (mHealth) which is the application of mobile and wireless technologies to deliver medical or public health services remotely (Currie & Seddon, 2014; Martin, 2012). A key tool of mHealth is the mobile (cell) phone which is increasingly being medicalized since its introduction in 1983 in a rudimentary form (Gubitosa, Eigbe, Ahmed, & Fagan, 2014). The mobile phone device is creating a new health paradigm shift from doctor-controlled episodic care to patient-centred promotive care. It is challenging the way traditional healthcare is delivered (Currie & Seddon, 2014; Gleason, 2015). Mobile phones have been used to deliver various aspects of health services delivery such as in treatment adherence for chronic diseases, appointment reminders, public and primary health care, disease surveillance, epidemics and telemedicine (American Telemedicine Association, 2012; Brian & Ben-Zeev, 2014; Cable News Network, 2009; Gurol-Urganci, Atun, Car, & Vodopivec-Jamsek, 2013). The third WHO Global Observatory on the state of mHealth among member countries reports that mHealth adoption is on the ascendancy and being implemented by its 114-member countries for the delivery of various healthcare services (WHO, 2009). It is argued that several lives could be saved if mobile phones were equipped with basic healthcare information on first aid, maternal and child health, among others for citizens (Healthcare Information for All [HIFA], 2016). Tariq and Akter (2011) report that initial empirical mHealth studies have mainly focused on mHealth adoption and use by physicians and nurses and limited to the hospital settings in developed countries. They, therefore, call for evidence in other settings such as the developing country context to ascertain mHealth benefits in enabling patient care for spatially distributed healthcare providers. Mhealth adoption in Africa is experiencing moderate increase just as other developing countries (African Strategies for Health, 2016; Etzo & Collender, 2010; Surka, et al., 2014), and is helping to place the future of healthcare within the control of individuals and the general population (Topol, 2015;

Vodafone Global Enterprise, 2013). The mobile phone has become an indispensable health device (Gleason, 2015), driven by its growth across the globe, especially in developing countries (Canadian Medical Association , 2014; Voice of America News, 2013). This is serving as a platform for the launching of various mHealth projects aimed at taking advantage of the identified benefits. Mobile phones can reach the unreached with information, enable the activities of remote health workers, and reduce inefficiencies which offer opportunities for development (mHealth Alliance cited in Coleman, 2011). Health managers use the mobile phone as a tool for reaching clients to deliver a package of services that sometimes eliminate the need to physically visit communities, especially hard-to-reach ones. The mobile phone has communicational and knowledge-sharing advantages, which are essential for leveraging to undertake public health services.

Despite the high expectations of the mobile phone as a cost-effective and impactful alternative for health delivery, other scholars (Tamrat & Kachnowski, 2012; Huang & Matricardi, 2016) disagree that it is the future healthcare delivery tool (Kaplan, 2006; Mendoza, Okoko, Morgan, & Konopka, 2013). Despite the reported growth, Sub-Saharan Africa's mobile penetration rate (Unique Mobile Subscriber) as at end of 2017 was 44% which was still quite below the world average of 66% (GSM Association, 2018). The knowledge of the mobile phone's usefulness and the willingness of mobile users to adopt mHealth is still considered a challenge even in the wake of its high penetration among populations (Akter & Ray, 2010; Katz, Mesfin, & Barr, 2012). Governments in developing countries, faced with limited funding and competing needs, demand critical evidence of the efficacy of mHealth to serve as a basis for financial commitment (Labrique, Vasudevan, Kochi, Fabricant, & Mehl, 2013). In developing countries, mHealth adoption is further challenged by illiteracy, lack of electricity, language barriers, poor network coverage, and socio-cultural factors (Dicianno, et al., 2015; O'Connor, O'Donoghue,

Gallagher, & Kawonga, 2014). Thus, it is imperative to ascertain the viability of mHealth as an alternative health delivery channel which this research wishes to explore (Reddy, et al., 2016). A survey of the empirical evidence on mHealth shows that mobile phones have been applied in some public health interventions such as disease surveillance (Mtema, 2013), Human-Immunodeficiency Virus/Acquired Immuned-Deficiency Syndrome (HIV/AIDS) (Mushamiri, Luo, Iiams-Hauser, & Amor, 2015), Ante-natal services (Evans, Abroms, Propatich, Nielsen, & Wallace, 2012); Malaria (Moonen & Cohen, 2012), Tuberculosis (Elangovan & Arulchelvan, 2013) and Child Vaccination (Uddin, et al., 2016). The evidence gleaned from these general mHealth studies reveal the need for more empirical studies to validate existing knowledge (Labrique, Vasudevan, Kochi, Fabricant, & Mehl, 2013; Tariq & Akter, 2011; Vallespin, Cornet, & Kotzeva, 2016), need for studies in a variety of settings and contexts (Lund, 2012), need for methodological rigour and theoretical depth ((Labrique, Vasudevan, Kochi, Fabricant, & Mehl, 2013; Shuchman, 2014; Tariq & Akter, 2011; Watterson, Walsh, & Madeka, 2015) and limited cholera-related studies.

However, the few cholera-related studies reported were during the 2010 Haiti cholera epidemic (Bengtsson, et al., 2015; Teng, Thomson, Lascher, Raymond, & Ivers, 2014), monitoring cholera outbreak among Mecca pilgrims in Senegal (Overney, 2016) and cholera disease surveillance in Cameroon (Ngwa, et al., 2016). Findings of these cholera-specific studies indicate that the mobile phone helped in improving cholera reporting, preparedness, response, and containment. Apart from the study by Ngwa et al., (2016), which reviewed the use of the integrated disease surveillance and response system to report cholera outbreaks, all the cholera studies used spatio-temporal data (anonymized telecommunications data) to track the disease's outbreak and dispersion pattern. This revealed the need for a primary study on the use of mobile phones for the prevention and management of cholera, particularly for the Ghanaian context.

In Ghana, mobile phone penetration is 140% (National Communication Authority, 2019), which shows high adoption of technology and offers opportunities for mHealth adoption. However, a relatively few major mHealth projects have been piloted such as the Mobile Technology for Community Health (MOTECH), which revealed the effective and impactful use of mobile phones to increase antenatal visits and reduce maternal and child mortality in the Upper East Region (Awoonor-Williams, et al., 2012). Other studies have examined the role of mobile phones in disease surveillance to manage possible Ebola outbreak (Adokiya & Awoonor-Williams, 2016), reporting on mass drug administration against Lymphatic Filariasis (Vroom, 2017); while Senyo (2015) reports of the use of smartphones among young medical doctors for purposes of diagnoses of patients' conditions. The findings of these studies indicate mhealth in Ghana is in its nascent stage, having limited empirical evidence; and that its role in disease surveillance (public health services) is limited. There is, however, high adoption of the device among a section of medical staff for clinical decision-making and those healthcare providers are willing to use the mobile phone for public health services. Adokiya & AwoonorWilliams (2016) calls for the leveraging of the mobile phone for disease surveillance of infectious diseases. Despite these findings and recommendations, there were also reported challenges in using mobile phones such as lack of technical knowledge of the smartphone, low institutional motivation, and support, low ownership of smartphones, and poor network. The literature reveals that there were no studies on cholera for which this study explored to help extend the empirical evidence of the viability of the mobile phone for public health delivery.

From the foregoing, the study on the viability of the mobile phone for the prevention and management of cholera in Ghana was vital to help explore the potential to leverage the technology to enhance the activities of public healthcare providers.

1.2 mHealth and related concepts

There are some concepts that need clarification for a better understanding of mHealth. Ehealth, Telemedicine, Telehealth, and mHealth can all be categorized as part of a group of interrelated concepts. The literature does not present any agreed definition on eHealth and mHealth but there is a convergence on the fact that the latter emanates from the former and both are used to enhance health outcomes and their technologies work together towards similar objectives (Vital Wave Consulting, 2009). Ehealth is, however, a much broader concept of health innovations that comprise all technologically based platforms used to enhance patient care and health services delivery. It is the use of ICT such as computers, mobile phones, satellite communications, and others to leverage patient care and wellbeing through a combination of medical informatics, public health, and business (Lim, et al., 2011; Vital Wave Consulting, 2009). It involves processes aimed at transforming healthcare practices from a manual or paperbased system to electronic or digital formats (Quarshie, 2016). Ehealth applications include patient records management, medical diagnostics and procedures, remote monitoring and care of terminal or chronic diseases and home care, health surveillance, health literature, health education, knowledge and research (Chen, Wen, & Yang, 2014; Mechael, et al., 2010; Mendoza, Okoko, Konopka, & Jonas, 2013). It is underpinned by three essential components such as information processes, communications strategy, and technology infrastructure (Quarshie, 2016). Ehealth is categorized into four separate components comprising mHealth, management information system, telemedicine, and distance learning (Mendoza, Okoko, Konopka, & Jonas, 2013). This research focuses on the mHealth component of eHealth.

Telemedicine and telecare are linked; and described to be the use of telecommunications and its related platforms to conduct remote diagnoses and treatment of patients. It involves the remote exchange of medical and health information via electronic communications platforms to enhance patients' clinical health status (American Telemedicine Association, 2012; Lim, et

al., 2011). It includes a variety of applications such as the use of two-way video, email, smartphones, wireless tools, and other forms of telecommunications technology. Telehealth involves both clinical and public health activities while telemedicine is limited to clinical practice but both have a wider mobile platform other than the mobile phone alone (Mechael, et al., 2010). Literature is also replete with numerous definitions of mHealth, with no agreement on a single most accurate one. Mhealth is generally accepted by literature as a subset of eHealth (Brinkel, Kramer, Krumkamp, May, & Fobil, 2014; WHO, 2011). The definition of mHealth narrows down to the use of mobile or cellular telephones to offer health services to patients or health clients. The mHealth definitions can be synthesized as including mobile technologies or gadgets such as PDAs, mobile phones, laptops, others (Akter & Ray, 2010; Brinkel, Kramer, Krumkamp, May, & Fobil, 2014), or wireless technologies such as Bluetooth and Wi-fi (Vital Wave Consulting, 2009) which is aimed mostly at delivering various aspects of healthcare (Mechael, et al., 2010; WHO, 2009). The WHO (2009) defines mHealth as a part of eHealth for the provision of health services and information through mobile technologies such as mobile phones and PDAs. It further lists fourteen categories of mHealth services in their survey of 114 countries; of which some of them are health call centres, emergency toll-free telephone services, mobile telemedicine, appointment reminders and treatment adherence (WHO, 2011). For this work, mHealth was equated to all interventions using mobile or cell phones for the delivery of health services.

1.3 Research problem

Cholera is reported to have been detected in Africa in 1970 (Eric, Tauxe, & Tauxe, 2013; OforiAdjei & Koram, 2014) which also was the same year Ghana recorded its initial cases. Most cases are reported in Africa; where Ghana was ranked second in the most affected top 16 countries. Ghana, Nigeria, and the Democratic Republic of Congo accounted for 85% of

cholera cases reported in 2013 (Awalime, 2015). The real number of infections is believed to be much higher and continues to remain a public health challenge particularly for Sub-Saharan Africa (WHO, 2015). Cholera in Ghana is largely an urban problem, affecting the urban poor who mostly live in peri-urban areas with poor social amenities such as water and sanitation. (Myjoyonline.com, 2014; Ofori-Adjei & Koram, 2014). In Ghana, a general ranking of risk of contracting diseases of public health emergencies places cholera as second with the topmost being viral haemorrhagic fevers such as Ebola and Lasser fever and meningitis in the third place (Ghana Health Service, 2017). This reveals the importance of cholera on the national emergency map for which a study on it is needed. Since its first incidence in the country, cholera seems to have defied all interventions of eradication with periodic virulent outbreaks as occurred in 2014 (Ofori-Adjei & Koram, 2014).

The decision to choose cholera and the selection of GAR is because it threatens most of the population and is prevalent in the region; it accounts for about 29% of the total suspected cases reported from 2012 to 2016 (refer to Table 2.1, section 2.2.3). Most cholera cases break out in the GAR before spreading to other parts of the country and almost always reported on an annual basis since it was introduced to the country through the region (Ofori-Adjei & Koram, 2014). UNICEF factsheet on cholera indicates that GAR accounted for 53.4% of all cases from 19982013, with the longest period of duration of the outbreak being 65 days (UNICEF, Undated). The worst cholera outbreak in 30 years which occurred in 2014 was first reported in the GAR before spreading to other parts of the country (Myjoyonline.com, 2014).

Public health management of cholera in Ghana is conducted through physical outreach programmes to the communities and routine paper-based disease surveillance as part of general communicable disease management (Ghana Health Service, 2017) with little or no purposive input of mobile technology in its management. The role of mobile technology in leveraging

cholera prevention and management is limited as revealed from the empirical literature. Most mHealth interventions have mainly focused on non-cholera areas such as maternal care, malaria, tuberculosis, general disease surveillance, and treatment adherence. The study on cholera in Ghana by Awalime (2015), examined the economic cost of the disease without covering any role of the mobile phone. Most cholera-related mHealth studies that explored the efficacy of mobile phones for cholera prevention and management have been few and at the level of meta-studies, using secondary spatio-temporal data for analysis. As already indicated, mobile phone application in cholera management helped improve effective cholera reporting, response, and containment. Healthcare providers were yet to leverage the mobile phone as an effective communication and knowledge-sharing device to support the delivery of public health services in Ghana, which this study explored.

1.4 Research Aims and Objectives

1.4.1 Research Aim

The research sought to explore and gather views from Healthcare Providers of the viability of the mobile phone as a tool for the prevention and effective management of cholera in the Greater Accra Region (GAR) of Ghana.

1.4.2 Research Objectives

The research objectives were therefore carved out of the aim as follows:

i. To determine public health services delivered through the mobile phone to prevent and manage cholera in the GAR.
ii. To explore challenges encountered with the use of mobile phones which may affect the effective implementation of mHealth for cholera prevention and management in the GAR.

iii. To explore the enablers and facilitators for a viable implementation of mHealth for cholera prevention and management in the GAR.

1.4.3 Research Questions

Research questions were based on the research objectives. Thus, based on the research objectives, the questions that the study sought to answer were as follows:

i. What are the public health services that are delivered through mobile phones to prevent and manage cholera in the GAR?
ii. What are the challenges encountered in the use of mobile phones which may affect the effective implementation of mHealth for cholera prevention and management in the GAR?
iii. What are the enablers and facilitators for a viable implementation of mHealth for cholera prevention and management in the GAR?

1.5 Research Outline

The research is organized into six chapters. Chapter one provides a general introduction and background to the research and gives an overview of the key objectives and research questions. It briefly discusses the rationale for the research. Chapter two undertakes a review of extant empirical and theoretical literature on the research. It also discusses the relevant concepts and definitions of study. It then proposes a conceptual framework to guide data collection and analysis. Chapter three provides the approach and philosophical underpinnings of the research and the methods adopted. It, therefore, provides a detailed description of how the field research work was undertaken which included the target population, study sites, and sampling techniques used. Chapter four provides details of the findings of the study based on the research objectives. Chapter five discusses the implications of the findings in relation to the empirical

and theoretical literature but situated in the conceptual framework. Chapter six provides the major conclusions and recommendations of the research. It also provides key contributions to knowledge and advice for future research.

1.6 Chapter Summary

The chapter discussed the overview and motivation of the research. It identified the role of technological innovations such as eHealth and its mHealth offshoot in challenging traditional healthcare delivery. It discussed the choice of cholera and briefly reviewed the literature on the topic area and presented the research aim, objectives, and questions. It finally provided a summary chapter disposition of the research. The ensuing chapter undertakes a review of the conceptual, theoretical, and empirical literature on the phenomenon.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Chapter Introduction

This chapter provides a review of relevant and current literature on the application of the mobile phone in health care delivery and management. It initially explains and introduces general concepts that have a bearing on the topic such as innovation in health care, evolution, and features of the mobile phone, overview of mHealth, and cholera. It then reviews the relevant theories and empirical works underpinning the research; after which a conceptual framework is developed and knowledge gaps for which the research intended to fill are proffered.

2.2 Introduction of General Concepts

2.2.1 Innovation in Health Care and its implications for Mobile Health

Mobile phones in healthcare have the potential of saving lives daily and improving health outcomes if it is equipped with basic healthcare information and applied correctly (Healthcare Information for All [HIFA], 2016; Mendoza, Okoko, Konopka, & Jonas, 2013). It is argued that innovation is essential for corporate survival and growth and acknowledged as key in the creation of value and ensuring sustainability and competitive edge for survival (Baregheh, Rowley & Sambrook, 2009; Omachonu & Einspruch, 2010). One of the earliest definitions of innovation defines innovation as the generation, acceptance, and implementation of new ideas, processes**,** products or services (Thompson, 1965) while Baregheh et al., (2009) define it as a multi-stage process in which organizations convert ideas into new products, services or processes to help differentiate themselves effectively in their marketplace. Aslani and Naaranoja (2013) suggest that innovation is an important means of creating value and ensuring improvement for clients and has the most potential to affect an entire population when applied in the field of public healthcare. Even though innovation has been applied in various fields including health, it has however been noted that the health sector has been relatively slow in its adoption due to several factors including conservativeness, ethics, culture, privacy, safety, malpractice and others (Christensen & Dahlia, 2009; Poon, et al., 2006). Adoption of innovation in health care settings is acknowledged as a complex process by Aslani and Naaranoja (2013) and risky (Quarshie, 2016) which also invariably tend, to worsen its slow adoption in health.

Health care is suggested to be mostly grounded in evidence-based innovations. Even where there is success in implementation elsewhere, there may still be a challenge of slow dissemination or outright rejection by others. According to Berwick (cited in Omachonu &

Einspruch, 2010), diffusion of innovations, which is the widespread adoption and application of innovation, is a major challenge in all industries particularly healthcare. One of the reasons adduced is a lack of entrepreneurial culture among medical centres (Ostrovsky & Barnett, 2014) and a lack of clear financial benefits concerning initial cost outlay, particularly for privately owned healthcare centres (Poon, et al., 2006). Innovation therefore may hold important prospects for healthcare delivery if adopted and properly diffused into the health delivery system, which this study explores.

2.2.2 Evolution of the Mobile Phone Technology

The mobile phone consists of two distinct parts; the hardware and software functions. The hardware comprises all the tangible parts while the software includes all programmes and applications which help to operate the phone (Mohadis & Ali, 2014). Brinkel, Kramer, Krumkamp, May & Fobil (2014) identify four reasons for the potential impact mobile phones can have on health systems such as its rapid technical development, reduction of costs, widening network coverage, and high user adoption rates across the world. It is one of the innovative devices that continues to impact the lives of individuals and populations since its reported introduction in 1984 in a rudimentary form (Gubitosa, Eigbe, Ahmed, & Fagan, 2014; Martin, 2012). The technology which is classified in three levels has evolved over three generations such as feature (first generation), multimedia phone (second generation), and smartphone (third-generation) (Mohadis & Ali, 2014). All these come with incremental superior features. First-generation phones are low-cost, have smaller-sized screens, with a low-resolution cameras, and mechanical keypad buttons with basic functionality for voice calls, sending and receiving text, taking pictures, and video messaging. Multimedia phones can handle extra features including music, pictures and videos, improved resolution camera, colour screen, and quality sound. Third-generation phones have more advanced mobile computing

features and operating systems and the most expensive (Mohadis & Ali, 2014). In summary, the evolution of the mobile phone can be phased into analogue and digital; with the latter having more superior features such as higher speed, smaller size, and lighter weight (Babar, Pervez, & Muhammad, 2016). The mobile phone, especially the smartphone has been described as a digital bank, commercial enterprise, and health and learning centre (Nchise, Boateng, Shu, & Mbarika, 2012; Thornton & Houser, 2004).

This evolution has implications for mobile health development in that as the technology evolves, it also helps the evolution of mHealth. Reducing prices and network expansion means that more people could afford the mobile phone and thus encourage increased ownership while expansion in mobile technology infrastructure allows for the extension of mHealth in new unchartered terrains and contexts. The advent of 3rd Generation smartphones, with superior features such as computing capabilities, applications, and processing speed allow for the introduction of enhanced mHealth services and offer new platforms such as social media for mass communication and provision of public health services to the population. These have good implications for the provision of public health services for cholera management since the reporting, communication, and information-sharing needs during cholera epidemics could be delivered through the mobile phone, particularly using smartphones.

2.2.3 Key facts about cholera and its management

Cholera is said to have emerged during the 19th century from its source location of Ganges delta (India) and spread across the globe from South Asia, Africa and Americas over time (WHO, 2017); and reported to affect about 69 countries (Ali, Nelson, Lopez, & Sack, 2015). Cholera is now prevalent in many countries and is described as an infectious or communicable

disease due to its ability to spread from one person to another. It is an acute diarrhoeal infection caused by consumption of contaminated food or water having the causative agent bacterium vibrio cholera and mainly prevented with a combination of surveillance, provision of clean water, sanitation and hygiene, treatment and vaccination (Mengel, Delrieu, Heyerdahl, & Gessner, 2014; WHO, 2015; WHO, 2017). Other reasons for its spread have also been attributed to extreme weather patterns, conflict, poor housing, political and economic crises. (Mengel, Delrieu, Heyerdahl, & Gessner, 2014). It is described as an epidemic as it affects many people; mostly at the same time (Centre for Disease Control, 2012) and remains a worldwide threat to public health, affecting over one million people yearly, resulting in over 21,000 deaths globally. It is however easily treatable if medical attention is sought early or proper education is offered to the population on prevention and management. Cholera is a reportable disease and an outbreak is defined by the occurrence of at least one confirmed case in an area where transmission is not usually reported (WHO, 2017).

In Africa, cholera is reported to have entered the continent at the start of the 1970s, spreading throughout a good part of it (Eric, Tauxe, & Tauxe, 2013; Ofori-Adjei & Koram, 2014; WHO, 2017) and accounts for a major portion of the global burden of the disease (Ali, Nelson, Lopez, & Sack, 2015). Since its introduction into Africa, over 3 million suspected cases of cholera have been reported (1970 and 2011), representing about 46 % of global reports.
Contrary to the global pattern of reducing case fatality, that of Africa is reported to be stable (Mengel, Delrieu, Heyerdahl, & Gessner, 2014).

In Ghana, cholera was first reported in 1970 just at the time it entered Africa. Even though it reduced between 1990 and 2010, the disease resurged with large outbreaks in 2012 and 2014 (Ofori-Adjei & Koram, 2014; UNICEF, Undated) with a case fatality rate of 0.8% in 2015.

The coastal regions of Ghana (Volta, Greater Accra, Central, and Western) account for over 70% of reported cases, with Greater Accra being the major outbreak region with 53% from 1998 to 2013 (Dowuona, 2015). A data set from Ghana District Health Information Management System 2 (DHIMS2) by the Centre for Health Information Management (CHIM), Ghana Health Service- 2017, shows that GAR accounted for about 30% of all suspected cholera cases in the country from 2012 to 2016. The two reports (Dowuona and DHIMS2) reveal the importance of the GAR as the major source of cholera epidemics, which served as the basis to select it as a study region. Table 2.1 below shows the regional distribution of suspected cholera cases from DHIMSs (2012-2016).

Table 2. 1: Suspected cholera cases (2012-2016)

	Suspected Cholera Cases						
Regions	**2012**	**2013**	**2014**	**2015**	**2016**	**TOTAL**	**%**
Ashanti	170	343	982	2,912	3,440	7,847	9.0
Brong Ahafo	290	20	1,738	2,977	2,343	7,368	8.4
Central	171	28	3,151	1,658	1,676	6,684	7.6
Eastern	873	222	1,991	6,835	6,568	16,489	18.8
Greater Accra	2,958	542	11,192	6,431	4,039	25,162	28.7
Northern	108	0	49	68	247	472	0.5
Upper East	257	15	2,587	3,723	3,330	9,912	11.3
Upper West	50	5	24	854	538	1,471	1.7
Volta	520	70	930	592	629	2,741	3.1
Western	679	660	2,053	3,441	2,614	9,447	10.8
Ghana	**6,076**	**1,905**	**24,697**	**29,491**	**25,424**	**87,593**	**100**

Source: Data from Ghana District Health Information Management System (DHIMS2) by courtesy of Centre for Health Information Management (CHIM), Ghana Health Service-2017. (Calculation of regional percentages performed by the researcher)

Key sources of spread in Ghana are suggested to be from filth, contaminated water, open gutters, lack of personal hygiene, and unhygienic foods sold to the public (Laary, 2014). The incidence of cholera in Ghana, just as in other developing countries, falls disproportionately on the urban poor with inadequate housing, low or no education, low income, poor environmental conditions, lack of potable water, and high population concentration (OforiAdjei & Koram, 2014). As indicated under the problem statement, healthcare providers have used the traditional health delivery strategy of physical outreach, contact tracing, paper-based disease surveillance system, hospital-based treatment, and public education through traditional public address, radio, and other non-mobile phone channels. The role of mobile phones was yet to be leveraged to support the delivery of public health services to help prevent and manage cholera effectively. The study, therefore, explored this gap.

2.3 Overview of the public health system of Ghana

2.3.1 Introduction to the concept of public health

Public health services are targeted at mass populations and mostly delivered close-to-clients and preventive. They involve all health interventions that are aimed at protecting and improving the health of people and their communities and realized through promoting healthy lifestyles, disease surveillance for the protection of individuals, groups, societies, and whole populations (CDC Foundation, 2018). The 'public' refers to a handful of people, village, region, province, the continent, or any combination of these. It evolved from Primary Health Care (PHC) which was launched in Alma Ata (1978) with the vision of health for all by the

year 2000 and given a boost with the quest for Universal Health Coverage (UHC). It is also delivered at a hospital or static health facility where curative care normally is delivered. The growing importance of public health was given impetus when the WHO recognized that health is invariably also impacted by social determinants such as the physical environment, incomes, education, employment, poor living conditions.

2.3.2 The Ghanaian public health system

A health system refers to all the organizations, establishments, resources and individuals whose primary aim is the improvement of their individual and collective health. It influences the determinants of health and provision of healthcare activities in the areas of preventive, curative, promotive and rehabilitative care (WHO, 2010). The organization of public health services in Ghana is aligned with the administrative structure of its health system. At the national level, public health policies are formulated by the health ministry for its autonomous agencies. The GHS is the largest agency mandated to implement approved national policies (including public health) aimed at providing primary and secondary healthcare to all people living in Ghana. The GHS is primarily responsible for the planning and organizing public health services which are administratively organized at three levels comprising the national, regional and district; while functionally, it is organized into five levels consisting of national, regional, district, sub-district, and community (Adokiya M. N., Awoonor-Williams, Beiersmann, & Muller, 2015; Ghana Health Service, 2017).

The national level of the GHS undertakes planning, budgeting, organizing, and coordinating all public health activities in the country. Government bureaucrats of varied backgrounds conduct these functions. The regional level is a replica of the national one but operating at a step lower and with a sphere of operation confined to a geographic region. The district-level

operates within a geographic space charged with planning and implementing national public health plans and priorities within the district. Actual delivery of public health services commences at the district level, as primary healthcare providers interact with communities to deliver and promote health directly or through the sub-districts and Community Health and Planning Services (CHPS) zones or compounds. This is done in collaboration with other relevant agencies and civic societies in the ten administrative regions of Ghana as of 2018 (Adokiya M. N., Awoonor-Williams, Beiersmann, & Muller, 2015; Ghana Health Service, 2017).

The planning and delivery of public health services in Ghana is also founded on the WHO six health system's building blocks which include health technologies. Some of the key public health issues include Malaria, HIV/AIDS, Tuberculosis, Cholera, Meningitis, and Upper Respiratory Tract Infections; with major public health activities comprising immunization, public health education, and promotion and disease surveillance and control. The Ghanaian public health sector is managed by a mixture of human resources comprising medical doctors, nurses, pharmacists, allied health staff, and paramedical staff. There are reported inequities in service delivery and mal-distribution of human and facility resources to the detriment of rural and resource-challenged settings (Ghana Health Service, 2017). Public health services are mostly required by rural populations with fewer health facilities and healthcare providers. The need to reach out to these rural communities in remote areas with critically needed services are most crucial. Even though mobile phone penetration in Ghana is generally appreciable, remote parts of the country lack reliable mobile networks and most are hard-toreach with physical health services for lack of transport services and poor rural road networks. This backdrop constrained the effective delivery of public health services to the general population using only the traditional means. There was therefore the need to explore

an alternative channel in reaching the population for which the mobile phone could serve as a viable tool due to its universality and portability in use and information and knowledgesharing utilities.

2.4 Review of Theoretical Literature

This section reviews the relevant theories that underpin the research topic. The theories broadly fall within the technology acceptance and adoption models. It also refers to a set of interrelated concepts, variables, definitions, and propositions that present a systematic outlook of events or phenomena by specifying relationships among variables to explain and predict events or situations (Glanz, Lewis, & Rimer, 1997). It is relevant in driving and guiding research which is equally true for this research as it concerns the application of mobile phone technology in the delivery of health services. The review covered various theories on technology acceptance and its diffusion, the interaction between technology and task, and application of technology in the health domain. A choice of theories was made to underpin the study with justifications. For any technology to be useful to people and organizations, it must be accepted by patrons and used for its intended purpose(s) without which the best technology may not be useful or serve its intended purpose. The theories were reviewed in chronological order; from the earliest to the latest.

2.4.1 Diffusion of Innovation

The Diffusion of Innovation Theory (DOIT) was propounded by Everett Rogers (1962). This was after other initial works by Gabriel Tarde (1903) who proposed the original S-shaped diffusion curve. Subsequently Ryan and Gross (1943) introduced the adopter categories that were adapted by Rogers in his DOIT. It describes the process by which innovation (idea, behaviour, or product) is adopted and communicated through certain channels over time

among a social system or population. It also refers to the process that occurs as people adopt a new idea, product, practice, and philosophy (Kaminski, 2011).

It shows that different people adopt innovation at different times. Some adopt innovation early while others do it at a later stage based on individual characteristics. The theory suggests five categories of adopters with assigned percentages comprising Innovators (2.5%) who may be the few who want to try an innovation and Early Adopters (13.5%) who embrace change opportunities. The others are Early Majority (34%) who adopt new ideas before the average person upon credible evidence of its efficacy, while the Late Majority (34%) refers to the skeptics of change who only adopt an innovation after the majority has tried it. Laggards (16%) are the very conservative, cynical of change and hardest group to adopt innovation. Different stages of communication by which innovation is adopted are suggested to be Awareness, Decision to adopt or reject use, Initial adoption, and Continuous use (Bianchi & de Figueiredo, 2017; LaMorte, 2016; Kaminski, 2011). Five main factors have been suggested to influence technology adoption such as Relative advantage, Compatibility, Flexibility, Trialability, and Observability (Dwivedi, Rana, Jeyaraj, Clement, & Williams, 2017). The theory has been applied in various fields such as agriculture, criminal justice, social work, marketing, and public health. The theory is reported to have been used to accelerate the adoption of important public health programmes that are concerned with behaviour change among the population (LaMorte, 2016; Kaminski, 2011).

2.4.2 Technology Acceptance Model

Technology Acceptance Model (TAM) as a theory finds grounding with Davis' article on the matter (Davis, 1989). It is an information systems theory that explains how users end up accepting and using technology. It further explains how and when users utilize new technology and the various factors that influence their decision (Davis, 1989). It predicts

behavioural intention to use and actual use of technology in a personal or organizational viewpoint and how technological innovation may enhance productivity (Bianchi & de Figueiredo, 2017; Chi-Ping, 2015). It is argued that irrespective of the prospective technical advantage and promised advantages, an unutilized or underutilized technology cannot be effective. User acceptance is a crucial factor in IT adoption and individual, technological, and organizational factors play a key role in this success (Hu, Chau, Sheng, & Tam, 1999). Thus, the acceptance and use of technology form an essential philosophy that serves to drive most researchers in the field of TAM. Since the model's introduction, it has been applied in various fields and areas such as mobile library application (Yoon, 2016), cultural settings (Ashraf, Narongsak, & Seigyoung, 2014), teaching (Wong & Teo, 2009), policing (Colvin & Goh, 2005), farming (Flett, et al., 2004), gender differences and its influence on TAM (Venkatesh & Morris, 2000) and religion (Al-rahmi, Zeki, Alias, & Saged, 2017).

In healthcare, TAM has been used to test the acceptance and adoption of new health technology applications (Becker, 2016), telehealth for the elderly with chronic diseases (ChiPing, 2015), mental health (Becker, 2016), healthcare e-learning (Neo, Park, Lee, Soh, & Oh, 2015), healthcare information systems (Pai & Huang, 2011), physicians acceptance of telemedicine (Rho, Choi, & Lee, 2014), nurses acceptance of information systems (Ifinedo, 2016), etc. TAM has also been tested by integrating it with other theories such as Health Belief Model (HBM) (Ahadzadeh, Pahlevan, Ong, & Khong, 2015), Social capital and cognitive theories (Tsai, 2014) and Task Technology Fit in online education (Wu & Cheni, 2016). These were to help test the combinational effect on the adoption and use of technology in the health domain. The two theories of HBM and TAM were together able to predict internet technology use for health purposes (Ahadzadeh, Pahlevan, Ong, & Khong, 2015). The literature suggests a limited or almost non-existent application of TAM on the specific use and testing in the prevention and management of cholera in general and Ghana in

particular. This study, therefore, attempts to explore perceptions of Healthcare Providers on the adoption and use of mobile technology for the delivery of health services for a disease such as cholera.

It has linkages with other theories such as Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) and others; which makes TAM one of the superior behavioural models (Bagozzi, 2007; Legris, Ingham, & Collerette, 2003). The main constructs presented in the classical TAM are Perceived Ease of Use (PEOU) and Perceived Usefulness (PU). PEOU refers to the degree to which using a particular technology will be effortless while PU is the extent to which people believe that the use of technology will result in improvement of job performance or help them achieve their intended objectives. These two factors predispose or influence individuals' attitudes towards using technology, which in turn creates a behavioural intension to use and ultimately using it. A good amount of studies applying TAM in healthcare included behavioural intention to use health information technology (Ahadzadeh, Pahlevan, Ong, & Khong, 2015). It is worth noting that technological gadget for adoption and use during TAM development was the computer which was quite complex to use at the time. Over time, computers have been made much simpler in their use; with personal computers and tablets having in-built assistive support for users. The wide adoption and use of the mobile phone may also suggest that perspectives on PEOU may be much better in recent years. This has implications for the study in the adoption of the mobile technology for cholera management. Early comprehensive reviews (1980-2001) of the use of various TAM theories reveal that the significance of PU and PEOU constructs on Behavioural Intention and usage behaviour have varying degrees. Their relevance depended on context, attitude, socio-economic, and other exogenous factors (Legris, Ingham, & Collerette, 2003). Even though this study may be quite old, it still offers some insight into the validity and

usefulness of the TAM models to predict Behavioural Intention and usage behaviour. PU was particularly posited to be a good predictor of healthcare professionals' intention to use technology which was explained to be probably due to the pragmatism of this professional group. This group is suggested to be focused on the use of technology itself (Hu, Chau, Sheng, & Tam, 1999) which is still relevant as healthcare workers have recently been described as conservative and slow in adopting technology due to their need for evidence-based technological innovations (Omachonu & Einspruch, 2010).

Despite the strengths of TAM as having high predictive value, internal and external validity for acceptance of technology, it has inherent weaknesses such as the theory's parsimony, too deterministic, absence of rigorous theory and method for ascertaining the determinants of PU and PEOU. It is criticized for the reason that human action is not characterized only by an individual acting in isolation. Thus, the other limitations such as the absence of group and socio-cultural factors influencing individuals and others, have led to a call for a new paradigm shift which has further resulted in various extensions to the original TAM (Bagozzi, 2007). It is suggested that the unbridled adaptation of TAM in numerous fields and different periods have resulted in theoretical chaos and confusion (Benbasat & Barki, 2007).

Some of the main additional constructs to TAM are Perceived Effectiveness (Segars & Grover, 1993), PU and PEOU 2x2 Grid (Keil, Beranek, & Konsynski, 1995), social influence (subjective norms), cognitive instrumental processes [output quality, job relevance, others] (Venkatesh & Davis, 2000) and other external variables, which have led to what is called TAM2. Eleven years after the publication of TAM by Davis, Venkatesh & Davis (2000) updated the framework with detailed external parameters that influence both main parameters of the previous one, which is widely seen as a credible extension of TAM1 to TAM2. Some of the new variables suggested are image, job relevance, and output quality. Both TAMs

(TAM1 and TAM2) may be used to evaluate the information technology adoption process from a personal or organizational point of view. Identifying a further gap in TAM, Venkatesh & Bala (2008) present what is acknowledged as TAM3, which focuses on how corporate managers decide to adopt new technologies to enhance productivity (Bianchi & de Figueiredo, 2017). New constructs introduced in TAM3 are anchor and adjustment with new moderating and influencing arrows linking the various TAMs (1, 2 & 3).

TAM as a technology acceptance and use model has been suggested as one of the most prominent models with superior predictive power for Behavioural Intention and actual use of technology. Despite its parsimony, the same has been mentioned as its advantage in addition to its IT specificity, robust theoretical basis, and abundant empirical support (Hu, Chau, Sheng, & Tam, 1999).

2.4.3 Task-Technology Fit

Goodhue & Thompson observe that there are two streams of research on management information systems focusing on utilization and performance streams. They suggest that most key research works have dwelt on the utilization of technology with less focus on performance. They, therefore, propose that there was the need to pay attention to how technology fits into tasks of individuals which led them to propose the Task-Technology Fit (TTF) model. They opine that TTF is a key but often ignored concept in appreciating the impact of technology on individual performance (Goodhue & Thompson, 1995). TTF refers to the degree to which technology assists an individual in executing his or her tasks. Two key philosophies postulated under TTF is that for any information system or technology to have the desired impact on individual task and/or performance, it must be first utilized and also fit the task that is supported. More specifically, it is the degree of fit among task requirements and individual capabilities as well as the functionality of the technology for the task. It is hypothesized that attitude acts as a predictor of technology utilization while TTF is a predictor

of performance. They suggest that utilization does not necessarily translate into performance just as technology fit also does not automatically lead to utilization. A combination of the two streams in research therefore presents a potent predictor for both utilization and performance. Utilization refers to employing the technology to perform or complete a task which is seen in the usage frequency and diversity of applications employed. Performance impacts construct refer to an individual's ability to accomplish a given task. It is suggested that at any level of utilization, a system with superior TTF will result in higher performance. Technologies refer to tools used by individuals in carrying out their tasks or assignment while tasks are activities performed by individuals in turning inputs into outputs. Thus, technology is said to add value to the individual and overall organizational performance (Goodhue & Thompson, 1995). In summary, TTF predicts usage continuance and performance (individual and organization), while TAM predicts usage of technology. They suggest that combining the two theoretical streams in research presents a more potent predictor of both *Use, Usage Continuance, and Performance.*

The original version of TTF has key independent constructs such as task, technology and individual characteristics; of which task and individual characteristics combine to create tasktechnology fit. Technology characteristics however do not influence task-technology fit but rather influence the task and individual characteristics. The task-technology fit construct then impacts on performance alongside utilization construct. The utilization construct is influenced by precursors of utilization in the areas of social norms, habit, and facilitating conditions (Goodhue & Thompson, 1995).

The simplified version of the theoretical constructs of TTF comprises two independent variables of task characteristics and Technology characteristics that combine to create a tasktechnology fit; this in turn results in utilization and performance impacts (Tariq & Akter,

2011). Gebauer & Shaw (2012) suggest three broad organizational task characteristics to comprise operational, management, and informational, while Goodhue & Thompson (1995) suggest individual level tasks as knowledge tacitness, task independence, and others. Organizational task characteristics are further classified into simple (repetitive/routine) and complex (unstructured/high uncertainty) tasks which include administrative and operational activities. Goodhue & Thompson (1995) identify eight TTF factors including compatibility, ease of use and training, production timeliness, systems reliability, and users. Technology characteristics include systems reliability, output quality, completeness, relevance, compatibility, and processing speed (Tariq & Akter, 2011). Other researchers have confirmed the TTF model's effect on fit and utilization and performance in their research at the individual (Cooper & Zmud, 1990) and group (Zigurs & Buckland, 1998) levels.

The implication of the TTF for the study is that where mobile healthcare providers hold the perspective that the mobile technology fits well into their normal (daily) tasks and enhance or amplifies their performance impact, they are more likely to utilize it for their routine delivery of health services. This in turn is expected to result in improved performance impact as espoused by its proponents. Thus, TTF helps to achieve the dual purpose of utilization and performance in areas of efficiency, effectiveness, and output quality. TTF is seen as an extension of the theory of TAM as espoused by Fred Davis (1989).

2.4.4 Unified Theory of Acceptance and Use of Technology

The Unified Theory of Acceptance and Use of Technology (UTAUT) is another model in the family-line of the cluster theories of technology acceptance models developed by Venkatesh et al (2003). UTAUT attempts to develop a model that seeks to integrate various technology acceptance models into a unified framework probably to sanitize the theoretical chaos

adduced by Benbasat & Barki (2007), to help overcome the limitations of the complexity of these models (Bianchi & de Figueiredo, 2017). The key target models (eight) identified by Venkatesh et al (2003) in information adoption research for unification comprised TRA, TAM, Motivational Model, TPB, combined TAM and TPB, Model of Personal Computer Utilization, Innovation Diffusion Theory and Social Cognitive Theory (Lescevica, Ginters, & Mazza, 2013; Mutlu & Der, 2017).

The UTAUT model prescribes four constructs comprising performance expectancy, effort expectancy, social influence, and facilitating conditions. The first three constructs mentioned above directly influence behavioural intention and thereby leading to use of behaviour while facilitating conditions are direct determinants of BI to use technology. Performance Expectancy (PE) refers to the point at which an individual believes that adopting and using a system will help attain one's aims in job performance; whilst Effort Expectancy (EE) is the degree of ease as related to the use of a technological system. PE obviously may be linked to TAM1's Perceived Usefulness and Perceived Effectiveness (Segars & Grover, 1993) constructs while EE may be linked to the PEOU construct of TAM1. Social Influence (SI) construct is the degree to which one perceives that it is important others believe that one should use new technology. It refers to the societal expectations of people that influence their behaviour. Facilitating Conditions refer to the degree to which an individual is of the view that structural and technical infrastructure exists to support the use of a system. The second set of constructs comprises four individual characteristics moderating variables such as age, gender, experience, and voluntariness of use which separately moderate the other set of constructs (Lescevica, Ginters, & Mazza, 2013; Venkatesh, Thong, & Xu, 2012). The first set of constructs is described as exogenous constructs and represents technology attributes

(Performance Expectancy and Effort Expectancy) and contextual factors (Facilitating Conditions and Social Influence). Performance Expectancy has been suggested to possess a more superior predictive power compared to the others on Behavioural Intention and has a significant effect on Behavioural Intention on the use of mobile applications. UTAUT has been empirically tested in several fields such as internet banking, e-recruitment, egovernment, and online ticketing (Mutlu & Der, 2017).

The UTAUT was further extended by Venkatesh, Thong and Xu (2012) by identifying a gap in consumer technology use context as against organizational employees' acceptance of technology in UTAUT1. UTAUT2 maintains the constructs from UTAUT1 but introduces new ones such as price or value, habits, and hedonic motivations which also influence behavioural intentions. Thus, UTAUT2 extends the constructs to eight parameters which influence behavioural intentions (Bianchi & de Figueiredo, 2017; Venkatesh, Thong, & Xu, 2012). The rearrangement of constructs with its new linkages was aimed at helping to further the generalizability of UTAUT to a different context (Venkatesh, Thong, & Xu, 2012). Dwivedi et al. (2017) propose UTAUT 3 with a re-examination of the model with new directions for influencing arrows even though they maintain the constructs of UTAUT1.

2.4.5 Technology acceptance among healthcare providers

It is posited that information service theory should be tested for continuous examination and validation particularly where it involves new technologies, populations, or organizational contexts (Hu, Chau, Sheng, & Tam, 1999). Early technology acceptance studies in healthcare focused on telemedicine acceptance among physicians and nurses (Tariq & Akter, 2011). Telemedicine, as an IT-based medical intervention has the potential in leveraging healthcare to populations to improve universal access and quality and achieve cost-effectiveness. Most telemedicine and IT-based healthcare which emerged over 40 years ago failed or were found

not viable due to primitive infrastructure, immature and inefficient technology, and funding challenges. User acceptance of the technology was suggested as one of the most critical challenges facing healthcare organizations that were envisaging introducing telemedicine or IT-enabled health services.

Earlier research focused on technological developments and applications rather than user acceptance, even though recent works in the field of telemedicine and mobile health, in general, have seen a significant increase (Akter & Ray, 2010; Aranda-Jan, Mohutsiwa-Dibe, & Loukanova, 2014; Gleason, 2015). Studies in mHealth among Healthcare Providers show that PU is a better predictor of intention to use technology than PEOU. Other factors that affect TAM among Healthcare Providers are the non-linear work processes level of autonomy of their work. TAM and UTAUT have been reported to be the two major theoretical underpinnings in research in the health sector with researchers recommending the amendment of various constructs to improve the predictive power of these theories (Baker, et al., 2013). The uniqueness of Healthcare Providers, national and global importance of healthcare, increasing digitization of health infrastructure and services have been cited as some of the reasons why user acceptance and use of technology are imperative (Hu, Chau, Sheng, & Tam, 1999). These suggested reasons though quite early during the nascent period of IT-enabled healthcare services, they are still relevant currently and particularly for the geographic context (LMIC) of this study where the adoption and diffusion of IT had lagged behind generally such as 3rd and 4th generation technology even though there is some level of IT leap-frogging recently.

2.4.6 Choice of theories to underpin the study

In summary, the theoretical review focused on surveying relevant technology acceptance and diffusion theories for this study. Some of the theories reviewed included DOIT, TAM, and its

key extensions, UTAUT, and TTF. Despite this, the study chose TAM and TTF to serve as theoretical underpinnings guiding the research. This was mainly due to the predictive superiority of TAM in predicting technology *adoption and use*; while TTF helps predict *Utilization (Usage Continuance) and Performance.* For healthcare providers to use and have continuance in the usage of technology, which leads to performance, there was the need to adopt mobile technology and continue to use it for their activities. However, this would be possible if mobile technology fit-in well with their health delivery tasks. Thus, adopting one (either TAM or TTF) would only partially answer the phenomenon. DOIT and UTAUT were not considered as appropriate theories based on the study's aim and objectives. The study focuses on use of the mobile phone technology by healthcare providers to deliver public health services which TAM predicts but not the process by which mobile phone technology is adopted and communicated through certain channels over time among a population as for espoused by DOIT. UTAUT was not also considered appropriate due to its inability to predict utilization and performance as done by TTF but the use of technology, for which TAM already predicts.

2.5 Review of Empirical Literature

This section surveys and synthesizes key empirical findings of the efficacy, challenges, and enablers and facilitators of mHealth.

2.5.1 Mobile phones and their use in healthcare

According to the mHealth Alliance cited in the work of Coleman (2011), mobile phones can reach the unreached and can empower the public with information and enable remote health workers in their activities. A significant body of literature reports the usefulness and favourable impact of mHealth on health services delivery in general across both developed and developing regions (Lester & Karanja, 2008; Lester, et al., 2010). Researchers have tried

to assess how mobile phones can be used to leverage delivery of health services to individuals, populations, and health systems via different scientific inquiries and have found a moderately favourable impact on target populations and individuals (Orr & King, 2015; Tamrat & Kachnowski, 2012). Mhealth is touted to have the potential of impacting greatly on health care in the next decades; which challenges the way traditional episodic healthcare is currently conducted to a patient-centred delivery model (Gleason, 2015; Currie & Seddon, 2014).

The helpful effect on Behaviour Change Communication (BCC) has been empirically found in other studies (Atienza, et al., 2015; van Heerden, Tomlinson, & Swartz, 2012). Mhealth has successfully resulted in the reduction or cessation in smoking habits (Orr & King, 2015), drug addiction (Milward, Day, Wadsworth, Strang, & Lynskey, 2015), telehealth (Kenyon, Poropatich, & Holtel, 2011; Mechael, et al., 2010), health education seeking (Lim, et al., 2011) and clinical diseases such as Cardiovascular Disease screening (Surka et al., 2014), management of appointments (Gurol-Urganci, Atun, Car, & Vodopivec-Jamsek, 2013), among others. Other empirical studies have revealed the efficacy of mHealth on the management of diseases such as alcohol abuse (Quanbeck, Chih, Roberta, Gustafson, & Isham, 2014), HIV/AIDS (Chi & Stringer, 2010; Lester, et al., 2010), health worker productivity (Surka, et al., 2014), abortion management (Constant, de Tolly, Harries, & Myer, 2015), among others. MHealth was reported to have no significant impact on emergency obstetric care, postnatal services, or breastfeeding in meta-analysis studies in Nigeria (Jennings, Omoni, Akerele, Ibrahim, & Ekanem, 2015) primarily due to unequal access to mobile phones by women. Some mHealth interventions using short messaging service has been reported to be inadequately tested for efficacy and whether mobile phones in health leads to overall improved health outcomes and reduced disease burden is still unknown (Déglise, Suggs, & Odermatt, 2012a).

Mhealth interventions in maternal and child health (MCH) studies have covered several other health themes such as prevention of mother-to-child transmission of HIV/AIDs (Mushamiri, Luo, Iiams-Hauser, & Amor, 2015; Noordam, et al., 2015), uptake of Ante/prenatal services (Evans, Abroms, Propatich, Nielsen, & Wallace, 2012), increasing supervision and performance of maternal staff (Modi, et al., 2015), general maternal health services utilization (Jennings, Omoni, Akerele, Ibrahim, & Ekanem, 2015) and abortion (Constant, de Tolly, Harries, & Myer, 2015). Others are post-partum haemorrhage (Andreatta, Depuur, Danquah, & Perosky, 2011), post-natal depression (Husain, et al., 2016), maternal health education (Roberts, Birgisson, Chang, & Koopman, 2015) and child vaccination (Uddin, et al., 2016).

The efficacy of mobile phone usage in maternal health has also been reported in antenatal attendance studies of pregnant women. Pregnant women with mobile phones who attend antenatal in the community are identified and registered by community health workers for intervention with mHealth services. Most interventions were done with the sending of text messages and interactive voice calls and the allocation of SMS-sent vouchers. Pregnant women receiving mHealth services had higher uptake of recommended antenatal care visits (at least four) during pregnancy. These also helped to manage secondary care issues such as immunization and symptomatic treatment of malaria and antepartum referrals (AwoonorWilliams, et al., 2012; Lund, 2012; Watterson, Walsh, & Madeka, 2015). In effect mHealth generally had the potential of improving the quality of maternal care as the primary and secondary care outcomes are dealt with through the uptake of antenatal visits. Some studies disclose various evidence of success at changing behaviour to help increase antenatal and postnatal care attendance, or childhood immunization rates. (Lund, et al., 2014; Watterson, Walsh, & Madeka, 2015). This is particularly important for LMICs as it has the potential of improving maternal and child health in resource-challenged settings as literature reveals the majority of interventions in such settings (Watterson, Walsh, & Madeka, 2015).

It is however worthy of note that even where some successes were reported, researchers also posit that a number of the studies (including some of the successful ones) were not conclusive or did not result in a significant increase or uptake of antenatal services. These were attributed to some factors such as a limited sample, observational nature of some of the studies, need for methodological rigour, etc. There is also the need for evaluation of mHealth programmes in a much wider variety of situations and settings (Lund, 2012; Watterson, Walsh, & Madeka, 2015). Irrespective of the mixed evidence, Lund (2012) represents the hopefuls who recommend the use of mobile phones in maternal and child health management to policymakers as still presenting potential advantages for leverage, particularly for healthcare systems in resource-constrained settings.

Mobile phones are reported to have been successfully applied for management and control of communicable disease areas such as HIV/AIDS (Chi & Stringer, 2010; Lester & Karanja, 2008), Malaria (Moonen & Cohen, 2012; Zurovac, et al., 2011) and Tuberculosis (Elangovan & Arulchelvan, 2013) and among others. Their communicable nature may serve as useful lessons for cholera which is also communicable disease. One of the earliest applications of mHealth was in treatment adherence and the use of anti-retroviral therapy. Many mHealth studies reveal a good impact on patients' adherence to the use of anti-retroviral drugs for HIV/AIDS and its management, of which SMS represented the majority of the communication platforms, with some supplemented by interactive voice calls (Belzer, 2013; Chi & Stringer, 2010; Devi, et al., 2015). Some of the works on the disease have covered the use of mobile phones for treatment adherence. The empirical efficacy of mHealth in HIV/AIDS management is described in one study as feasible and highly acceptable (Schwartz, et al., 2015). A review of empirical literature totalling 90 peer-reviewed articles found that 73% reported positive effects on HIV/AIDS. Devi et al. (2015) however indicate

that 23% of all empirical works (90) reviewed said there was no effect on participants while 4% reported negative results. A number of studies on the impact of mHealth on malaria prevention and treatment have been conducted (Moonen & Cohen, 2012; Zurovac, et al., 2011), covering aspects of malaria such as case detection (Prue, et al., 2013), diagnosis (Pirnstill & Coté, 2015), pharmaco-adherence (Steury, 2016), epidemiology (Hamainza, Killeen, Kamuliwo, Bennett, & Yukich, 2014) and eradication (Quan, Hulth, Kok, & Blumberg, 2014), among others. Mobile phones have been successfully used to adequately and accurately report malaria transmission from remote locations to help in its effective management (Hamainza, Killeen, Kamuliwo, Bennett, & Yukich, 2014). Phone data on population movement have been used to develop risk and transmission maps for malaria exposure for appropriate intervention measures which helped reduce the infection rate and raised overall effective management of malaria (Ryan, 2016; Wesolowski, et al., 2012). Irrespective of these good effects of mobile phones on malaria as a communicable disease, some limitations have been identified such as availability of telecom infrastructure (cell towers), inability to capture cross-border migration, network variability and the non-use of mobile phones by carriers of the parasite (Wesolowski, et al., 2012).

Most mHealth interventions in tuberculosis (TB) management have centred on drug adherence as the treatment of TB takes a considerable period. Consistent defaulting in drug administration has the potential creating resistance by the bacteria and the ultimate increase in mortality or prolonged morbidity (Garfein & Munoz, 2017). Most SMS messages are sent to remind patients to take medications to help avoid non-adherence through forgetfulness and lack of social support (Nglazi, Bekker, Wood, Hussey, & Wiysonge, 2013). Mobile phones also have been reported to support drug adherence, increased rates of clinic attendance, and cure (Nglazi, Bekker, Wood, Hussey, & Wiysonge, 2013). Despite the moderate mHealth

success in TB clinical management, some empirical findings report that interventions, especially SMS (which was the most dominant communication platform) did not considerably improve adherence to tuberculosis treatment (Liu, et al., 2015; Velayutham, et al., 2015).

The review of literature on disease surveillance is more purposively tilted towards LMICs, of which most are also resource-challenged and it was the researcher's opinion that it would help inform the study which is also situated in Ghana, described as a LMIC with the similar resource-limited setting. It is suggested that most surveillance systems of these countries use traditional paper-based methods, said to be laborious and inefficient, and will require alternative innovative tools such as mobile phone technology to help strengthen infectious disease surveillance systems due to the extraordinary progress made in mobile telephony. This option is seen as offering more benefits of data accuracy, completeness, and timeliness even though it may require a larger investment outlay (Mtema, 2013).

The speed with which data are collected and analyzed for rapid response are some of the key activities needed for an effective response to epidemic threats, including cholera. The mobile phone is seen by some researchers as capable of playing a key role in the realization of the surveillance goals (speed, accuracy, and timeliness) due to its ability to reach large sections of the population in near real-time, especially for remote locations (Adokiya M. N., AwoonorWilliams, Beiersmann, & Muller, 2015; Adokiya & Awoonor-Williams, 2016). Evidence has been adduced that mobile phones may be an appropriate and likely tool for disease control interventions in developing countries (Déglise, Suggs, & Odermatt, 2012b), laboratory-based infectious cases detection and reporting and immediate cholera reporting and outbreak control (Ngwa, et al., 2016; Safaie, Mousavi, LaPorte, Goya, & Zahraie, 2006), rapid reporting of infectious diseases during an earthquake (Yang, Yang, Luo, & Gong, 2009), surveillance of population movement during disasters (Mayor, 2011), mobile phone-based

data collection (Mwabukusi, Karimuribo, Rweyemamu, & Beda, 2014; Diwan, Agnihotri, & Hulth, 2015), among others. Some of the key goals of these research reports were to achieve effective case detection, data collection, reporting, and analysis of which mobile phones were revealed as being efficacious for accuracy, rate and timeliness of reporting and ease of analysis (Yang,

Yang, Luo, & Gong, 2009; Mwabukusi, Karimuribo, Rweyemamu, & Beda, 2014; Pascoe, Lungo, Kaasboll, & Koleleni, 2012).

In Ghana, some studies have been conducted on infectious disease surveillance which covers geographic and disease areas such as Brong Ahafo Region on febrile illness (Jephcott, Wood, & Cunningham, 2017), Northern Region on disease surveillance core and support functions (Adokiya M. N., Awoonor-Williams, Beiersmann, & Muller, 2015), Upper East Region on Ebola Virus (Adokiya & Awoonor-Williams, 2016) and Brong Ahafo Region on Ebola (Issah, et al., 2015). The rest include GAR on Influenza (Jones, et al., 2016) and Eastern Region on Syphilis (Dassah, Adu-Sarkodie, & Mayaud, 2016) and Western Region on Lymphatic Filariasis (Vroom, 2017). The empirical literature on disease surveillance in Ghana reveals that studies in the area are quite recent and have appreciable geospatial distribution and cover diverse diseases apart from cholera. The application of mobile phones in leveraging disease surveillance, in general, is not mentioned by these studies apart from the cursory mention of its use in few works such as Adokiya et al. (2015) and Adokiya & Awoonor-Williams (2016). Despite this, Vroom (2017) reports the use of mobile phones to collect data and report for mass drug administration against Lymphatic Filariasis. These studies indicate that the use of mobile phones could help improve the integrated disease surveillance and response chain, which is also useful for effective surveillance management of cholera. The study, therefore, identified this empirical gap for exploration.

A summary description of the empirical impact on general disease and health services delivery has been mixed. Some describe the impact as having limited success at scale in achieving its objectives, particularly through the SMS platform (Chib, van Velthoven, & Car, 2015). One reason adduced by Lim, Hocking, Lellard, & Aitken (2008) which support this assertion is that only a few of mHealth interventions have received evaluation while Labrique et al (2013) observe lack of large-scale mHealth implementation and integration into health programmes as well as the paucity of empirical evidence itself. Literature reveals no scale-up activities of mHealth interventions despite its promise (Vroom, 2017). Some researchers, therefore, suggest circumspection when considering the potential overall effect of mHealth programmes (Chib, van Velthoven, & Car, 2015). A literature review by Watterson et al. (2015) concluded that much of the empirical evidence on mhealth reveals weak methodological rigour which makes it difficult to draw any strong conclusions on the effectiveness of mHealth interventions such as in immunization. They recommend further rigorous evaluation of mHealth programmes in a diversity of settings for which the study identifies cholera in GAR of Ghana as another programme and setting for study.

Specific empirical works on cholera have been published on the use of mobile phone operator data to predict the possible onset of the epidemic by analyzing spatial data of anonymous subscriber identification module (SIM) cards movement such as that of the 2010 Haitian cholera epidemic which was used to produce national mobility network and helped in an early response to cholera (Bengtsson, et al., 2015; Overney, 2016). It was also used to track the possibility of cholera spread during Islamic pilgrimage in Senegal (Overney, 2016) . It was realized from the analysis of the phone-based data that infections at the initial stages of the outbreak were significantly correlated with reported cholera cases in the very early days of

the epidemic. Other researchers have also reported similar findings (Finger, et al., 2016; Ngwa, et al., 2016; Overney, 2016).

Population mobility patterns are normally reconstructed from mobile phone data to decipher their movement patterns for necessary action. The data are added up at antenna sites where mobile phones are logged in. Calls or text messages are picked up and aggregated into a bigdata (spatio-temporal) covering time and space by service providers from which mHealth researchers analyze and model for epidemiological studies (Finger, et al., 2016). To this extent, it is posited that mobile operator data may be a likely data source for improving cholera preparedness and response efforts during cholera outbreaks as it is suggested to be a good predictor (Bengtsson, et al., 2015; Ngwa, et al., 2016; Overney, 2016). This provides the opportunity to develop what may be termed digital epidemiology where mobile technology is being leveraged for the tracking of diseases, dispersal patterns, mode of transmission, and susceptible population. Limitations of using spatiotemporal data have been reported to cover issues such as bias due to a lack of information on demographic backgrounds of populations being tracked. It is suggested that richer people with phones have the capability of emigrating from such source points concerning poor populations who may not afford to move or even attend hospitals. Even where movements involve people without mobile phones, they may not be part of such big-data as the antennas are not capable of picking up signals (Finger, et al., 2016). Other areas of favourable empirical findings of uses of mobile phones in cholera management are in mass oral cholera vaccination where vaccination data uploaded onto mobile phones were analyzed to help plan for next day's vaccination based on records of missed vaccinations by affected populations. This helped reduce the need for paper-based registers and manual inputting of data, which is described as costly, laborious, and having a high rate of error (Teng, Thomson, Lascher, Raymond, & Ivers, 2014).

Despite the above, other studies also reveal that the empirical foundation of mHealth impact is not grounded enough to be convincing. The sustainability and scalability studies to engender more confidence in its efficacy require further studies (Huang & Matricardi, 2016; Tamrat & Kachnowski, 2012). It is observed that evidence is sparse in the effectiveness of mHealth which needs further empirical research rigour and theoretical applications. Empirical evidence concerning the potential benefits of interventions using smartphones and social media are still developing (Kumar et al, 2013); for which critics posit that the mobile technology is overhyped of which lack of empirical evidence may be summed up in the description of the mHealth interventions as replete with numerous pilot projects termed 'pilotitis' (that is the proliferation of pilot projects that fail to reach scale), leading to weak methodological rigour and theoretical depth (Shuchman, 2014). The GHS indicates that the period of mHealth pilots in Ghana, aimed at proving a concept was no longer tenable and should cease for a refocus on nationwide scale-up (Ghana Health Service, 2014). Methodological rigour which standard is set against Randomized Controlled Trial by some mHealth researchers as a gold standard is disputed by other researchers who believe that other methods of mHealth evaluation should be considered apart from this type of research design. This may be due to different research settings, types of health intervention, and level of analysis (Forrest, et al., 2015). This is likely to help inform methodological depth and breadth. Despite the above, some mHealth studies adopted various methodologies such as quantitative (Bigna, Plottel, Kouanfack, & Koula-Shiro, 2014), qualitative (Medhanyie, et al., 2015) and mix-methods (Tamrat & Kachnowski, 2012) for their research inquiries.

From the foregoing, there is substantial empirical evidence that mHealth has the potential to impact health outcomes. Many researchers, multilateral, and governments across the world are vigorously interested in, and implementing mHealth programmes to help take advantage

of innovation that mobile technology presents (WHO, 2011). The WHO in its 2011 Global Observatory for eHealth reports that 114 of its member countries had adopted 14 mHealth intervention categories at various stages in all their six regions. There is therefore the quest to deepen mHealth research and implementation but not cessation. In Ghana, the empirical coverage of mobile phone use in prevention and management of cholera is almost nonexistent at the time of this review, apart from few studies that focus on general integrated disease surveillance and response management (Adokiya & Awoonor-Williams, 2016; Adokiya M. N., Awoonor-Williams, Beiersmann, & Muller, 2015). This provides a key empirical research gap for which this study undertakes to explore.

Notwithstanding the reported positive role of mobile phones on healthcare delivery, there is empirical evidence that this role is constrained by some factors, particularly for LMICs. Mhealth challenges affect healthcare providers, beneficiaries of the services, technology providers, policy-makers, financiers, and business investors. Other categorizations include soft (non-physical) and hard (physical) challenges; user-side and provider-side challenges. These challenges were reviewed with mHealth in focus.

Even though mobile telecommunication infrastructure development has been greatly expanded to cover about 80% of the world's population, wide gaps still exist in access to these services (voice and data) in rural and poor settings of the world, particularly in the developing countries of Africa and parts of Asia (Hunting, et al., 2015; ITU, 2013; Leon, Schneider, & Daviaud, 2012; Mtema, 2013). This infrastructure is critical and serves as a foundation for the launch of various services and products to meet commercial and social needs and wants (Garg, et al., 2016; Mechael, et al., 2010; Senyo, 2015). Their nonavailability affects mobile penetration particularly for LMICs as investments in telecom infrastructure involve enormous

investment for which funding is a challenge in such regions (Leon, Schneider, & Daviaud, 2012; Poon, et al., 2006).

One key challenge with mobile phone adoption and use is language. The multiplicity of languages within countries poses a major challenge to the delivery of services through the medium of the mobile phone. This makes it challenging to propagate a standard set of information to people who have varied languages such as in India (Skaria, 2013). It is suggested that the world has over 7,000 living (active) languages which make it a daunting task even though English is the most widely spoken language (106 countries) (Lewis, Simons, & Fennig, 2016). The language barrier has been noted in several mHealth studies, as being one major concern for patrons of services delivered through mobile phones. Even though few languages have become international languages such as English, French, and Spanish, populations may still prefer receiving services in their local language rather than an officially spoken one which may not be their mother-tongue (Bigna, Plottel, Kouanfack, & KoulaShiro, 2014; Brian & Ben-Zeev, 2014).

Some empirical studies have shown that language is one of the most formidable challenges inhibiting the effective design and implementation of mHealth interventions, especially for Lower-and-Middle-Income Countries (LMICs) and affects the ability to reach all targeted population, coding of messages, trust and cost (Bigna, Plottel, Kouanfack, & Koula-Shiro, 2014; Brian, & Ben-Zeev, 2014; Leon, Schneider, & Daviaud, 2012; Mechael, et al., 2010; Medhanyie, et al., 2015). The challenge of multiple languages is worsened by the 160character limitation of the SMS which has been already indicated as a key mHealth communicational channel. This is further exacerbated by the different alphabetical characters of various languages (Khan, et al., 2015). This warrants the need for more sophisticated and bespoke messaging systems targeted at individual patients or clients (Mechael, et al., 2010).

The evidence, therefore, suggests that it is imperative the language variable in mHealth interventions is given the needed attention in mHealth design, especially during mHealth scale-up programmes (Awoonor-Williams, et al., 2012; Mechael, et al., 2010).

Illiteracy refers to the uneducated or people without formal education. Empirical evidence shows that there are two types of illiteracy which are actual (natural) and digital. Actual illiteracy may refer to mHealth clients who did not have formal education, while digital illiteracy refers to those who are or have been formally educated but technologically challenged and cannot understand and manipulate technological products which may be referred to as technological incapacity (Khatuna, Heywood, Ray, Bhuiya, & Liaw, 2016). Digital literacy has been reported to be closely associated with the internet-savvy young population, of whom Prensky (2001) terms as 'digital natives' and those who are digitally illiterate described as 'digital immigrants'. Digital natives are said to be native speakers of the digital language comprising video games, internet, computers, etc.; while digital immigrants attempt to speak the digital language but as aliens, leaving a 'foreign accent'. He postulates that the deeper the illiteracy, the deeper the accent. This has implications for mHealth digital communication which must take into consideration these two digital divides. Thus, just as 'natives' may speak their language effortlessly, so will digital natives 'speak' the digital language fluently. The reverse is true for digital 'aliens'. This has implications for mHealth interventions involving digital 'natives and aliens' concerning the language of communication and the ease with which each group may appreciate communication platform, content, etc.

Illiteracy may particularly constrain text-based (SMS) mHealth interventions and worsen the digital divide (which refers to the differential gaps among people's access to digital and information technology) as well as affect the general adoption of mHealth (Dicianno, et al.,

2015; Mechael, et al., 2010; O'Connor, O'Donoghue, Gallagher, & Kawonga, 2014). It has been posited that consumer literacy and awareness play a crucial role in mobile phone product usage and adoption, as it is essential in appreciating mobile phone user interface, reading its display, and using its basic features such as the digital keyboard. Regions with high levels of illiteracy have been identified to fall behind the uptake of mobile services such as the internet. This is exacerbated by digital illiteracy which elevates the barrier to mobile internet adoption, having the ability to affect individuals' capacity to navigate a handset's functionality, consume and create content, among others (GSMA Intelligence, 2016). There is a strong relationship between actual illiteracy and digital illiteracy. The former impacts the latter. However, it has also been reported that not all educated persons are digitally literate as the latter may sometimes require special learning and support to help appreciate the intricate feature of mobile phones such as smartphones (GSMA Intelligence, 2015). The technological complexity of mobile phone systems also exacerbates the already challenging concomitant effect of both types of illiteracy mentioned above (The PLOS Medicine Editors, 2013).

Security, safety, and privacy have also been identified as key challenges affecting clients' willingness to adopt mHealth products and services. These factors normally are intertwined as a breach in security may lead to compromising the safety and privacy of individuals. These factors are more important for patients and individuals due to the need to protect patient records and data, the sensitivity of these records and integrity to help build trust which is important in a client-provider relationship (Huang & Matricardi, 2016; Isabel, Nunes, & Simões-Marques, 2015; Khatuna, Heywood, Ray, Bhuiya, & Liaw, 2016; Leon, Schneider, & Daviaud, 2012). Security, safety and privacy have been specifically mentioned by Vodafone Global Enterprise report and other researchers as representing notable challenges, apart from regulation, to be taken into consideration in mobile phone adoption and use

(Vodafone Global Enterprise, 2013; Terry, 2015; Vallespin, Cornet, & Kotzeva, 2016). Security, safety, and especially privacy have implications for patient or user confidentiality needs which mHealth interventionists must be sensitive to (Christensen & Dahlia, 2009; Milward, Day, Wadsworth, Strang, & Lynskey, 2015). Security, safety, and privacy have been jointly stated in different permutations with confidentiality which suggests close linkage of these challenges (Mechael, et al., 2010; Turner, 2016; van Heerden, Tomlinson, & Swartz, 2012). Kaplan (2006) has posited that the phenomenon of mobile phone-sharing could be a source of limitation for mHealth adoption as it may affect privacy, security, and confidentiality. Mobile phone-sharing still exists (especially in rural areas) despite the progressive mobile phone penetration of over 100% in Ghana, which was reported as a source of concern during a mHealth study in maternal and child health care project in the Upper East Region of Ghana (Awoonor-Williams, et al., 2012).

Even though existing literature is not replete with culture as a major limitation to mHealth, there are some which report cultural factors such as actual beliefs of particular societies and gender issues such as female access to mobile phones (Awoonor-Williams, et al., 2012; Leon, Schneider, & Daviaud, 2012; Sun, Guo, Wang, & Zeng, 2016). Gender (female) access to mobile phones has been suggested as a potential constraint in access to mHealth interventions where in some findings, participants could only access phones held by their male partners (Awoonor-Williams, et al., 2012). It was found out that in settings women had unequal access to mobile phones compared to men, mHealth services for pregnant women failed to reach them. This group, therefore, may require improvement in access to mobile phones to help enhance maternal health services this group (Jennings, Omoni, Akerele, Ibrahim, & Ekanem, 2015) or male partners may need to be involved in the mHealth programme to help create access (Awoonor-Williams, et al., 2012). Skaria (2013) suggests that the more culturally

diverse a population is, the more difficult it may be to design and implement mHealth interventions. Mechael et al. (2010) therefore recommend that it may be imperative to better understand context and culture to help develop effective mHealth interventions, especially in LMICs.

Cost of mHealth services is a source of interest for researchers as empirical work on it has been quite significant. A significant section of the literature mentions cost as a source of mHealth barrier, particularly for LMICs (The PLOS Medicine Editors, 2013; Fletcher & Jensen, 2015; Tamrat & Kachnowski, 2012; Parker, Jessel, Richardson, & Reid, 2013). Most mHealth challenges have been identified by literature as replete with projects which have funding from interested donors which may mask the actual cost of scale-up and eventual affordability (Aranda-Jan, Mohutsiwa-Dibe, & Loukanova, 2014). Literature is not conclusive of the affordability of mHealth. Even though some researchers have found mHealth, particularly SMS-based mHealth interventions as cost-effective (Orr & King, 2015; Rodrigues, Bogg, Shet, Kumar, & Costa, 2014), others also disagree and view cost as a key barrier to mHealth adoption (Fletcher & Jensen, 2015; Katz, Mesfin, & Barr, 2012). Even though SMS is relatively inexpensive, the cost of infrastructural expansion and system set-up may be an additional financial challenge in utilizing this technology (Poon, et al., 2006; Senyo, 2015).

Because of the foregoing, Garg et al. (2016) recommend the need for further research to investigate how different texting platforms and intervention designs affect sustainability and scalability. Sustainability of financing and impact on scalability was also acknowledged in other works (Leon, Schneider, & Daviaud, 2012). The incidence of cost is not experienced by only one member of the mHealth ecosystem but all members. Cost affects health care providers, users of mHealth services, infrastructural providers, financiers, and government

(Tamrat & Kachnowski, 2012). Related to cost is the need for funding for mHealth interventions (Brian, & Ben-Zeev, 2014; Dicianno, et al., 2015). It is suggested that such mHealth interventions require some upfront financial outlay (Teng, Thomson, Lascher, Raymond, & Ivers, 2014) as there is the need for financial incentives for the provision of mobile handsets, phone credits and per diem for mHealth activities (Gibson, et al., 2017; Xeuatvongsa, et al., 2016). These empirical findings may be instructive for policy-makers who intend to implement mHealth on large scale or adopt a nationwide approach to mHealth services.

Interoperability is the ability of different information technological (IT) systems to communicate or integrate. It concerns the degree to which different systems and devices can exchange, interpret, and share data (Quarshie, 2016). As suggested by the Healthcare Information and Management Systems Society (2017), interoperability is important for digital integration. It is worsened by the proliferation of different standards which further complicate technological systems (The PLOS Medicine Editors, 2013). It is a key technological challenge mentioned by a good amount of literature. Interoperability is essential to help reduce the cost of IT deployment (Gleason, 2015; Leon, Schneider, & Daviaud, 2012; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). The proliferation of non-standard equipment may be attributable to the heavy donor-funding of the mHealth interventions and programmes described as ‘pilotitis’ which refers to the mushrooming of pilot projects that unfortunately do not go beyond scale (Shuchman, 2014). The barrier to extensive adoption of mHealth has been linked to the non-existence of a uniform standard. Even though many pilot projects are being implemented globally which offer opportunities, there is also the problem of interoperability (Gleason, 2015) which must be addressed.

Even though most modern phones operate and behave like a computer, they are limited in the areas of size, screen resolution, software processing capacity, malfunctions, general phone, and complexity. (Medhanyie, et al., 2015; Leon, Schneider, & Daviaud, 2012; Fletcher & Jensen, 2015; Khan, et al., 2015). A study of Singaporean women's use of their mobile phones to seek health information is reported to be influenced by technical concerns and design limitation factors of mobile phones (Lim, et al., 2011). These limitations undoubtedly may limit the ability to handle big data which is also a growing facet of IT and therefore limit the phone's ability to hold large epidemiological data as more interventions are applied in the area of spatiotemporal data analysis (Finger, et al., 2016).

Some human limitations with the use of mobile phones have been empirically determined. Some of the human physical limitations have been identified as aging which results in slowing motor (motion), cognitive (mental), and sensory reflexes (visual, touch, auditory, etc.). In a literature review of challenges with the use of mobile phones among the elderly population, it was realized that the above limitations were identified as common barriers to the use of mobile phones for health purposes within the elderly demography (Fletcher & Jensen, 2015). It is posited that the elderly are a neglected user group in the design of mobile devices and services even though they are keen on the adoption and use of mobile phone technology for purposes of attaining independence, social and active lifestyle (Mallenius, Rossi, & Tuunainen, 2007) . The elderly are said to be less adept at the use of technology in relation to other younger age categories (Chi-Ping, 2015) and it has been posited that there is a generational gap to the disadvantage of the aged in the use of social networking sites (Sippl, Imminger, Geissel, Bohm, & Isemann, 2017). It is suggested that age affects the functionality of a person (Mallenius, Rossi, & Tuunainen, 2007). Older patrons of technology are reported to face more difficulty in handling new or complex information technology, which invariably

affects their ability to adopt new technologies. This challenge is ascribed to the decline in cognitive and memory capabilities and functionalities associated with the aging process (Venkatesh, Thong, & Xu, 2012). Physical functionality challenges, financial limitations, lack of interest in using high-end technology are among some of the key challenging determinants for the elderly as well as differences in user preferences of types of phones (feature and smartphones) and phone functionality or utilities (SMS, multimedia, etc.) as reported by Mohadis & Ali (2014). Thus, older people may experience challenges with the adoption of the mobile phone for mHealth provision if such barriers exist; which may be worsened with complex smartphones needing digital dexterity in software use, applications, and utilities.

Literature suggests that mHealth evidence is typically simple evaluations of pilot programmes which have been referred to as 'pilotitis' (proliferation of mHealth projects and end of project evaluations). It has also been already acknowledged that funding for mHealth projects have been donor-driven and led more than government-funded and not yet integrated into general health systems. This has resulted in varied systems that are not properly coordinated and integrated. Because of that, governments have been advised to ensure a coherent mHealth policy framework and regulation to guide and direct issues such as interoperability, security, safety, confidentiality of patient data and standardization. Some governments are supportive of the development of mHealth, but there is the need for regulations and standards that have been noted to be lagging (Sun, Guo, Wang, & Zeng, 2016; Tamrat & Kachnowski, 2012). Even though there is evidence of the viability of mobile phones as a tool for health delivery, more empirical evidence may be needed to convince governments as it has already been reported that evidence is scarce (Vallespin, Cornet, & Kotzeva, 2016) to convince them of the viability and efficacy of mHealth and the need to show more interest and commitment for holistic development of the growing field (Mechael, et al., 2010; Reddy, et al., 2016). One of

the related issues of regulations is the need to assure people of ethical protection and integrity of their health data and information. In Ghana, key laws such as Data Protection Act, 2012 (Act 843) and Electronic Transactions Act, 2008 (Act 772) are critical for the health sector to note in the consideration of any mHealth implementation (Quarshie, 2016).

Other challenges identified from the literature as affecting adoption and use of mobile phones and, for that matter, mHealth have been suggested as Network variability which refers to poor network availability, particularly for rural and resource-challenged setting (Jain, Singh, Koowal, & Gupta, 2015; Leon, Schneider, & Daviaud, 2012; Mtema, 2013). Lack of electricity supply and its stability has also been reported (Brian, & Ben-Zeev, 2014; O'Connor, O'Donoghue, Gallagher, & Kawonga, 2014; Mtema, 2013); lack of awareness of mHealth services (Akter & Ray, 2010); lack of convincing evidence to link mHealth and health outcomes (Mechael, et al., 2010; Vallespin, Cornet, & Kotzeva, 2016). Others are lack of use by patrons (Katz, Mesfin, & Barr, 2012); possible effects on the health of users of phones (Babar, Pervez, & Muhammad, 2016), staff attrition through transfers and others (Medhanyie, et al., 2015); quality of the mHealth applications (Isabel, Nunes, & SimõesMarques, 2015) and perceived ease of use (Davis, 1989), medical staff resistance to technology adoption (Poon, et al., 2006), among others. In Ghana, some of the specific challenges identified by the GHS as constraining effective mHealth implementation are financing, infrastructure, disconnect between practitioners and the telecommunication companies, donor-driven mHealth projects, parallel mHealth programme implementation, and underdeveloped ICT networks, among others (Ghana Health Service, 2014).

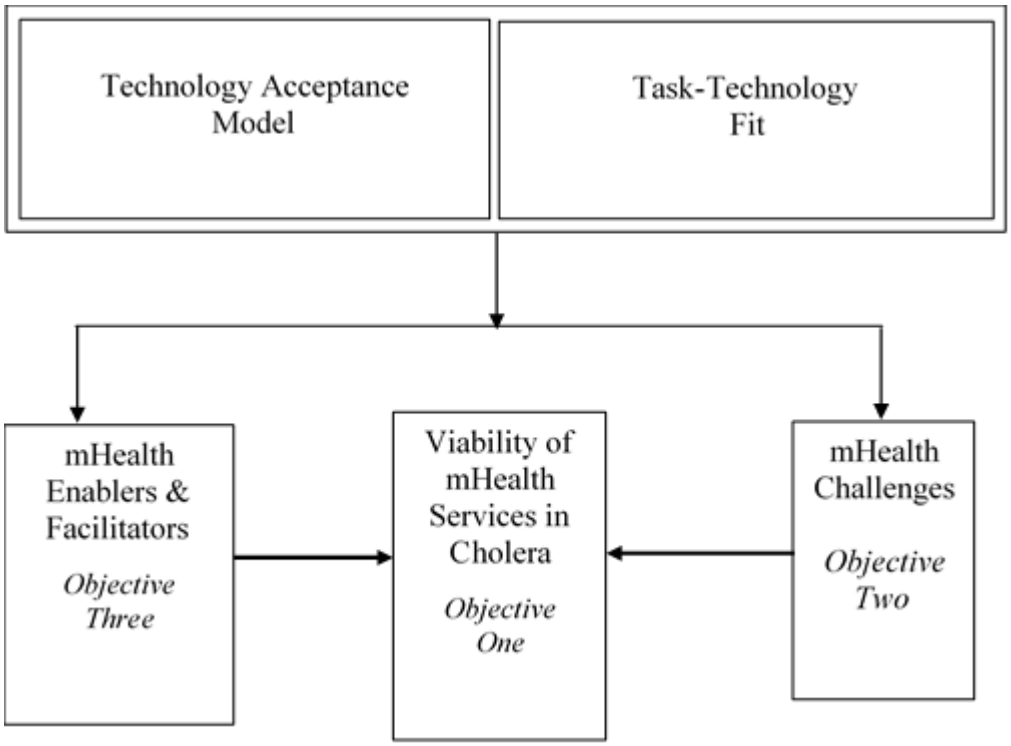
Despite the numerous challenges discussed above, researchers have also outlined several factors that help facilitate the smooth implementation of mHealth programmes. Enablers and facilitators have been mentioned by researchers as prerequisites for a successful mHealth

implementation. A summary of some of these have been gleaned from empirical literature such as high mobile phone penetration (Leon, Schneider, & Daviaud, 2012); supportive policy environment (Akter & Ray, 2010); continued efficacy of SMS (Sun, Guo, Wang, & Zeng, 2016); cost-effectiveness (Leon, Schneider, & Daviaud, 2012; Brian & Ben-Zeev, 2014), open standards or interoperability (The PLOS Medicine Editors, 2013; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013; Mechael, et al., 2010), training for users and operators (Parker, Jessel, Richardson, & Reid, 2013; Turner, 2016) and high smartphone penetration (Senyo, 2015).

2.6 Conceptual Framework for conducting the research

A Conceptual Framework is used to identify and define concepts and proposing relationships among the concepts. It helps to organize a study and provides for the context of a phenomenon for effective data gathering and analysis (Brink, Van der Walt, & Van Rensburg, 2006). Based on the theoretical and empirical reviews, the following conceptual framework was proposed to guide the research.

Figure 2.1: Conceptual framework for research



Source: Constructed by the researcher from the literature review

The conceptual framework consists of the two main constructs comprising the Theoretical and Empirical constructs. The Theoretical constructs comprise TAM and TTF which are the adopted theories underpinning the study. The study measured the PEOU and PU of TAM of mobile technology through the level of its adoption and use by healthcare workers. A Technological Capacity and Digital Literacy Assessment Tool (TCDL) was developed for this purpose in addition to the In-depth Interview (IDI) Guides. The outcomes of this theoretical construct in the areas of high adoption and use of the mobile phone due to a good PEOU and PU became enablers and facilitators of mHealth, which were captured under the mHealth Enablers and Facilitators empirical construct. TTF constructs in the areas of Task characteristics, Technology characteristics, Utilization, and Performance were measured through IDI Guides. A good fit leading to utilization and performance of healthcare tasks were considered enablers and facilitators of mHealth. Low adoption due to poor PEOU and PU and

a poor task-technology fit were considered challenges to mHealth and captured in the empirical construct of mHealth challenges. These two empirical constructs impacted separately on the delivery of public health services using the mobile phone, which construct was measured through an IDI Guide.

The two independent empirical constructs (Enablers and Facilitators and mHealth challenges) act as force-field on mHealth for public health services construct. Enablers and Facilitators act as a driving force while mHealth challenges act as restraining forces and therefore the elimination of these restraining forces helps provide impetus to the driving forces to strengthen the viability of providing public health services for the prevention and management of cholera. In the case where the restraining forces are dominant over that of the driving forces, then the viability of mHealth in cholera may be ill-affected.

2.7 Chapter summary

This chapter reviewed the key theoretical and empirical literature on the topic. It discussed key technology acceptance theories, choice, and justification of theories to underpin the study and proffered a conceptual framework to guide the study. It also surveyed the empirical literature to explore the general efficacy of mobile phones in various aspects of public health services including cholera, the challenges with the adoption and use of mobile phones, and enabling and facilitating factors that enhance the viability of mHealth in the prevention and management of cholera.

Based on the review, the study identified several gaps in empirical research. First, the literature suggests a very limited empirical research on the systematic use of the mobile phone in cholera prevention and management; of which literature is nascent. In the case of Ghana, empirical mHealth studies on cholera are virtually non-existent. The study, therefore, intends

to explore the role of mobile phones in cholera prevention and management in Ghana and helps fill a *Disease Intervention* gap. Second, this helps achieve a critical need to fill a *Contextual* gap in respect of Ghana as LMIC country. Third, the research helps fill a *Methodological Rigour* gap by designing a special instrument in assessing the Technological Capabilities and Level of Digital Literacy (TC & DL) of participants interviewed. Fourth, it adds to theoretical depth by combining two theories (TAM and TTF) to help provide a fuller understanding of the phenomenon. The next chapter discusses the methodology of the study.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Chapter Introduction

Methodology concerns the best means of gaining knowledge about a phenomena as accepted by the community of researchers in the field, which also includes the process of research (Creswell, 2014). This chapter discusses the key research paradigms, research approach, and scope of research, research design, methods of data collection including sampling techniques, study sites, and population. It also covers inclusivity and exclusivity criteria and provides information on the ethical dimensions of the research and the researcher's reflexivity.

3.2 Research paradigms and philosophy

This section discusses in detail the selected paradigm for the research and provides a brief overview of the other paradigms. It further outlines the choice of research approach, how the research was designed with its effect on data collection, analysis, and interpretation. Wahyuni (2012) defines the research paradigm as consisting of a set of essential assumptions and beliefs

on a worldview which influence researchers' thinking and behaviour. This study adopted the Interpretivist/Social Constructivist paradigm.

3.2.1 The Interpretivist/Social Constructivist paradigm

According to Interpretivists, there is a clear difference between what empirical studies inform us of the world and what may be occurring. The Interpretive worldview emanated from the works of Edmund Husserl's phenomenology and other philosophers' work on interpretive understanding called hermeneutics (Antwi & Hamza, 2015; Davidsen, 2013). The social world sees reality as a projection of individual realization which is a subjective act of creative imagination. This extreme stance is called solipsism, which states that outside oneself, there may be no reality as it may be internally placed (Morgan & Smircich, 1980). They posit that people may see the same thing differently and come to varied conclusions due to the various cognitive, experiential, and other lenses they wear. They construct understanding premised on detail and specificities and shared meaning. Contrary to the positivists' view of objective quantification of what is researched, interpretive-constructionists posit that meaning assigned to a number is socially constructed, not an absolute that objectively exists that people give it. Thus, numbers do not speak for themselves but take on what meaning has been put on them by people (Rubin & Rubin, 2005).

Interpretivism therefore suggest a redefinition of rationality in 'provable true' (logic), probable true (Bayesian reasoning), and plausible true (convincing a reasoning audience). They opine that future research should be redefined as soft issues such as language, arguments, and discourse for which policy is constructed and enacted (Russell, Byrne, Greenhalgh, & McDonnell, 2008). There is therefore the need to shift from the concept of production of a *'single truth'* to discuss the possibility of conducting research using a framework that embraces the existence of a *'multitude of equally valid truths'* (Worrall, 2004). The ontological

implication is that there is a multiplicity of valid realities of the same issue rather than a sacrosanct truth. Thus, their worldview of reality is subjective**;** concerned with appreciating the world from the subjective experiences and inferences of individuals (Antwi & Hamza, 2015).

The ontological view of Interpretivists is that truth is constructed in different ways based on context, subjects, and interpretations rather than a sole truth to be known by all. The worldview of the interpretivist is that reality is multiple, which is based on its social construction by individuals' and society's lived or shared experiences and how they view reality. Interpretivists are relativists regarding the reality, seeing it as contextual. The main ontological perspective is that truth is multiple, intangible mental constructions, which are socially and experientially based and may be local and specific with elements often shared among many individuals and societies (Guba & Lincoln, 1994).

Epistemologically, the reality is imperfect and probabilistic (Guba & Lincoln, 1994) and subjectively determined in an interactional manner (Bergman, et al., 2012). Creswell (2013) suggests that interaction between the researcher and the participant is vital in the creation of knowledge, which must happen in a natural setting. Because of this, the researcher cannot separate him/herself from the research process and that research results are directed by the interpretive part of scientific observation and interactions.

Methodological approaches for interpretivism is more qualitative. Research evidence is only a part of the entire pieces of evidence sought, which is constructed through local and subjective practices. Knowledge is gained by an inductive approach recognizing, understanding, developing, and contrasting constructions through dialogue. Dey (1993), cited in (Saunders, Lewis, & Thornhill, 2009), argues that the more uncertain and mutable our concepts, the more difficult it is to achieve exactitude in data collection. According to Miller (1990), rhetoric or language used even plays a role in deciphering meanings. These are also influenced by

individual and collective values, suggesting the strong role of value-laden judgements for an interpretivist's axiological considerations. The axiological perception of interpretivism is that facts and values are not *'clearly separable'* (Russell, Byrne, Greenhalgh, & McDonnell, 2008).

Critics of interpretivist paradigm have argued that it is limited in its ability to generalize findings and because of that replication of research in other contexts and periods is impossible. Another criticism is the question of credibility and reliability of findings and conclusions. They contend that positivists ensure validity, reliability, objectivity, accuracy, and generalizability through a superior scientific rigour of quantitative methodology concerning the subjective and non-scientific methods used by interpretivists (Antwi & Hamza, 2015; Bhattacherjee, 2012).

Interpretivists however contend that the objective of qualitative studies is not to generalize but to explore the meanings, lived experiences, and obtain deeper insights from participants on a phenomenon. Such meanings are best socially constructed by both participants who experienced it and the researcher who is collecting the data in a mutually engaging setting. It is also argued by interpretivist-social constructionists that human behaviour is dynamic across time and space, and therefore generalization beyond the particular people and time studied is not the main aim of qualitative studies (Antwi & Hamza, 2015; Creswell, 2013; Rubin & Rubin, 2005). On the issue of credibility and reliability, it is also argued by interpretivists that the mutual interaction and long engagements with study participants can result in deeper understanding of the context and phenomenon under study, which adds richness and depth to the collected data. This leads to a high possibility of discovery which qualitative studies aim at with their inductive methodology which ensures high validity like trustworthiness and credibility. This is achieved with prolonged engagements with participants, member checking, and inductive methodologies (Boampong, 2017; Creswell, 2014; Rubin & Rubin, 2005). From the foregoing, the study notes the advice of Guba and Lincoln (1994) to the effect that

paradigms represent a researcher's set of basic beliefs and therefore must decide to accept them simply on faith. Every researcher should therefore choose which paradigm best reflects his or her set of individual beliefs and decide to adopt that worldview. This should be accompanied by the selection of methodologies that are fit-for-purpose. The study, therefore, selected the interpretivist-social constructionists' paradigm which, according to the researcher, represents the best set of philosophical beliefs for the inquiry and which also informed the methodology that was fit for the research purpose. Based on the nature of the phenomenon, which involved exploring the lived experiences and views of participants with using mobile phones for healthcare and the nuances characterizing their perspectives, the interpretivist/social constructivist paradigm was selected to help elicit a better understanding and ensure effective co-construction of the multiple realities involved.

3.3 Research approach

The research was set in a qualitative study approach. According to Creswell (2014) qualitative research seeks to discover and appreciate the meaning individuals or groups attribute to a social or human problem. It is a form of inquiry that examines information transmitted via language and behaviour in a natural setting and includes the capture of information not conveyed in quantitative data concerning views, moods, and values that underpin human behaviour and action (Berkwits & Inui, 1998). It helps attain intricate details about phenomena that may be difficult to obtain or learn through more conventional methods (Creswell, 2012). This approach was used due to the study's exploratory nature and the need to discover ideas, views, and the meanings participants brought to bear on the phenomenon (Creswell, 2012; Rubin & Rubin, 2005).

3.4 Scope of the study

To ensure unity of purpose and focus, research inquiries must be properly placed in their subject confines (Gilbert, 1993). The research is mainly placed within the public health care sector in the GAR of Ghana; and collects perspectives of Healthcare Providers and people whose activities leverage or impact on mobile health care delivery for the prevention and management of cholera. Three administrative enclaves (Metropolis, Municipality, and District) were selected for data collection. The research focused on how mobile phone technology impacts on health rather than the technology itself.

3.5 Research Design

Research designs are plans and the procedures for research that span the decisions from broad assumptions to detailed methods of data collection and analysis (Creswell, 2008). The study adopted a phenomenological design that looks at capturing participants' lived experiences which influence their construction of meaning (Creswell, 2013; Rubin & Rubin, 2005). The choice of phenomenological design was based on the premise that the study sought to collect the views or perspectives of participants in their natural settings which involved languagebased in-depth descriptions of their lived experiences on the mHealth phenomenon (Creswell, 2014; Lincoln & Guba, 1985). It also helped to explore and gain more insight into the worldviews of the participants (Creswell, 2014).

3.5.1 Research Population and Participants

The target population for the study was public Healthcare Providers and administrators, policy managers working at various levels of the Ghanaian public health system in the GAR. The others were data services providers, mHealth Financiers, and Implementers, Software Engineers, among others. Mainstream Healthcare Providers cut across the various levels of the health sector comprising the Ministry of Health (National), GHS (National), Regional

Health Service (Regional), District Health Service (District), Health Centres (Sub-district) and Community Health Planning and Services (Community) (Ghana Health Service, 2017). In addition to these core groups, other participants who did not fall within this service delivery structure but whose specialist knowledge was critical to enriching the data required were purposively or through the snowball technique identified for interview. This specialist group was described by the study as 'Wildcards'. A total of forty (40) participants divided into four categories were interviewed. Refer to **Error! Reference source not found.** (section 3.5.2) for summary of participants' list and information. Participants had in-depth knowledge of one or more of the related areas such as public health, epidemic management, disease surveillance, emergency services management, telemedicine, mHealth, social marketing and communication, telecommunication, and engineering.

3.5.2 Sampling approach and technique

A sample is a subset of a population that is selected for any given research. The sample size depends on the research objectives, features of the study population such as size and diversity, time and resources (Family Health International, 2011). The study adopted a purposive sampling technique, with its sub-techniques such as maximum (multiple) variation and Snowball (Creswell, 2012; Family Health International, 2011). Purposive sampling is posited to be the general sampling method for qualitative studies which helps to effectively provide indepth or rich information within limited resources (Palinkas, et al., 2015). Palinkas et al., further suggest that Purposive sampling, just like probability sampling procedures are intended to identify issues of similarity and differences, or measures of central tendencies and dispersion, which are important for the discovery of new knowledge through comparison. The reasons for the adoption of such sampling techniques were to help identify participants who were most appropriate to provide in-depth views and insights to help answer the research question or phenomenon.

Maximum variation sampling was needed to help ensure a balanced and exhaustive data for all aspects of the phenomenon as the delivery of public health services is a combined effort of various health and non-health cadres; from doctors to community health volunteers. Maximum variation sampling was therefore adopted to achieve dissimilarity akin to quantitative measures used to describe the spread of values for a specific variable while snowballing was used to determine measures of central tendency in quantitative studies. Maximum variation sampling was however conducted without diminishing the need for in-depth knowledge of the phenomenon (Palinkas, et al., 2015). Thus, the study was of the view that it was essential to seek the views of not only particular health cadres but that of other ancillary providers and intermediaries in the health delivery chain. Snowball technique was also required to unearth hidden participants and key informants who were not prior identified at the outset of data collection and only identified through other participants who had been interviewed (Creswell, 2014; Rubin & Rubin, 2005).

A total of forty (40) individual participants and one focus group of five participants were interviewed. The sample size of qualitative studies has been debated with various recommendations on the ideal sample (Creswell, 2014; Mason, 2010; Rubin & Rubin, 2005). However, some factors have been suggested to influence a qualitative sample which include the type of research, data collection methods, academic requirements, heterogeneity or homogeneity of the population, special interest groups, scope of the study, multiple samples, availability of resources and study sites, among others. Albeit, the concept of saturation refers to where beyond a number, no new information or idea is generated from new participants (Mason, 2010). The number of participants and discussants recruited was influenced by the heterogeneity of the population, special interest groups, need for similarity and dissimilarity, data collection methods, and the number of study sites.

All participants were purposively selected based on their in-depth knowledge and experience providing detailed appreciation on the phenomenon. Despite this, maximum variation sampling was used to help ensure a wider representation of participants due to the heterogeneity of the population as the delivery of public health services is provided by multiple healthcare and other non-health providers. The table below provides detail on the participant category and their role in healthcare provision, which provides them with the leverage to contribute to an in-depth understanding of the phenomenon.

Table 3. 1 Participant category and role in healthcare provision

No.	Participant category	Role in healthcare provision
1	Community Health Volunteers	They are community-based individuals who provide voluntary services in health surveillance and advocacy, including cholera
2	Community Health Officer	They are the first call of care and mostly located at the community level offering primary health services and disease surveillance of infectious diseases such as cholera. They work and supervise the work of the community health volunteers
3	Disease Surveillance Officer	They are specialists in monitoring and tracking disease outbreaks such as cholera and advising on an appropriate response. They work with community health officer in ensuring effective disease surveillance
4	Emergency Medical Technologist	These are emergency care specialists and part of the national ambulance service. They focus on pre-hospital care and emergency calls from the communities which include the outbreak of cholera epidemic
5	Health Communication Specialist	They are specialists in crafting appropriate health messages for delivering to the population on health issues
6	Health Information Technology Specialist	These specialize in health informatics; using health data to process into useful health information for effective decision and policymaking
7	ICT Specialist	This cadre specializes in managing information technology and infrastructure to support the delivery of healthcare
8	Health Promotion Specialist	They coordinate activities aimed at interacting with the public and educating them to help promote public health
9	Health Services Administrator	They oversee the day-to-day management of hospitals and coordinate health administration of the region in support services
10	Innovation Specialist	Provides mHealth innovation services
11	Medical Director	In charge of general management and direction of the hospital where clinical management of cholera may take place

12	Public Health Nurse	Coordinates the delivery of public health services in the district health directorate
13	Nursing Manager	In charge of general management and direction of nursing care at the hospital where clinical management of cholera may take place
14	Pharmacist	Coordinates and provides pharmaceutical services at the hospital or community for the treatment of diseases such as cholera
15	Nurse Educator	A nurse specialized in health education and part of mHealth project
16	Telemedicine Specialist	Specializes in providing healthcare through the mobile phone and other wireless technologies
17	Public Health Doctor	Specialized in public health. Leads the overall delivery of public health services at the region/district
18	Phone Sales Executive	Markets and provides maintenance services for mobile phones
19	Software Engineer	Develops, maintains and advises on appropriate software packages to operate mobile technology infrastructure
20	Data Manager	Manages data generated during provision of mHealth services
21	Transport Manager	Provides transport services for the movement of health staff and logistics for the delivery of health services
22	Policy Expert	Involved in policy analysis, formulation, advice, and implementation which has implications for mHealth policymaking
23	Health Planner	Plans and budget for health resources for public health delivery and other healthcare provision, including mhealth
24	Administrative Manager	Supports the provision of health services in administrative communication with the regions and health facilities
25	Public Relations Officer	Coordinates corporate communications internally and externally and helps with advocacy and public relations with media. Services crucial during public health emergencies as they engage the media and manage the corporate social media

Error! Reference source not found. and **Error! Reference source not found.** below provide summary of the professional categories and sectors of operations of participants.

Table 3. 2: Professional category of participants by sector (IDIs)

No	Profession	Total	Government Health Sector							Other Government Sectors	Private Sector	
			al tion	Regional Health Directorate	Regional Hospital	District Health Directorate	District Hospital	Polyclinic/ Health Centre	CHPS	Community	Regulatory/Digital Support	Private Sector Not for Profit	Private Sector for Profit
1	Community Health Volunteer	**3**	-	-	-	-	-	-	-	3	-	-	-
2	Community Health Officer	**1**	-	-	-	-	-	-	1	-	-	-	-
3	Disease Surveillance Officer	**3**	-	-	-	2	-	1	-	-	-	-	-
4	Emergency Medical Technologist	**1**	1	-	-	-	-	-	-	-	-	-	-
5	Health Communication Specialist	**1**	1	-	-	-	-	-	-	-	-	-	-

Health Information	6 **1**											
						74						
Technology Specialist		1	-	-	-	-	-	-	-	-	-	-
ICT Specialist	7 **1**	1	-	-	-	-	-	-	-	-	-	-
8	Health Promotion Specialist **2**	1	1	-	-	-	-	-	-	-	-	-
9	Health Services Administrator **3**	1	-	-	-	1	1	-	-	-	-	-
10	Innovation Specialist **1**	-	-	-	-	-	-	-	-	-	1	-
11	Medical Director **1**	-	-	-	-	1	-	-	-	-	-	-
12	Public Health Nurse **4**	1	-	-	3	-	-	-	-	-	-	-
13	Nursing Manager **1**	-	-	-	-	1	-	-	-	-	-	-

14	Pharmacist	**1**	-	-	-	-	1	-	-	-	-	-	-
15	Nurse Educator	**1**	1	-	-	-	-	-	-	-	-	-	-
16	Telemedicine Specialist	**3**	1	1	1	-	-	-	-	-	-	-	-
17	Public Health	**6**											
								75					
	Doctor		1	3	-	1	-	-	-	-	1	-	-
18	Phone Sales Executive	**1**	-	-	-	-	-	-	-	-	-	-	1
19	Software Engineer	**1**	-	-	-	-	-	-	-	-	-	-	1
20	Data Manager	**1**	-	-	-	-	-	-	-	-	1	-	-
21	Transport Manager	**1**	1	-	-	-	-	-	-	-	-	-	-
22	Policy Expert	**2**	2	-	-	-	-	-	-	-	-	-	-
23	TOTAL	**40**	**13**	**5**	**1**	**6**	**4**	**2**	**1**	**3**	**2**	**1**	**2**

Source: Researcher's fieldwork- 2018

Table 3. 3: Professional category of participants by sector (FGD)

No.	Profession		Government Health Sector							Other Government Sectors	Private	
		Total	National	Regional Health Directorate	Regional Hospital	District Health Directorate	District Hospital	Polyclinic/ CHPS Health Centre	Community	Regulatory/Digital Support	Private Sector Not for Profit	Private Sector for Profit
1	Health Service Administrator	**1**	1	-	-	-	-	-	-	-	-	-
2	Health Planner	**1**	1	-	-	-	-	-	-	-	-	-
3	Administrative Manager	**1**	1	-	-	-	-	-	-	-	-	-
4	Transport Manager	**1**	-	1	-	-	-	-	-	-	-	-
5	Public Relations Officer	**1**	1	-	-	-	-	-	-	-	-	-
6	TOTAL	**5**	**4**	**1**	-	-	-	-	-	-	-	-

Source: Researcher's fieldwork- 2018

3.5.3 Data collection methods and sources

The study sourced data through IDIs and FGDs for effective triangulation. These methods were adopted to help directly capture nuanced views and experiences of the participants on the phenomenon which were more amenable than in other techniques. The need for a rich and detailed description of the phenomenon and the exploratory nature of the study required flexibility in the data collection instruments, which was better offered by IDIs and FGDs (McCusker & Gunaydin, 2015; Rubin & Rubin, 2005).

The key technique for administering IDIs and FGDs was based on initial questions, probes, and follow-up questions (Rubin & Rubin, 2005). IDIs were conducted for purposively selected national, regional, and district level staff as officers selected were involved in disease surveillance or offered public health services including cholera. One FGD was conducted for purposively selected operational staff (middle level) from the national and regional levels. The combination of participants from these two levels (macro and meso) was aimed at providing rich data from multiple levels and perspectives at a snapshot. This helped to avoid the need to organize many FGDs with the view that the multiple variation sampling which comprised varied participants provided enough data for the study. High-level policy directors/staff were, however, excluded from the FGD due to their limited time and availability; and that their views had been adequately represented in the IDIs. The participants for the FGDs included but not limited to those who were involved directly or support in the operational execution of various public health services and have the experience of using a mobile phone in delivering aspects of such healthcare. FGDs are used in health care research and important when depth is required and the area of the study is not well researched (Gill, Stewart, Treasure, & Chadwick, 2008).

3.5.4 Data Collection Instruments

Research instruments are the tools and data capture aids that are used to gather participants' data. The main instrument used was a semi-structured interview guide for IDIs and FGDs, which helped to gather data on lived experiences (mostly historical) not easily observable (Rubin & Rubin, 2005). An instrument for assessing the Technological capacity and level of digital literacy was also developed to collect data on the ability of participants to use mobile technology. The guides and tools were administered in a face-to-face individual participant interview with the aid of a digital literacy questionnaire, audio recorder, and supplemented field notes. Even though a standard research instrument was designed with semi-structured guides, its actual administration for each interviewee varied slightly or substantially depending on what he/she knew and was willing to share which resulted in each IDI being unique (Creswell, 2008; Rubin & Rubin, 2005).

Four versions of IDI guides (Appendices A3-A6) were developed targeting four broad categories of participants who were all part of the mHealth provider-side ecosystem. One FGD guide (Appendix A7) was also designed for a group interviews. The guides were divided into sections covering motivation for the research, background characteristics, assessment tool for technological capabilities and digital literacy, phone ownership, and sets of questions.

Interviews were conducted using these guides and voice data were captured through an audio recorder which served as the main data capture equipment while the researcher's mobile phone was used as a back-up recorder to help prevent any possible loss of data. To prevent interference of calls from mobile phones, it was always put on flight mode to block all such calls until after an interview. This strategy also helped in cross-checking patches of audio data that were not

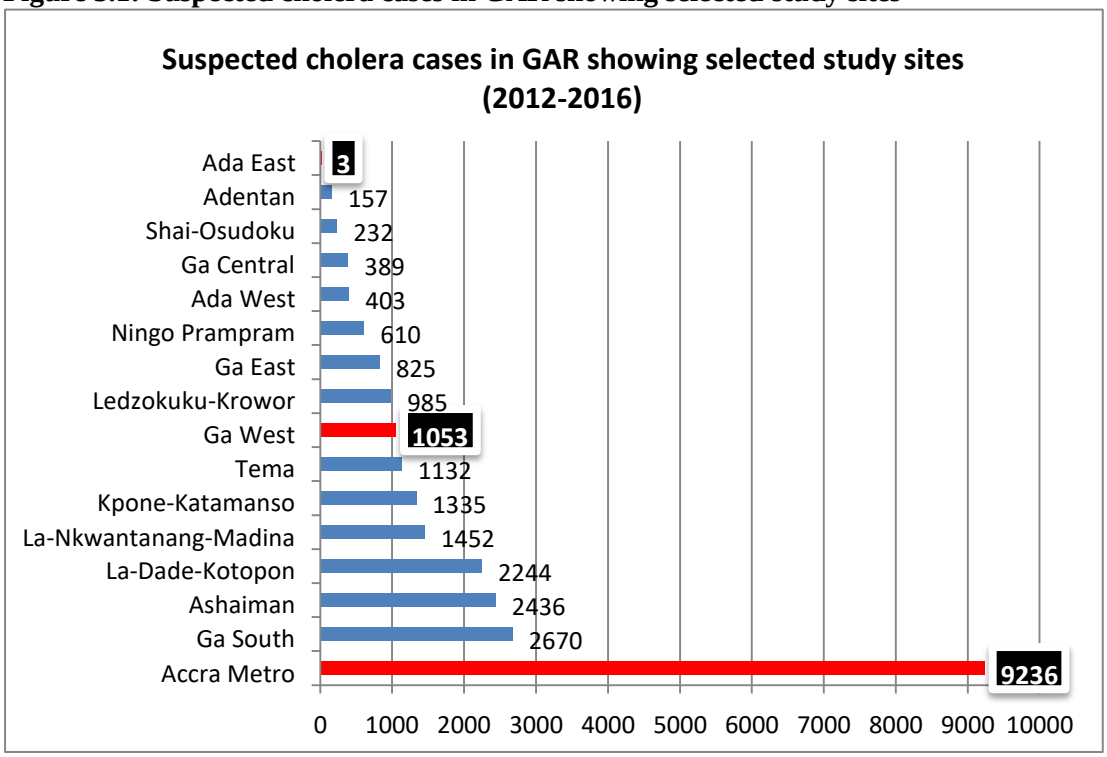
clear on the main recorder during transcription. Field notes were also taken during all IDIs and FGDs which captured salient points and themes mentioned by participants. This served as back-up and supplement to the voice data, helping to shape and reshape the interview for a deeper understanding of the phenomenon.

3.5.5 Study area/sites

As indicated above, the research was conducted at various levels of the public healthcare system and other relevant connected mHealth providers in the GAR. The levels of Healthcare Providers were MOH, GHS Headquarters, Regional Health Directorate, and three purposively selected District Health Directorates, albeit based on some parameters. The selection of the three districts was based on the highest, median, and lowest cholera cases reported from 2012 to 2016. The specific study areas/sites were selected based on suspected cholera incidence were Accra Metro (highest), Ga West (median), and Ada East (lowest). The median district fell between Ga West and Ledzokuku-Krowor and the study purposively selected the former because the highest and lowest selected sites are both coastal districts and purposively avoided all study sites being coastal locations; as Ada East was also a coastal location. This was to help improve on obtaining varied research settings which are also important for research triangulation purposes. .

Figure 3.1 below is a graphical presentation of the suspected cholera cases in GAR showing the selected sites.

Figure 3.1: Suspected cholera cases in GAR showing selected study sites



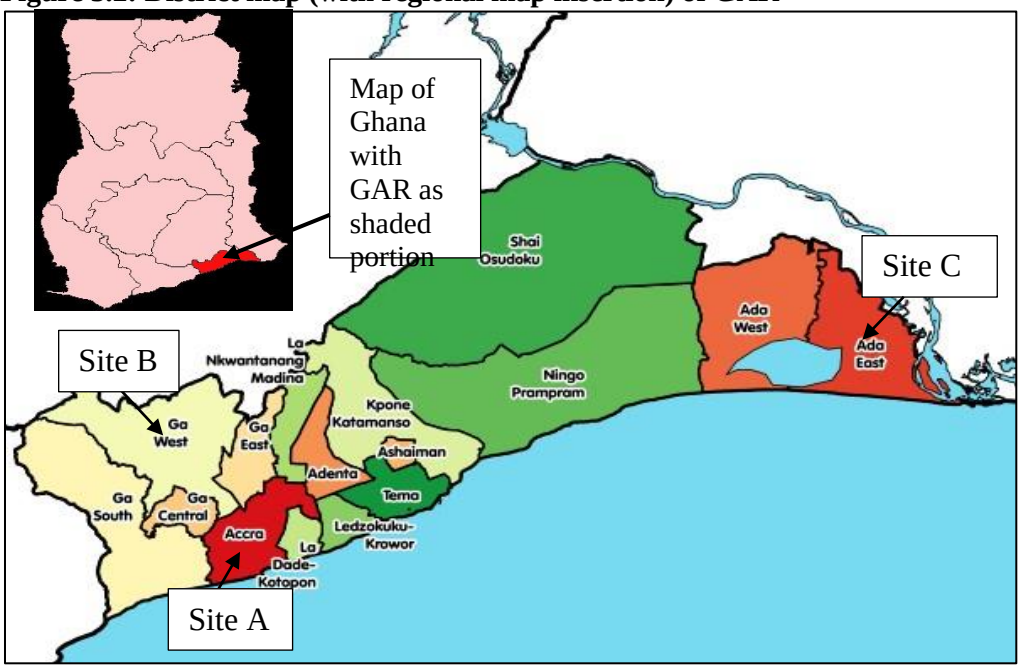
Source: Data from Ghana DHIMS by Courtesy of CHIM, GHS-2017 (Processed into a graphical presentation for ease of analysis)

The total population of Ghana is projected as 28,308,301 million (2017) with GAR's stated to be 5,055,765 million (2017) which makes it the second-most populous region after Ashanti,

with 16.3% of the population and forms 1.4% of the total landmass of the country. Accra is the capital city of Ghana and has the highest population density. The region has a coastal line of over 200 km (Government of Ghana and UNICEF, Undated). It is not well endowed with mineral resources apart from granite, clay, and salt. There are challenges with housing conditions, that concern poor toilet facilities, and waste disposal of both solid and liquid waste for households. This presents high-level unsanitary conditions, particularly for parts of Accra and Tema Metropolis (Government of Ghana, 2018).

The population of the three selected sites (2017) was also projected to be 1,986,580 (Accra Metro), 256,703 (Ga West), and 82,469 (Ada East) (Ghana Statistical Service, 2018). The region is the smallest in terms of land size, with a total land area of 3,245 km2 or 1.4 % of the total landmass of Ghana (Government of Ghana, 2018). Figure 3.2 5 below depicts the sites that were selected for the study in GAR:

Figure 3.2: District map (with regional map insertion) of GAR



Source: (Wikipedia, 2018)- With Annotation by Researcher

The Ghana population census (2010) report indicates that Accra metro has a mobile phone density of 75.7%, Ga West was 76.5% and Dangme East (where Ada East was part until redemarcation) was 44.5%; being the lowest. The three selected study areas also had different populations and urban dynamics such as Accra metro (Urban), Ga West (Peri-urban), and Ada East (Rural) (Ghana Statistical Service, 2013). The differences among the study sites allowed for variety and contributed towards effective triangulation based on different settings for data collection. It also provided a good basis for comparative analysis based on tele-density penetration and mHealth adoption which further enhanced the richness of the study (Creswell, 2014). A summary of the study area selection criteria is presented in the table below.

Table 3. 1: Summary of criteria used for the selection of study areas

No.	Metro/District	Criteria				
		Cholera Incidence 2012-2016	Teledensity	Population	Level of Urbanization	Administrative Classification
1	Accra Metro	9,236	75.7%	1,986,580	Urban	Metropolitan
2	Ga West	1,053	76.5%	256,703	Peri-urban	Municipal
3	Ada East	3	44.5%	82,469	Rural	District

Source: Tabulated by Researcher from already acknowledged published sources

3.5.6 Inclusion and Exclusion Criteria

To ensure effective participant identification, targeting, and recruitment, the study outlined the inclusion and exclusion criteria as follows:

i. participants working or had worked in the GAR ii. a user of a mobile phone iii. district-level participants working in the identified communities/districts selected

iv. prior or no experience of mHealth project implementation including cholera was not a basis for exclusion but should have knowledge or experiences which were relevant for the study

v. Telecommunications or Software organizations that had experience in implementing some form of mHealth services with its key informant(s) having knowledge or experience on the phenomenon
vi. Health partners that had previously provided or were providing and/or financed or financing mHealth services
vii. 'Wildcard' participants had specialist knowledge that had a bearing on mHealth services provision in general or its leverage

3.5.7 Pretesting of data collection instruments and actual fieldwork

The instruments were pretested to help refine them for effective data collection. Pre-test interviews were conducted to help ascertain instrumentation rigour and identify measures to address any inherent limitations or bias in the main study. This approach helped to increase the methodological reliability which is essential in the conduct of any credible qualitative research (Hurst, et al., 2015). A total of five participants were recruited for pretesting of instruments in the Ga South District of the GAR with a population of 499,313 (2017) (Ghana Statistical Service, 2018); bounded to the west by Central Region, east by Accra Metro, north by Ga West and south by the sea. It thus borders two of the selected sites for the main study (Ga West Municipality and Accra Metropolis). Ga South was purposively selected as it had the characteristics of rural, sub-urban, and urban features. The pre-test interviews were conducted in June 2017 and comprised a Public Health Doctor (also a telemedicine specialist), Disease Control Officer, Physician Assistant, Medical Doctor, and Community Health Officer. Pre-test interviews were conducted to evaluate wording and consistency, ease of understanding of questions, identification of emerging themes, patterns and gaps, and interview duration. The average duration of interviews was 30 minutes. Key Objective One themes identified were disease surveillance, maternal health services, telemedicine, and health promotion. Objective Two themes were cost of communication, ownership, and access to the mobile phone, illiteracy, funding, network coverage, and quality and infrastructure cost. Objective Three

themes included the need for education and sensitization, policy direction on mHealth, provision of official phones, and maintenance.

Key challenges faced in the pre-test were distractions during interviews as participants were interviewed in the normal work setting. The distractions included patients and staff entering participants' consulting rooms or offices during interviews, noise from adjoining offices, cars where they were close to the road, and telephone calls. It was also observed that participants were willing and enthusiastic to offer information on the phenomenon but not all had the same depth. Some of the lessons learnt included the need to conduct interviews at the appropriate time where the participants were free of heavy work schedules, multiple variation sampling to help achieve some level of breadth in addition to depth on data collected as the lived experiences vary across the health spectrum. It was also found that some parts of the pre-test setting were hard-to-reach and difficult to geographically access during rainy seasons. There were physical barriers such as river courses which could only be accessed by boat or by way of a long and winding road network which were unpaved.

Actual fieldwork was between July 2017 and April 2018 after the necessary research permissions. Access to study sites and participants were gained with the combination of a letter of introduction from the researcher's department and personal contacts via email, telephone, or personal visits of some identified participants who were not easily located in static facilities. Visits to health facilities were done hierarchically by first visiting the Head of Facility or Organization, Director, or Officer-in-charge for introduction and discussion of the purpose of visit. The researcher was accompanied by a research assistant who worked in the region and knew most of the participants which were helpful in locating the sites and several participants for the interview. Researcher was well-received by almost all the participants due to familiarity

with the research assistant and the fact that researcher was also a health staff. Respondents who were Healthcare Providers and are outside the health sector were also willing to grant interviews due to proper introduction by their close associates or through good references.

In most cases, the various in-charges assisted in the identification and locating of participants interviewed. Where the in-charges were visited before locating the actual participant, they were informed on the purpose of the visit while the participants were provided with details of the study. Written consents were obtained from some participants after explaining the consent guide to them, which covered their rights and obligations and most importantly, the assurance of confidentiality. Some of the respondents declined to complete the consent forms for various reasons such as satisfaction with the verbal explanation, did not see the information to be provided as sensitive which required legalism and the fact that some of the respondents were personally known to the researcher as fellow health workers which fostered trust. All participants consented to be recorded on audio-taped. In providing biodata, some participants declined to provide information on aspects of the background characteristics, particularly age.

The interviews were done in the consulting room, participants' office or ward, researcher's office, conference room, restaurant, and other locations as were deemed convenient for the respondents. Interview duration varied based on respondent's depth of knowledge, experience(s), and time constraints due to work schedule or load. Time spent on various interviews was between 20 and 55 minutes for IDIs and one and a half hours for the FGD. The researcher personally interviewed all interviewees and moderated the FGD. All the interviews were conducted in the English Language since all the respondents were literate in at least spoken English.

3.5.8 Data processing and analysis procedure

A systematic process was followed in data management and analysis as this study was a scientific research. Raw voice data collected from all categories via IDIs and FGD were immediately downloaded from the audio recorder onto a laptop and assigned an identification name and stored in folders based on the study sites. The bio-data were tabulated and presented in a table format with explanations. Some of the bio-data analyses included basic arithmetic analysis such as totals, averages, and percentages. Audio recordings were transcribed verbatim for coding. Transcripts were read a couple of times for data cleaning such as correcting clear grammatical and typographical errors and styling as well as immersing in participants' worldview (Aziato, Dedey, & Clegg-Lamptey, 2014). Transcripts were uploaded and coded with NVIVO 11 software, which is a software package for analyzing qualitative data.

Coding was based on an inductive approach which allowed data to determine emerging themes rather than predetermined (deductive) constructs. This allowed the themes to reflect the actual perspectives of the participants and enhanced reliability and discovery. Coding was also guided or informed by the research questions which were important to ensure that all the basic themes derived would help answer the research questions to assure the trustworthiness of findings (Creswell, 2014; Rubin & Rubin, 2005). To ensure simplicity, the study decided to adopt the generic nomenclature proposed by Attride-Stirling (2001) for various levels of coding techniques described generally in themes and sub-themes. The analytical framework for data analysis was based on Attride-Stirling's Thematic Network Analysis, which involves a hierarchical network of themes. Thematic analyses extract the relevant themes in a text at various stages and help to simplify the organization and representation of identified themes. They are web-like networks with well-linked hierarchical themes, and are suggested to have similar characteristics with hermeneutic analysis. Attride-Stirling proposes *Basic Themes* for

first level (open) coding, *Organizing Themes* for second-level themes, and *Global Themes* for third level themes. The simplicity is in the use of themes for all coding levels but which are qualified appropriately to differentiate the levels. The study further simplified AttrideStirling's proposal by reclassifying it as the main theme and sub-theme(s). The main themes used comprised all themes at the level of Global Themes (third level) and sub-themes comprised the Organizing themes (second level). However, all first-level themes, which were numerous were collapsed for use to provide further explanation and rich details for the main and sub-themes. This was to help simplify the flow of analysis and prevent undue complexity for ease of understanding. Data from IDIs and FGD were processed and analyzed separately. A folder was created to store data from the FGD, separate from all IDI data. Analysis with NVIVO was also performed separately to extract its themes and sub-themes. The themes and sub-themes of the both IDIs and FGD were presented separately in the Findings section to help in clearly showing the various themes generated from both data collection methods and helped in the comparative analysis of the similarities or dissimilarities in the findings. The most accurate data from interviewees and discussants based on the research objectives were used to describe themes that represent findings or phenomena being reported (Aziato, Dedey, & CleggLamptey, 2015; Rubin & Rubin, 2005).

3.5.9 Ethical considerations

Ethical permission was granted by the University of Ghana Ethical Research Committee of the Humanities with Identity Number ECH 107/16-17. Special introduction letters were also written by the researcher's Head of Department and Principal Supervisor for the health facilities. The researcher also conducted self-introduction by showing copies of the ethical clearance letter to other organizations and individuals purposively selected for the introduction. Verbal permissions were given by in-charges and participants before interviews were initiated.

This was after they had been briefed on key ethical issues bordering confidentiality, freedom to participate or opt-out of the interview, and risks or benefits involved in research. The consent form was administered for all interviewees for their express consent before the interview. Where a participant declined to sign the consent form, verbal consent was accepted for the commencement of the interview. The verbal consent included the consent to be recorded on audio to aid transcription.

The interviewee anonymity and confidentiality were ensured during data collection and coding by avoiding the use of names and titles that may offer a lead to specific participants. Interviews were conducted in a congenial atmosphere and as much as practicable, they were conducted without the presence of a third person, including the research assistant. No palpable physical or psychological risk was observed during the interview. Even though depth was sought during interviews, due to the pressure of time, it was ensured that interviews did not run longer than needed to prevent stress for participants. This was ensured through the simplicity of questions and allowing participants to talk freely after being asked questions with fewer interruptions. Monetary rewards were not generally offered for interviewees but GH₵10 call credits were given to the community volunteers only. This was not announced and only given after the interview (Tishler & Bartholomae, 2002). Water was provided for all focus group participants during the group discussions.

3.6 Quality of qualitative work

3.6.1 Internal Validity

Internal validity was ensured through method and data triangulation. Method triangulation involved different types of data collection procedures such as IDIs and FGD. This helped to even out the weaknesses and strengths inherent in the data collection procedures (Creswell, 2012). Second, portions of participants' interviews which were to be used as evidence for corroboration or modification were shown them before use, to help prevent any misunderstanding or misrepresentation of their views (Agbo, 2014). Concerning FGD, participants and researcher reviewed all the emerging themes which had been written on a whiteboard as they emerged for agreement or confirmation. Third, all interviews were audiorecorded and then replayed to check for adequacy and any gaps to guide subsequent interviews. Fourth, the use of English in all interviews helped to reduce errors that might arise from translation and risk of losing portions of data through misunderstanding or diction difficulties which might have compromised internal validity (Boampong, 2017). Fifth, the study always applied member checking to improve on the trustworthiness of the results. This was ensured by intra-member checking which was done through requesting interviewees, where appropriate, to confirm statements or explain seemingly contradictory statements. Intermember checking was achieved by asking other interviewees to confirm or disconfirm statements or views of previous interviewees (Rubin & Rubin, 2005; Aziato, Dedey, & CleggLamptey, 2014). To further strengthen accuracy and authenticity, the views of participants were summarized and shared with them individually, of all emerging themes and salient points made during the provision of answers for each research objective before moving on to the next one. A concluding summary of initial key themes that emerged during the interview was also made for mutual agreement before parting with interviewees. The study adopted this form of concurrent quality assurance to achieve trustworthiness, which was viewed as cost-effective and time-efficient to completing all the interviews and after reverting to interviewees for validation. However, quotes used were cross-checked with respective interviewees for

concurrence before they were used. Results of the pilot interviews served as useful lessons, which helped to refine data collection instruments, patterns of questioning, and identification of emerging themes for enhanced quality of the main study.

The researcher's status as a senior management member of staff and rapport with several interviewees, especially at the national and regional levels, offered fellow health staff trust and confidence which were useful for the willingness to provide information on the phenomenon. This was one of the reasons why most of the interviewees declined to sign the consent form in preference for verbal consent. Signing the consent form was seen by such categories of interviewees as formalizing their acquaintance contrary to their informal relationship with the researcher (Boampong, 2017; Rubin & Rubin, 2005). Despite the relationship with some of the interviewees, the researcher's experiences and perceptions on the phenomenon were subservient to that of the interviewees as they could provide their views with minimal interruptions.

Data triangulation involved the collection of data from multiple sources. Data were collected from various categories (professional, sectors, gender, executive, senior and junior staff) of interviewees, from national to community levels, at three different study sites with varied profiles and had a relatively long engagement in the field (Aziato, Dedey, & Clegg-Lamptey, 2014; Rubin & Rubin, 2005).

3.6.2 External validity (Transferability)

Even though the key aim of a qualitative study is not for generalization, external validity attempts to assess the extent to which a study can be generalized to other populations, settings, and periods. The study achieved this through the provision of a rich context description of the fieldwork in the areas of data collection methods, sampling techniques, description of study

sites, and information about participants, data analysis techniques, and ethical considerations. Despite the above, it was not the aim of the study to generalize it, in keeping with qualitative study philosophy which is to provide an in-depth understanding of a phenomenon (Creswell, 2014).

3.7 Researcher reflexivity

Researcher's motivation for the study was borne out of the over twenty years in supporting policy formulation and leading the operations of transportation and the movement of health logistics and health staff for the delivery of health services. The researcher is a graduate of the University of Ghana Business school and graduated with a Bachelor of Science Degree in Administration (1993), specializing in Health Services Management. The researcher worked in the hospital set-up for a couple of years before moving to the national office to take up the management of transport. The researcher continued further education by enrolling at the University of Edinburgh and graduating with a Master of Business Administration in 2000. The researcher is a Chartered Fellow of the Chartered Institute of Logistics and Transport International and currently the National President of the Ghana Branch.

As a Health Services Administrator with a specialization in logistics and transport, the researcher has over these years appreciated the challenges the health sector faces in accessing populations to deliver health services especially in rural, hard-to-reach, and peri-urban areas. Intra-staff communication and engagement with the public at a distance was limited in the 1990s and early 2000s. However, over the past decade communication infrastructure in the country has seen unprecedented development, with third and fourth generation mobile technology that has revolutionized communication among health staff, general populations, and others. This development serves as the bedrock to leverage the technology to support health

services delivery just as other sectors such as finance and banking have leveraged their operations on the back of this mobile technology (Addison, 2018; Ghana News Agency, 2016).

The study identifies two traditional models for health distribution comprising first, static facilities such as hospitals, health centres, among others; where populations access health services and second, the use of transport such as pickups, motorcycles, mobile health vans, boats, and others to reach the communities to distribute health services, particularly for public health services. The first model is described by the study as the *Pull model* while the second is a *Push model*. With the advent of mobile technology and high mobile phone penetration in the country, the study identifies an emerging third distribution model for which the mobile phone will be the new node for health distribution, at least for aspects of it such as public health services. This third model combines the first and second and therefore can be described as a *Push-Pull model* where health staff can reach the population and vice versa, at a distance. This served as a motivation for the study, which had the aim of ascertaining the viability of this newly-identified model.

3.8 Chapter summary

This chapter discussed the research methodology. It provided an explanation of the chosen paradigm underpinning the study. It also provided a detailed discourse on the study approach, scope, methods, and ethical issues guiding it. Finally, it discussed measures taken during the study to assure the quality of research through ensuring validity and reliability. The chapter concludes with researcher reflexivity. The above undoubtedly helped assure the credibility of the study in terms of its trustworthiness. The next chapter provides the results of fieldwork which details the responses of participants interviewed during individual IDIs and FGD.

CHAPTER FOUR

4.0 PRESENTATION OF FINDINGS

4.1 Chapter Introduction

This chapter provides the integrated findings and cross-respondent views on various questions that were asked during IDIs and Focus Group Discussion (FGD); of which key themes and sub-themes were inductively generated from the data. The presentation of findings was organized first under the three research objectives and then on the themes identified. However, the summary results of background characteristics and level of technological capacity and digital literacy of respondents are presented before the main findings.

4.2 In-depth Interviews

4.2.1 Respondents background characteristics

This section provides a summary of the key background characteristics of all respondents in the areas of age, gender, academic qualifications, marital status, and religion. The others were ethnicity, profession, mobile phone ownership, and type (analogue or smart). Thirteen (13) participants fell within the age bracket of 50-59 years and the least number of one (1) respondent falling in the category of 60 years and above. Eleven (11) and thirteen (13) respondents falling in the year brackets of 30-39 and 50-59 years respectively represent the top-two age brackets with a combined percentage of 45% of total respondents.

Twenty-nine (29) respondents representing 72.5% were males and the remaining eleven (11) representing 27.5% being females. Thirty-three (33) respondents representing 82.5% had more than ten (10) years' experience. Five (5) of the remaining respondents fell within the Up-to 5 years Work Experience bracket while two (2) were in the 6-10 years group. Hundred percent

(100%) of respondents, representing forty (40) interviewees, were Christians. None fell in the other religions categories such as Islam and Traditional Religion. More than half (54%) of respondents representing 21 people were Akan, eleven (11) were Ga-Dangme, seven (7) were Ewe and one (1) was Guan. Twenty-nine (29) respondents representing 73% were married; while the remaining eleven (11) were single. Concerning the educational background of respondents, 82.5% of respondents with a total figure of thirty-three (33) had a bachelor's degree or above. Specifically, ten (10) respondents were bachelor degree holders, twenty-one (21) had a master's degree, and the remaining two (2) having Doctor of Philosophy degrees. The rest were spread among diploma (1), Post-Secondary (1), Secondary (3) and Middle School (1).

Regarding the professional backgrounds of respondents, twenty-two (22) professions were represented in the study; of which six (6) were Public Health Doctors, four (4) were Public Health Nurses, three (3) each were Telemedicine Practitioners, Health Service Administrators, Community Health Volunteers, and Disease Control Officers. The remaining had either two (2) or one (1) respondents. All respondents totalling forty (40) owned a phone; with thirty-eight (38) of them representing ninety-five percent (95%) owning a smartphone. It must be indicated that two (2) respondents failed to provide information on their age. Table 4.1 to Table 4.3 below show the summary of the various background characteristics:

Table 4.1: Background characteristics of respondents-Biodata (IDIs)

Characteristics			
Age	**No.**	**Work Experience**	**No.**
20-29	4	Up-to 5 years	5
30-39	11	6-10 years	2
40-49	9	More than 10 years	33
50-59	13		
60+	1		
Gender	**No.**	**Religion**	**No.**
Male	29	Christianity	40
Female	11	Islam	0
		Traditional	0
		Other	0
Ethnicity	**No.**	**Marital Status**	**No.**
Akan	21	Married Single	29
Ga Dangme	11		11
Ewe	7		
Guan	1		
Education			**No.**
Postgraduate (Ph.D)			2
Postgraduate (Masters)			21
Bachelor's Degree			10
Diploma			1
Post-Secondary			1
Secondary/SSS Middle			3
School			1

Table 4.2: Background characteristics of respondents-Profession (IDIs)

Profession	**No.**
Community Health Volunteer	3
Community Health Officer	1
Disease Control Officer	3
Emergency Medical Technologist	1
Health Communication Specialist	1
Health Information Technology Specialist	1
ICT Specialist	1
Health Promotion Specialist	2
Health Services Administrator	3
Innovation Specialist	1
Medical Director	1
Public Health Nurse	4
Nurse Manager	1
Pharmacist	1
Nurse Educator	1
Telemedicine Specialist	3
Public Health Doctor	6
Phone Sales Executive	1
Software Engineer	1
Data Manager	1
Transport Manager	1
Policy Specialist	2
Total	**40**

Table 4.3: Background characteristics of respondents-Phone ownership and type-(IDIs)

Phone Ownership		**No.**
Yes	No	40
		0
Phone Type		***No.***
Smart	Analogue	38
		2
Total		**40**

Source: Researcher's Fieldwork (2018)

4.2.2 Assessment of Respondents' Technological Capabilities and Level of Digital Literacy

With a specially designed Technological Capabilities and Level of Digital Literacy tool, the study assessed the level of technological capabilities and digital literacy level of respondents. Respondents were assessed on eight (8) technological capabilities variables with Yes or No response items. The variables covered voice, text, and application functions of the mobile phone. The capabilities were ability to make and receive a call; ability to text and retrieve a text message. These combined abilities represent the *Primary Digital Literacy Level.* The next set of technological capabilities comprised ability to use any mobile application such as social media and operating any social media account which represented the *Secondary Digital Literacy Level.* The final and highest-level concerned Awareness of other uses of the internet on the mobile phone aside social media and ability to conduct online searches on the mobile phone which represented the *Tertiary Digital Literacy Level.*

Table 4.4 below presents the results of technological and digital literacy scores. Primary Literacy Level had forty (40) respondents which represent 100% responding *Yes* to Ability to make a call, Ability to receive a call and Ability to send and retrieve a text message. However, one (1) respondent out of a total of forty (40) could not text a message. Apart from the *Ability to text a message* which had a total respondent score of ninety-seven and a half percent (97.5%), all the other technological capabilities under Primary Digital Literacy had a respondent score of 100%. Forty respondents under Secondary Digital Literacy indicated the ability to use any mobile application such as social media while thirty-nine (39) respondents mentioned the ability to operate a social media account such as Twitter, Facebook, WhatsApp, and others. The percentage group score for the ability to use any mobile application such as social media was ninety-seven and a half percent (97.5%) while respondents indicating the ability to operate a social media account had a group score of ninety-five percent (95%). Thirty-eight (38) Respondents under *Tertiary Digital Literacy* indicated awareness of other uses of the internet

on mobile phone aside social media while the same number of respondents (38) indicated their ability to conduct online searches on the mobile phone. Both tertiary technological capabilities had a percentage score of ninety-five percent (95%). The overall average total percentage score for the eight technological capabilities assessed was 97.5%. This was arrived at by calculating the total of the percentage score of the eight (8) technological capacity indicators and dividing by 8. Refer to Table 4.4 below for the full scores:

Table 4.4: Respondents' technological capabilities and level of digital literacy scores

	TECHNOLOGICAL CAPABILITIES	LEVEL OF DIGITAL LITERACY	YES	NO	(%) SCORE FOR TECHNOLOGICAL CAPACITY
No. 1	Ability to make a call		40	0	100
2	Ability to receive a call		40	0	100
3	Ability to text a message	PRIMARY	39	1	97.5
4	Ability to receive/retrieve a text message		40	0	100
5	Ability to use any mobile application such as social media	SECONDARY	39	1	97.5
6	Operating of social media account such as Twitter, Facebook, etc.		38	2	95
7	Awareness of other uses of the internet on mobile phone aside social media		38	2	95
8	Ability to conduct searches on mobile phone	TERTIARY	38	2	95
9	**% AVERAGE TOTAL SCORE**				**97.5**

Source: Researcher's fieldwork (2018)

4.2.3 Overview of perspectives of in-depth interview

Figure 4.1 below provides a *Thematic Network* presentation of the themes and their related subthemes for ease of appreciation of the thematic nuances on respondents' perspectives and experiences that emerged from the study's interactions with them. Respondents' perspectives covered public health and related services that mobile phones were used for, the challenges encountered in using them to deliver health services, and the enabling and facilitating factors that might enhance viability. The themes that emerged were grouped under *Public Health Services (objective one), Challenges (objective two), and Enablers and Facilitators (objective three).* Six (6) themes emerged under Objective One comprising *Data Collection, mLibrary and mLearning, Health Emergencies, Management and Leadership, Prevention and Promotions of Health Services, and Telehealth*. Objective Two had six (6) themes consisting

of *Management and Leadership, Financial, Access, Infrastructure and System, Technical and Human Resources*. Objective Three had two themes comprising the *Enablers and Facilitators*. These are presented in the figure below:

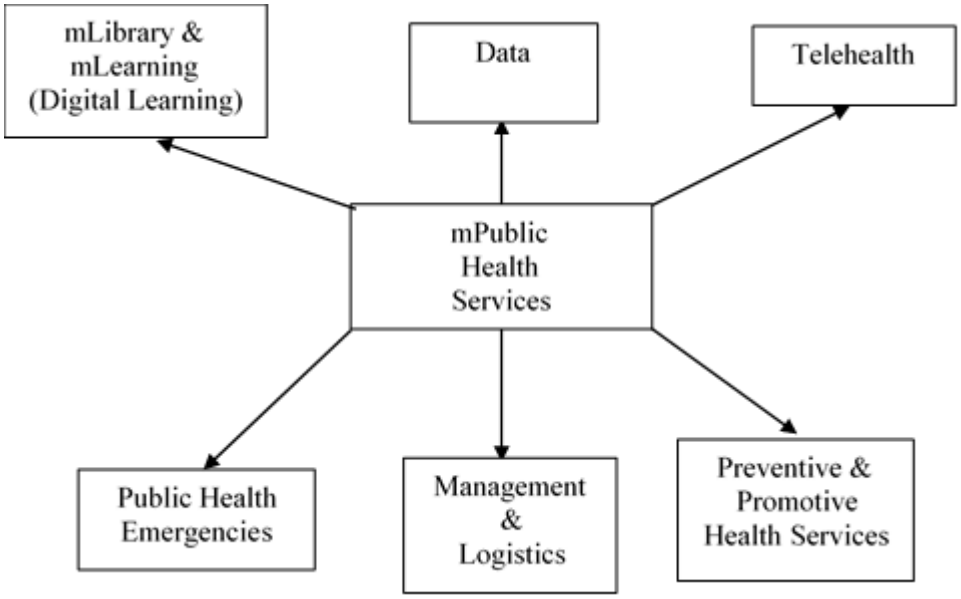
Figure 4.1: Thematic map of respondents' perspectives (IDIs)

4.3 Respondents' perspectives on public health services that are delivered through the mobile phone

This session provides opinions of Healthcare Providers who provide technical, technological, policy advice, and funding support for mHealth services. Their responses helped to provide insights on realizing Objective One which was '*To determine public health services that are delivered through mobile phones to prevent and manage cholera in the GAR.'* Figure 4.2 below provides a diagrammatic view of the themes and sub-themes which emerged from respondent responses. Six (6) themes emerged under objective one which were *Data Collection, mLibrary,*

and mLearning (Digital learning), Public Health Emergencies, Preventive and Promotive Health Services, Telehealth and Management, and Logistics.

Figure 4.2: Objective One- Thematic Network (IDIs)



4.3.1 Mobile data collection and reporting

Some respondents indicated that the mobile phone was used to collect various data on public health activities (including cholera) and reporting on them. Healthcare Providers adopted the use of mobile phones to collect and report on health threats such as cholera which were normally identified by health staff on the field or when reported to primary healthcare clinics that offered public health services. Supervisors also demanded the submission of routine public health reports and activities from health staff at lower health facilities through the mobile phone. It was noted by supervisors as facilitating quick reporting, especially during emergencies and eased staff work overload due to too much paperwork, reduction of errors, bridging the geographic gap, among others. The platforms for reporting with mobile phone comprised text messages, social media, particularly WhatsApp, Interactive Voice Call and Response (IV&R), or a specially designed application protocol installed on the phone.

Managers also provided feedback through one of these same platforms. The following respondent statements support this digital data collection practice:

> "Mobile phones are used in reporting cases. One of the fastest ways of reporting especially for rare conditions which are suspected. For example, where we had cholera epidemic where mobile phones were, you first call and report before you initiate the paper system of reporting…They call, they can text...WhatsApp... that's one of the most common ways of reporting these days." (C2)

Some of the objectives and benefits envisaged for adopting the mobile phone for data collection, reporting, and feedback were captured as the reduction in paperwork, promoting digitization, making work 'very easy', and promoting cost reduction. It is described as helping in the 'data revolution'. The following statements describe these objectives and benefits:

> "…. the ideal objective was also supposed to help generation of report for…community health nurses…do away with paper work, too much paper work on the field."; "the benefit we realize is the people were more on time in their reporting for follow ups" (C5B)
>
> "The mHealth project had two goals. One was to try and improve data collection at the lower level of Ghana which is at the CHPS level" (B2A)
>
> "… it's also facilitating the new data revolution…." (D9)

Data were collected and transmitted using different platforms such as SMS, IV&R and Social Media, and other appropriate formats. The choice of transmission platform depended on the type of phone (Smart or Analogue), network coverage, and generation of available technology (2^{nd}, 3^{rd} or 4^{th} Generation). The following statements provide information on this assertion:

"Yeah, actually our data from the lower level, they inform by text or WhatsApp…you are supposed to get the information to a higher level using the fastest means possible so you can call, or text or it can be a WhatsApp" (B5)

"Now it's all done through text message, through tele-consultation at the level of the district every day they all call" (B4).

4.3.2 MLibrary and MLearning (Digital Learning)

Mobile phones were used to support the storage of electronic library resources on health issues for health staff, particularly outreach workers who needed to make references to health protocols, disease diagnoses and treatment, and other health databases to aid their fieldwork. Some respondents who were involved in a mHealth project in the region described how mobile phones used for the project had pre-installed electronic libraries or had access to health-related databases to allow them to make quick references for effective diagnoses and treatment of cases such as cholera and others when on the field. These e-resources comprised e-books, audio recordings, websites, pictures, and videos on health issues.

Regarding mLearning, some respondents at the peripheral health facility level indicated that they were provided with specialized courses and materials which they could access while on the field.

This enabled them to study and still be able to prepare and participate in snap quizzes and tests for their continuous professional development programmes for promotion or personal knowledge development. Digital Learning provided information on disease management and personal health such as dieting, religion, social information such as conflict management and exercising. Managers explained that digital learning tools were designed to help Healthcare Providers overcome boredom in deprived areas. Below are some of the views expressed by health workers at the peripheries on the emerging use of mlibrary and opportunity for mlearning:

> "We have captured everything on our mobile phones so sometimes it helps us to educate". (C10B).

> "There is no need for us to carry a lot of research books along 'cos we can get a lot of things from our phones". (C9)

Some managers' opinions on the usefulness of digital learning are captured below:

> "We built special courses to basically improve on their knowledge in certain aspect of health care delivery... they could take a quiz and if they passed, they got credit that actually counted toward their progress in the GHS...then we also had a section that we call staying well and it had tips on how to deal with conflict and had tips on living well so what kind of diet you should keep, how you should exercise". (B2A)

> “One other aspect that it's being used increasingly is continuous medical education for staff in very remote areas so that with a mobile app mlearning application.... nurses in the community can access at their convenience, yes to update themselves” (D9)

4.3.3 Health Emergencies

Respondents’ perspectives on health emergencies covered public health emergencies, management of referrals during emergencies, and Healthcare Providers’ interactions with affected public through health hotlines. The responses revealed that preparations for health emergencies were based on identified threats, seasonal disease patterns, and human activities. Respondents who played a management role outlined a planning framework for an effective mobile phone-based epidemic management of cholera. They listed some of the strategies such as the need to identify affected people, a package of services to be provided, the message to be delivered, communication plan, and platform. According to these respondents, much of the services delivered through the mobile phone consisted of the provision of health information to the affected community and the general population. The objective was to take preventive measures, basic home management of cholera and sharing of health data and information among Healthcare Providers on the source, spread of the epidemic, mobilization of human resources for health and logistics. The following managers at the national level provide a framework for cholera management with the mobile phone in the statements below:

> “If you want to use the mobile phone to address cholera epidemics, first and foremost what do we want to do, who are our group, what interventions do we want to put in place okay so people get to know on their phones, it could be

> voice and SMS...to everybody on the catchment area to wash your hands before eating. Wash your food with soap under running water and keep the food warm before you eat it…we could also have such an app that could give you which facility is close by you, so basically that is the use to which we put a phone in the management of cholera." (B7)

> "Where now with the power of the software, you can have alerts on your mobile phone, thresholds, alert levels and everything. So, in real time." (B3)

A Health Service Administrator at a district level describes below how mobile phones were used to manage cholera at the hospital level which included staff mobilization and emergency communication.

> "Where we have multiple people coming in more due to outbreak of this epidemic cholera you realized that we use mobile phones to quickly reach our staff even those on annual leave… when we are overwhelmed then we will call you and we actually used it to mobilize as many of our staff as possible (C7A)

Irrespective of the above perspectives, there were other few respondents at the district, regional and national levels of care who indicated that they were not aware or privy to any use of the mobile phone for management of cholera. Some of the reasons adduced were lack of adequate education on the disease, limited effort by region, a complete denial of use of the mobile phone for cholera management. The views below capture this divergent perspective:

"For cholera we actually haven't gone out for that per say...we don't know much about because we have not been getting that much education about that [cholera] information" (C10B)

"Communicating with the public by mobile phone; I don't think we have developed that as a region much. Even with the cholera, I've been part of the cholera programme for so many years, so as for cholera it's like something that is uh huh. We have not." (C4)

"No, we didn't use phone to manage cholera." (C5B)

Notwithstanding the above, some respondents held the view that it held good prospects for use in cholera prevention and management. Some of these opinions were expressed in the statements below:

"I am not aware of that one but you know like we are saying it can be done. Yes, because through the mobile phone you can send quick information…. so, it can be used to manage [cholera]epidemics." (C7C)

"It can be used in cholera prevention easily. That is if the person is always with phone." (D7)

The management of cholera was done using different mobile phone platforms such as SMS, WhatsApp, and Voice when appropriate, as indicated below:

"We send SMS to alert them." (C10B)

"Yes, even getting it on WhatsApp...in text form, on WhatsApp..." (C1)

"Voice calls are used for emergencies and important but semi-urgent issues are also discussed on various platforms [WhatsApp]." (C7A)

Concerning patients' referral, respondents described types of cases referred to, the need for effective triaging to avoid unnecessary referrals, medium and platform of communication, various stakeholders involved in the referral management, and its benefits. Even though respondents did not specifically indicate that referrals involved cholera cases, they described the process and role of mobile phones in managing emergency referrals in general which was instructive in cholera case referrals. Healthcare Providers typically used the mobile phone communication platforms such as voice calls and social media (WhatsApp) to communicate among themselves to manage emergency referrals.

"If you are referring a patient to a facility, you call and ask if the doctor is around and it's making things very easy." (B8)

"The recent one that I heard was the use of WhatsApp and that one they are piloting in Accra and they are using WhatsApp to actually address any unnecessary referrals." (D1B)

A respondent noted that special Apps were installed on their phones to aid effective referrals.

It helped in screening patients in terms of the criticality of their cases to inform the decision to refer which helped prevent unnecessary referrals. One respondent who was involved in the design and implementation of a major mHealth project summarized the role of the mobile phone in referral management in the statement below:

"It also has a component that we called Punch and Care tool and it was a diagnoses tool that allows the nurses to very quickly narrow down the course of a delay or an element that they have noticed and it allows them to also basically refer only when referrals were needed and so using the tool, you could say this is a pregnant woman, she has headache, she has fever she has this and she could check for other signs...she then takes a decision to treat or quickly refer." (B2A)

Some respondents particularly at the national level who have in-depth experience in planning the delivery of mHealth projects and telemedicine, listed some of the benefits of using the mobile phone to manage referrals in emergencies. These included, enhancing the quality of care, preventing unnecessary deaths, effective management of hospital bed-state, reduction of roaming with patients looking for hospitals. Some of these benefits are embedded in the statements below:

"Mobile consultation can also improve referral system."; "it is important to say that most of the best referrals are those that are communicated as they are referring, 'am sending a case to you', then you are preparing, you know okay, you say oh what case is it and I you say oh it's this woman…oh let's get the

gynaecologist ready or let's get the surgery ready it also enhances life…it avoids delay, instead of going to Korle Bu, go to Maamobi, there are two beds there, otherwise people are crisscrossing by the time they finish, the patient is dead, so again that is another enhanced form of using mobile phone to enhance communication." (B4)

"And then the beauty of it is that the doctor or practitioners at the referral are already in readiness. So, by the time the patient comes in, they know the case, they are prepared for case so that there is an element of prompt care which also is an element of quality" (D1D)

4.3.4 Management and Logistics

This theme emerged as respondents described how they use the mobile phone to support their general administration, planning, and management and support services such as health logistics. Supervisors, particularly at the district level, used the mobile phone to conduct remote monitoring, coordination and supervision of staff activities, assignment of schedules, and organizing for logistics for delivery of health activities. Healthcare Providers were given preinstalled applications on their phone to facilitate some of the activities as stated below:

"We were able to design a mobile application specifically for this...a work planning component that allows the nurses to basically schedule the work".

(B2A)

Sharing their experiences on how mobile phones helped Healthcare Providers to schedule and plan their activities such as work schedule, community visitations, public education, and vaccination to aid effective service delivery, some respondents at the sub-district level stated the following:

"My colleagues that I normally work with and sometimes the client that we have to see in the community we call them to tell them maybe today or tomorrow we will be coming around this time, Yeah" (C10C)

"In the first way, I am saying the mobile is important because it makes communication very easy especially in the form of talking to our supervisors. Sometimes if they want to know wherever we are or if they need any information, they just use their phones to call us. They don't worry themselves to travel all the way to this place". (C9)

Monitoring and supervision on the mobile phone helped in quick dissemination and sharing of information, tracking health staff, ensuring productivity and green administration and to address early warnings, among others. Touching on remote monitoring with the mobile phone, a project Innovation Specialist of mHealth and a community health volunteer expressed their experiences as follows:

"Their supervisors were able to see the work they were doing and not necessarily having to come to the field to see it...they have the ability to track how well the nurses were doing on regular basis, it gave the opportunity for

them to dictate if there was a drop-in number early and to address it early with the nurses." (B2A)

> "Our superiors were monitoring our activities through the phones 'cos every month when we are about to start every month, they will ask us to put our itineraries on the phone and send to them so that they can know what we have every month and wherever we are supposed to go." (C9)

In managing logistics with the mobile phone, the key areas were managers tracking stock levels at the peripheral facilities, staff reporting on stock levels, pharmaceutical drug availability for cholera outbreaks, and coordinating the distribution of logistics, especially to places where there are reported stock-outs of emergency cholera drugs. This was typically described by two respondents at the national level who had the experience of managing mHealth projects using mobile phones to report stock levels from the lower to the national level in the statements below:

> "For instance, you want to track your stock levels, you can use the simple SMS messaging where your facilities can report on the stock level by just texting the number and then you have an aggregator that would aggregate and tell you what is there" (B9)

> "It's being used also for logistics management to inform managers about stock level at the various peripheral levels… sitting in his office the manager can know the remote places where the stocks are in various places". (D9)

4.3.5
Preventive and Promotive Health Services

Respondents mentioned Disease Surveillance, Immunization, Adolescent Health, Maternal and Child Health, Health Promotion, and Education as issues under this sub-theme. Even though respondents did not specifically mention cholera, respondents noted that these services were general and targeted all diseases including cholera. The main issues that came up during the discourse with respondents on disease surveillance comprised case detection, reporting, and tracking. After detection, cases were captured on phone through video or WhatsApp and reported synchronously (in real-time) or asynchronously (stored and forwarded later). Healthcare Providers also placed voice calls while on the field or showed pictures and videos to supervisors to report findings. Confirmed cases were tracked or traced by visits to the source point (index case) or through spatio-temporal tracking systems in liaison with Telcos. Spatiotemporal tracking uses the mobile telecom infrastructure to monitor the movement of people during cholera or other epidemic outbreaks to determine disease spread, pattern, and clusters. Respondents at the regional and national levels talked more on the planning arrangements for disease surveillance and the opportunities available while district respondents' views bordered more on actual disease surveillance operations. The following statements, one from a national officer and a CHO operating at the lowest level summarize this discourse:

> "a hospital information system could be able to kind of send an alert and say 'oh this number of diarrhoea diseases happened, can we look at the area and follow up by the disease control officer at the hospital or something'...you can send alert messages through your mobile phone". (B9)

> "Sometimes when you go, instantly when you see one or two symptoms from one or two people what normally I do is to call and then sometimes make video call...you normally take pictures and then we send, sometimes we take it and then send it there direct...so that they can see what exactly we are trying to talk about". (C10C)

Despite the above views, one respondent was of the contrary view that the region was yet to fully tap the potential of mobile phones for disease surveillance, especially in the case of community involvement in detection and notification. He acknowledged that it has been used in immunization to trace defaulters but not so in cholera management. He was however of the view that he had no doubt it would be viable if adopted. His view is expressed in the statement below:

> "…mobile phone now is kind of helping us to trace our defaulters when it comes to immunization but when it comes to cholera...we have not actually used our community-based surveillance system in Greater Accra very well…As it stands now I'm of the view that if we introduce mobile phone communication into surveillance it will go a long way to help us to address issues before it escalates". (C6A)

Confirmation of cholera cases was normally done by the laboratory. Respondents commenting on the main benefit of mobile phones in case confirmation indicated it provided a faster way of communicating results. Laboratory case confirmations via the mobile phone were sent to

Healthcare Providers to take necessary action or directly to the patient. Healthcare Providers also sent information to the laboratory of samples in transit for testing and release of results of cases from the laboratory through the mobile phone via text, voice call, or any appropriate mobile platform. The advantage was that Healthcare Providers were able to take proactive measures ahead of the official release of case results from laboratory tests. A Disease Control Officer and a Public Health Doctor, specialized in laboratory services provide their views on the issue as below:

> "cholera takes like three days to get the results so usually you have to go there to the lab to find out if it is positive or negative but we could text we have contacts there, was this case positive or negative so he will tell you it is negative before it even goes through national to region before it gets to you so you will get the information earlier than the normal routine through the text" (C6B)

> "A test is done; the results can be sent to the patient via mobile phone. This is very important because it cuts cost". (B8)

One aspect of disease surveillance that emerged during interaction with a national officer in charge of health informatics revealed that the mobile phone was also being used for *Verbal Autopsy* or *Death Surveillance* where deaths occurring in the communities from epidemics and others were reported through the mobile phones using a special application installed on the phones. Below is how his description was captured:

"volunteers in the community can alert on suspected cases and somebody can go but we have done some work using mobile devices more for mortalities; I mean death in communities ...volunteers will use the phone to call the CHO…there is an application what we call the verbal autopsy application that we put on the phone and then the CHO will administer the verbal autopsy on the phone and then comes out to our central server so we can analyze the community deaths…". (D9)

Maternal and Child Health (MCH) services were also mentioned by respondents to be offered through the mobile phone. The services offered comprised general antenatal services, abortion support, family health services, the keeping of database on pregnant mothers, and reminder services to visit clinics and outreach services. The services offered to pregnant women, nursing mothers, and children were general services that comprised comprehensive services throughout the continuum of care for such categories of people. Though respondents did not specifically mention cholera management, it was noted that the range of services provided for MCH comprised general health services including cholera, especially during an outbreak. A Nurse Manager at a District Hospital highlights some of the issues raised above in the statement below:

"They know the number of pregnant women and they register them on the phone; and that will prompt the pregnant woman when her time is due even when it's getting to the time she should deliver; the mobile phone will prompt them so that they go to the nearest facility". (C7B)

4.3.6 Telehealth

Tele-information, Tele-consultation, and Tele-medicine emerged as issues discussed by respondents which were themed Telehealth. From interactions with respondents, Teleinformation included the use of the mobile phone to seek authentic health information and advice (mostly informal) from qualified Healthcare Providers by the population. Teleconsultation was understood to refer to interactions and consultations among Healthcare Providers seeking clarifications and advice from colleagues on health issues for their information and knowledge. Respondents described Tele-medicine as referring to providing remote health services through the mobile phone to patients mostly through lower healthcare intermediaries.

Different communication models were identified in the three telehealthcare subsets. The first was *vertical* which referred to interactions between Healthcare Providers and the affected or general population and the other being *horizontal* communication which involved interactions among Healthcare Providers. The vertical communication concerned delivery and provision of health information by Healthcare Providers, online counselling, and other related services to the affected population, while the affected population also sought advice and health information on issues bothering them. Horizontal interactions involved Healthcare Providers' discussions on health issues, provision and sharing of information among themselves, administrative instructions from supervisors, and reporting on health activities from the lower healthcare facilities.

Table 4.5 below provides a summary of the full communication models gleaned from respondents:

Table 4.5: Communication models identified among healthcare providers and population

No.	Direction of Communication	Type of Communication Platforms	Groups Involved	Communication Model
1	One-to-One	Voice, Text	Provider-toProvider	Horizontal
2	One-to-Many	Voice, Text, Social Media	Provider-to-Providers	Horizontal
		Voice, Text, Social Media	Provider-toPopulation	Vertical
3	Many-to-One	Voice, Text, Social Media	Population-to-Provider	Vertical
		Voice, Text, Social Media	Providers-toProvider	Horizontal
4	Many-to-Many	Social Media	Providers-toProviders	Horizontal
		Voice, Text, Social Media	Population-toPopulation	Horizontal
		Text, IV&R, Social Media, Call Centres	Providers-toPopulation	Vertical
		Text, Voice, Social Media, Call Centres	Population-toProviders	Vertical

The statements below provide insights on some of the communicational models discussed above:

"When it comes to an epidemic [cholera], basically the issue at stake is time...so the earlier possible means by which information can be carried

around is through the phone and so when there are cases anywhere people can just call and speak to whoever officer by way of communicating or through the platform depending on the information" (C5A)

"...by and large, all of us use smartphones with most Healthcare Providers, doctors, nurses across board...we do WhatsApp and these days we even have WhatsApp groups so you come to a hospital and the doctors have a group. (D1C)

"And everybody gets the message [WhatsApp] spontaneously at the same time". (C5C)

The objectives of the interaction between Healthcare Providers and the general population centred on private discussions of health challenges and advice on management, remote followup of treated clients, and reminders for a clinic visit and outreach appointments. The perspectives of two CHOs' on their interactions with clients are captured in the statements below:

"Some of the members in the community sometimes want to get your number in case of a few questions that they would like to ask privately… so we normally give them our number so that when we are out they can feel free and call us and then we discuss a lot with them personally…We have a group in WhatsApp that whenever I get to hear some information I bring it straight to the WhatsApp group so that we discuss about it" (C10B)

> "So after the treatment if I am not able to go to see how the child is feeling, I just take my phone and call the mother and ask how is the child feeling, were you able to give the drugs, and if I need a message to be given to them like the next day that we will have our Child Welfare Clinic (static or outreach), I just call them and tell...so they can come on time". (C9)

Respondents discussing telemedicine indicate that it has been in existence since the advent of the mobile phone. They however distinguished between informal and formal telemedicine where the former is less structured and the latter, more structured in nature. In the less structured one, healthcare professionals on one part casually used the mobile phone to seek clinical advice and support from senior colleagues concerning cases they faced difficulty in handling. On the other part, senior healthcare professionals provided clinical support and advice to junior colleagues or health staff at the lower levels of care to help them effectively handle cases and make informed decisions, among others. Other services that are also part of telemedicine reported by respondents were mlaboratory (mlab) services where patients' samples were taken at their location and emailed to the physician for effective diagnosis and mpharmacy (mpharm) services where physicians sent mprescriptions to pharmacists at remote locations for their issuing and dispatch to patients wherever they were in the region.

For structured telemedicine, there were formal administrative and reporting systems, policies, monitoring and evaluation, and Tele-consultation Centres (TCCs). Due to the ingredients in establishing structured telemedicine as indicated above, it normally had a heavy capital outlay to the unstructured one. Respondents described telemedicine with synonyms such as 'eHealth', 'e-medicine', and 'm-medicine'. Some of the benefits of telemedicine were mentioned by respondents as including eliminating delays in care, cost-effectiveness, reduced need for

referrals, effective healthcare delivery, and reduced need for hospital attendance. The telemedicine model used was a public model, with limited private sector involvement. Visual and audio telemedicine were also identified. While visual telemedicine involved video, the audio was done through voice calls. Both types involved asynchronous (store and forward) and synchronous (real-time) systems.

On the issue of defining or describing telemedicine, two telemedicine specialists, and a Policy Specialist with experience in managing telemedicine provided some insights in the following statements:

"Telemedicine is a whole picture of using mobile technology...to drive the health system". (B4)

"Telemedicine simply is medicine at a distance. Tele means distance so medicine at a distance...it is exchange of medical information from one location to another location using ICT…you can also call it e-health, emedicine, m-medicine". (D1C)

"Yeah, I think basically as the name telemedicine suggests, it is actually the practice of medicine over a distance where practically knowledge is transferred through the tele-means between colleagues all from one provider to another provider to help a patient." (D1D)

4.4 **Respondents' perspectives on challenges encountered in the use of mobile**

phones for cholera prevention and management

This session presents the views of respondents on the challenges of using the mobile phone to manage cholera. These challenges represent views of respondents at all levels of healthcare in the region. They helped provide answers to research objective two which was '*To explore challenges encountered with the use of mobile phones which may affect the effective implementation of mHealth for cholera management in the GAR.'* Respondents were asked to share any challenges encountered in the use of mobile phones for the prevention and management of cholera in GAR. Where the experienced challenges were not particularly in cholera prevention and management, they were to share other challenges encountered with the use of the mobile phone for any other public health services which might be of relevance to the study.

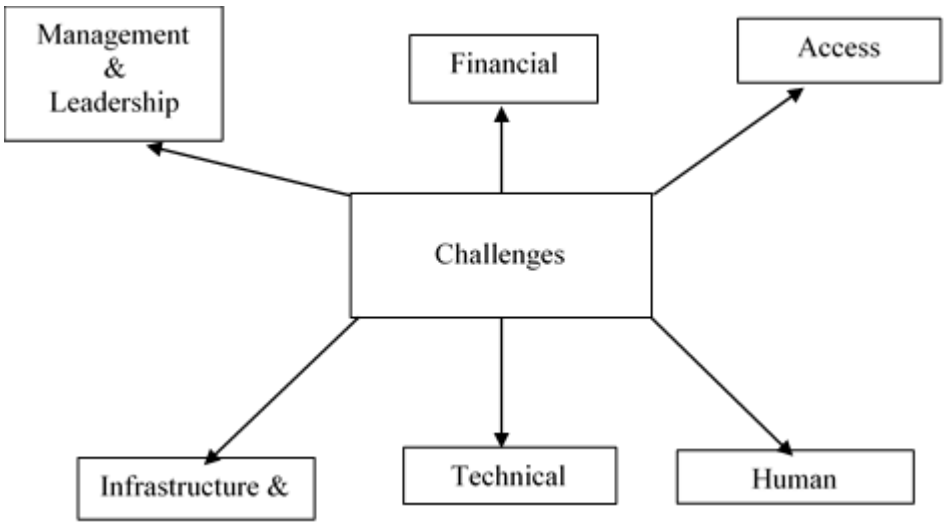
In all, six themes emerged comprising *Management and Leadership, Financial, Access, Infrastructure and System, Technical, and Human resources* challenges. These themes also had their respective sub-themes. To aid memory, these themes were arranged using the first letters of the six themes to form an acronym called 'MFAITH' challenges. Table 4.6 below illustrates the MFAITH acronym while Figure 4.3 provides a diagrammatic view of the same.

Table 4.6: MFAITH Acronym

Management & Leadership	Financial	Access	Infrastructure & System	Technical	Human Resources
M	F	A	I	T	H

Figure 4.3 below provides a diagrammatic view of the MFAITH challenges.

Figure 4.3: Objective Two- Thematic Network (IDIs)



4.4.1 Management and leadership challenges

The key management issues that emerged from interactions with respondents comprised the management of mobile phone resources deployed for Healthcare Providers' use and the management model for the implementation of mHealth projects. The health sector sometimes provides devices and equipment such as phones and other mHealth equipment under telemedicine services which must be managed as part of a government asset. Two sub-themes further emerged under this theme which was *Management of Official Mobile Phones* and the other was *'Projectitis and Pilotitis'*.

Relating to Management of Phones, Healthcare Providers identified the need to effectively manage the use of official and private phones for service delivery. Official phones were procured by the health sector mostly with the support of health partners. The issue of the deployment, management, maintenance, and other operational issues of these official phones and other resources were identified as key management challenges. One respondent with responsibility for information management expressed concern with the scale of management

and leadership responsibilities regarding managing the deployed phones throughout the region and even beyond. His remarks are captured as below:

> “we need to find ways of controlling the devices so one of the things that we are coming up with is what we call MDMs (Mobile Device Managers) that will centrally manage the mobile devices...and then managing the device has been a challenge for us and then it increases the cost”. (D9)

Projectitis-Pilotitis syndrome was identified by respondents as the proliferation of mHealth projects or over-reliance on foreign donor support to roll-out mHealth activities with little coordination, no due regard to country peculiarities, misalignment with needs and objectives and limited control by the health sector. Respondents noted that the syndrome affected financial and operational sustainability as most of the projects did not reach scale after their completion. This Projectitis-Pilotitis phenomenon was described by respondents with words such as ‘multiindependent, ‘un-integrated’ and ‘small pilots’, among others.

Commenting on some of the challenges with projectitis-pilotitis, one respondent intimates that little legacy was left with these mHealth projects.

> “It was supported by a major financier. It was big. Currently, we don't have any legacy...it's not just piloting or using mobile phone for something but there's a whole lot of things that go with it. The approach, the methodology, the sustainability, the cost-effectiveness, the leadership...” (B9)

One Health Policy Specialist indicates that Projectitis-Pilotitis was necessary to serve as useful lessons for future mHealth scale-up. He opines that that was the more reasonable thing to do. He indicates his view as below:

> "They are all pilots and during the evidence for national scale up and that is the right thing to do because you need to decide between what works and what doesn't work". (B4).

Another also indicates that the health sector should take advantage of these projects to leverage mHealth activities.

> "I'm sure these NGOs saw the status quo because that's why they came up with their projects in this area so, we could leverage in them". (C2).

Yet another respondent intimates that even though mHealth project she was involved in has ended, it is still being sustained through routine budgeting.

> "That's a very good question because as we speak now, our Donor Partner is not there. They've actually left and we are still sustaining the programme". (B2B)

Some respondents who were directly involved in mHealth projects advise that managers should prepare or plan for post-project sustainability. This view is captured as follows:

> "Most of the time we get a sole funder that is working with us. But then what happens when the funder is gone? And this is what policy-makers and managerial leaders should know that you may have funding but they will exit". (D1D)

> "…most of the support that we've had is donor projects. So, when they end, if you are not careful, if during the implementation you've not thought about sustainability, when the project ends you will find yourself wanting". (B2C)

A Director of the GHS involved in mHealth project implementation was quoted as seeking the ending of all mHealth pilot projects. A respondent report cites him in a statement below:

> "I quite remember the former Director saying 'stop all pilot, implement. The pilot is too much implement'". (D7)

4.4.2 Financial challenges (Cost)

Financial Cost also emerged as a challenge. This concerns all costs incurred and which constrains the effective prevention and management of cholera. The study classified them into upstream and downstream costs even though some of the sub-themes appeared in both classifications. Upstream cost challenges concerned all initial financial outlay required before mHealth activities could be implemented while Downstream costs comprised financial challenges that emerge after implementation to ensure its continuous operations, maintenance, and sustenance.

Some upstream costs which emerged were applications and software, infrastructure, and mobile phone handsets. Commenting on Application cost, a respondent listed some of the costs as consultancy fees, Apps development including updates, licensing, security, support, among others. He states:

> "One is analysis fee...consultancy...storage, licensing, it depends on the kind of software that you are running. Like if you are running on windows, you have to take care of licensing, you have to take care of security, you have to take care of support". (A4)

Infrastructure cost according to some respondents was high and included capital expenditure of servers and provision of general technological resources necessary for mHealth operationalization. The statements below reveal various views on the sub-theme:

> "It was expensive I mean getting the server". (B9)

> "Then there's also the financial aspect…technology is expensive if you are making a first initial investment...we have to spend money to get the infrastructure in place". (B7)

The huge cost involved in providing mHealth infrastructure seems to be a formidable challenge in attracting investment as remarked below by a respondent that the huge cost associated with infrastructure investment turns to let potential financiers 'shy away' from supporting mHealth projects.

> "... what we need to do here the budget is mind blowing so partners tend to shy away". (B2C)

Acquisition of mobile phone handset was identified by respondents as a key upstream input cost for the successful implementation of mHealth in cholera as it is the basic communication device or medium in mHealth. Respondents, particularly policy-makers and top leadership were of the view that acquiring mobile handsets for all healthcare workers would be a daunting cost while health workers at the lower levels indicated that there was the need for official phones to be purchased for them to use solely for mHealth activities. Some senior-level healthcare managers had the perspective that health workers already had their phones and could use them for mHealth activities; a view which was also supported by some lower-level health workers. The cost of official phones was said to be higher as they most needed to be customized for service delivery. The cost challenge was in the areas of the special casing and special applications. Much as customization was said to increase the cost, others had the view that there was the need for standardization of the phones to ensure interoperability and ease of connectivity which also may reduce the cost.

The following respondents' statements shed insights on the challenge of initial cost outlay of phone for mHealth activities:

> "most at times it has to be customized, especially for service delivery it has to be a customized device I mean the casing and thing have to be customized and it increases the cost so I think that is the key thing, the cost [of phone]" (D9)

> "I think even getting the mobile phone itself is also a huge challenge because this is adding to the financial challenge we talked about. Because to get appropriate mobile phone, you need a lot of money sometimes not less than GH₵500.00. So, to get the phone itself is a challenge" (D8)

The cost of mobile phone devices was identified by a respondent at the national level as being one of the causes of limitation of mHealth projects going to scale.

> "the cost of the devices because if you want to do a nationwide [deployment]; so that's why you have seen most of the mHealth projects being small…it's never scaled and one of the major limitations is the cost of the devices" (D9)

Regardless of the concern for phone cost, some respondents who also acknowledged the high cost of customized phones were also of the view that phones were nowadays less expensive even where the specifications were almost like that of a laptop. A respondent puts it as follows:

> "Something it is less expensive I mean despite we all complain about the cost it is less expensive because now I can get a very good tablet for almost 300 dollars, yes or even 200 dollars very good one with a specs almost like a laptop" (D9)

Downstream costs were expenditures incurred to help maintain and keep operating systems, devices, and equipment in a maintainable state. Key maintenance and operating costs mentioned by respondents included applications, software, system infrastructure, and mobile phones. Downstream Application cost comprised ensuring the continuous running of any installed application and its periodic upgrade and hosting. Others were maintaining internet connectivity and managing obsolescence. Two respondents with experience in managing

mHealth projects; with one at the policy level and the other at an operational level share their experience on some of the issues above in the following statements:

> "Technology is moving at a faster rate. Every day...there is a new software on the market. Our mobile applications we have to be updating it every six months. We have to be updating and taking into consideration most of the emerging issues in technology. We built a new mlearning platform...and it is now outmoded so we have to upgrade it. It's like every time technology is moving on." (B2C)
>
> "the cost of running the apps...that has been a challenge" (D9)

Communication cost included the cost of credit units for voice, data, text and other communication. The cost of communication according to respondents was either borne by the mHealth project finance, Internally Generated Funds (IGF) of institutions, central government, or individual Healthcare Providers. Respondents were concerned with the financial sustainability of communication cost as the majority of it was borne by Project finance and questioned who would bear the responsibility after the mHealth project ended. Staff also expressed concern about the financial burden on individual workers who bore their communication costs for official purposes. The Telcos' role in supporting communication cost was noted as limited. Respondents were of the view that Telcos always had profit motives and sought for long-term business models. There was therefore the call for support for communication cost in terms of credit units from IGF or central government.

Commenting on the various costs and funding of communication, some respondents shared the views below:

"…districts and sub-district pay through their IGF; pay for the data...". (B2C) 131

"people download the apps and they use their own data and then in that case, it means that if they don't have data, they can't access the app?" (A4)

"The cost in many cases is borne by the user…". (C5A)

"Normally we pay (for calls) ourselves" (C10C)

Respondents seem to have varied perspectives on who should bear the cost of communication which was described as expensive, especially data. Some were of the view that health staff should bear the cost, others opined that cost should be borne by facilities (IGF) or central government. These divergent views are provided below:

"I think that the health worker has to bear the cost himself…". (B5)

"The cost in many cases is borne by the user but then when it comes to something official in the more sustained manner, facilities are expected to take up that cost". (C5A)

Commenting on the demerits of inadequate funds for communication, respondents indicated that it affects the sustainability of mHealth, delayed electronic delivery of data, is a disincentive, and reduced access to information and willingness to download the same and operational incapacitation, among others. Some of these effects are captured in the statements below from two respondents at the lower healthcare delivery level who bear the brunt of this challenge:

"…and then for instance if you ask staff to let say on daily basis or weekly basis send you immunization report through the mobile phone, they may require you to give them some credit to do those things" (C6B)

"And if there are no credits, you can't do anything on the phone". (C9)

It emerged that some Healthcare Providers who bore their cost of communication did so based on altruistic considerations, and to enhance their work. A respondent remarks on the issue as follows:

"…but sometimes we have to do it [buy credit] because since you are working for human beings, I mean that's the nature of sacrificing for the community". (C10C)

The phone cost was in the areas of replacements due to misplacement, theft, and maintenance of mobile phones. The statements below support the view:

"Day in and day out people's mobile phone gets missing and then being stolen..." (C6A)

"...the whole issue of sustainability of...replacing the devices" (D9)

4.4.3 Access challenges

This section provides respondents' views and concerns about factors that impact access to

mobile phones for the delivery of mHealth services. Respondents expressed concern about illegal or unauthorized access to mobile phones. Unauthorized access was identified to be physical or digital. Physical access referred to actual physical contact with the phone to access its data while digital access concerned remote access to stored information through hacking and cloning. A key concern by respondents on access was on the issue of security, privacy, and confidentiality of both clients and Healthcare Providers' data and safety which were impacted by thefts, misplacement, left unattended to, and sharing of phones with unauthorized people. Unauthorized access to clients' data was seen by respondents as a serious breach of trust which could expose health facilities to legal suits. The security of data was therefore acknowledged by respondents as a key issue to be taken seriously by all Healthcare Providers. Two respondents at the national office and a district hospital comment as follows:

"The danger of somebody using his or her own phone especially for the health side is the confidentiality of data [health] sitting on personal phones which we think is not good enough. It poses challenges". (D9)

"One of the core values are privacy and confidentiality of our patient information and also privacy of data on staff. We believe that certain information is classified, and so it shouldn't come into public domain so whatever it takes to protect the data I think it should be done so that we can mitigate these potential challenges that may pop up". (C7A)

A respondent however questioned the issue of privacy and confidentiality during emergencies. He was of the view that during emergencies, privacy may be compromised as information needed to be passed on to others for quick action and saving of lives could result in a breach. He challenges the issue of privacy during an emergency in the statement below:

> "It wasn't a problem at all because in an outbreak which is an emergency what privacy do you need?". (D2)

4.4.4 Infrastructure and system challenges

This theme concerns challenges encountered with the structures, equipment, organizational architecture, technological services required for effective and efficient mHealth services. Infrastructure and technological systems provide the backbone support for enabling mHealth. Any challenges, therefore, experienced with them could constrain mHealth effectiveness and resultant viability. The main sub-themes that emerged from participants' interactions were network coverage and quality, availability and reliability of electricity, and technological infrastructure.

A few of the respondents expressed concern with the unreliability of electricity for the charging of phones. This challenge was experienced particularly in the remote areas and was not reported as a major issue at the time of the research. The effects of lack of electricity were stated by respondents as limiting the ability to use the phone, travelling a long distance in search of a source of power supply, inability to stay in touch with colleagues, and carrying battery backups

which were a burden. Commenting on poor electricity supply at remote locations, a respondent states that:

> "And some places we don't have electricity (very remote areas) so charging a phone is a problem. You have to come to the next place to be able to charge your phone". (B8)

Technological Infrastructure Provision also emerged as a sub-theme. This concerned the provision of critical, physical, and technological structures that needed to be in place to enhance mHealth viability. The infrastructure mentioned by respondents included fibre optic networks, special telemedicine infrastructure, information technology systems, and mobile network systems. The provision of mobile network infrastructure in urban and peri-urban areas was described by respondents as 'great' but indicated that that of the rural areas was a challenge, despite government incentives. The reason suggested for a relatively poor rural mobile network was due to a lack of business opportunities for Telcos. It was also noted that apart from national infrastructure provision, there was also the need for the provision of institutional level infrastructure at the Ministry of Health and GHS. Even though there was some provision of infrastructure for mobile health activities, there remained a gap in infrastructure provision by the GHS to host its data. The poor state of telecommunication infrastructure in the rural areas made it difficult for mobile health services to be delivered in these areas. The summary of challenges with infrastructure included its inadequacy, fast rate of technological changes, and over-dependence on donor financing.

Some respondents expressing challenges with infrastructure provision in general made the following statements:

"Infrastructure is a lot very difficult to deal with…". (B9)

> "The problem had always been how do… we in Ghana improve on our technology to enhance the use of telemedicine that is what has been the problem" (B4)

> "And the equipment too...we do not have it...the equipment to do it too should be in place" (D6B)

The majority of respondents mentioned *Network Coverage and Quality* as one of the Infrastructure and System challenges. It concerned all challenges relating to network coverage (rural and urban) such as connectivity and reliability or quality of the network. Main issues discussed by respondents included internet (availability, connectivity, speed, etc.), poor voice communication (call drops, signal weakness), network availability issues (network offline), general network unreliability, system faults and glitches, environmental factors (e.g. rain), among others. Network coverage and reliability were dependent on Telcos' network infrastructure deployment and level of quality. These Network Coverage and Quality challenges were experienced more in rural areas than in urban locations. Respondents were compelled to own multiple Subscriber Identification Modules (SIM cards) of different mobile companies. Despite the foregoing, respondents acknowledged that the Greater Accra generally had a better infrastructure compared to other regions. These identified network issues affected the smooth operations of mobile health activities. The combination of these network challenges generally affected the ability to offer mHealth services to clients. The following statements are typical of the challenges mentioned by respondents:

> "In our district the issue of network is a problem. There are some places when you go…the signal maybe very weak…you don't get proper network". (C7C)
>
> "Our internet services are not very reliable" (C7B)

One respondent revealed that in some of the newly built hospitals, parts of their locations did not allow mobile networks to operate which had implications for mHealth activities at these facilities. He states:

> "A case in point is...like Ada East district hospital there are some areas and also the new ridge hospital there are some areas within that hospital that you cannot use your mobile phone, connectivity is zero" (C7A)

4.4.5 Technical challenges

This theme concerned the mechanical, methodical, and procedural issues surrounding the usage of mobile phones. The sub-themes which emerged under this theme were *Interoperability and Techno-technical challenges.* Respondents acknowledged the need for different systems to communicate among themselves which was seen as important for smooth operations, allowing the flow of data and aiding functionality. Achieving interoperability also prevented the proliferation of many systems, which may be unnecessary, thereby reducing the cost of infrastructure. The multiplicity of different Telcos with different systems was also suggested

to affect interoperability. Respondents commented on the challenge of interoperability in the following words:

> "my view is that every system that is built particularly in the health system should provide the ability to integrate…or directly allowing integration with the system, integrate with other health systems and to allow for flow of data and flow of functionality". (B2A)

> "If you go to our dispatch centre, you have X line [name hidden], W line [name hidden], all the networks are having separate lines so it makes our work very difficult" (D4)

Techno-technical issues referred to the ease of operating equipment and mobile phones and the inherent limitations in operating the above technological systems. Their concerns included battery power, limitation of the mobile phone in providing some aspects of healthcare, underutilization of phone capacity and limited bandwidth of internet, mobile phone maintenance, and one-way communication of mHealth messages (SMS). Some of the techno-technical concerns raised by respondents are captured in the statements below:

> "you will be talking to someone and then the battery will be going down". (D2)

> "some patients may come, let's say a skin rash or maybe the doctor needs to see the patient and the mobile phone you cannot do that...sometimes we are unable to even describe the thing very well". (D6B)

“We will be working with the phone then the keys will not be working…”. (C9)

4.4.6 Human resource challenges

Human Resources issues emerged as another theme that concerned all people-related mHealth issues. Key sub-themes identified included *Illiteracy, Abuse, Job Interference and stress, Mistrust, Socio-culture and Staff Capacity and Availability,* among others.

Illiteracy included the inability to read and write and the capacity to operate at least the basic functions of mobile phones such as placing calls, texting social media operations, among others. It was noted by respondents to be a problem of the rural areas and described as a 'huge barrier' in the delivery of health services to such population. Illiteracy was however not a challenge among Healthcare Providers. Commenting on the challenge of illiteracy, respondents made the following statements:

"illiteracy is a big problem especially outside a lot of the urban areas". (B2A)

"when it comes to complicated things like sending WhatsApp messages, a lot of people cannot even send a text" (D1C)

Another implication of the illiteracy phenomenon that emerged was the use of multiple local languages to communicate with the population due to the inability to read and write the official language of English. This presented a challenge for Healthcare Providers with having the ability to speak multiple languages. It also warranted the need to package mHealth communication in various local languages. A Community Health Volunteer (CHV) who operates as a first-line healthcare provider comments as follows:

> "if you are a volunteer at least you are supposed to speak two or three languages so that in case the person changes the language you can also follow him or her. It's about the language". (C10B).

Notwithstanding the above, one respondent held the different view that the challenge of the inability to speak English is moderated by the fact that most people could speak the local Twi dialect which reduced the need to learn various languages. He states:

> "fortunately, almost everybody can speak Twi even the Gas can speak Twi so I didn't have that problem. Wherever I went, I made a lot of talks to a number of groups both in Twi and English". (D2).

Respondents had differing perspectives on the issue of the level of education of health providers. While some indicated that Healthcare Providers at all levels were generally educated, some respondents said certain Healthcare Providers, such as Community Health Volunteers at the lower level were not educated. These contrasting views are presented in the following statements by two participants:

> "The volunteers some of them are not educated and so such people it means whatever message you are sending you need to send it by voice and per the language, some of them they understand the English but they cannot speak because of their education...". (C5B).

> "As for illiteracy I think it's not a major issue. But as for the illiteracy, I think that within the GHS, even at the lowest level...I don't think it's a key challenge.

(C4)

The capacity and skill of Healthcare Providers to use digital resources and staff availability affected the effective delivery of mHealth services. Capacity gaps among Healthcare Providers were identified as inability or limitation in operating the mobile phone device, lack of understanding of basic techno-technical issues concerning mobile health, and IT staff's illknowledge of health issues. The ability to utilize or maximize the mobile phone was dependent on the level of technological savviness. It was, however, noted by respondents that most users were able to operate its basic technology. A respondent's comment on the foregoing is as follows:

> "Do we have the skill set? People with the skill set that can do this [mHealth]? I don't think so...because we haven't built human resource capacity" (B7)

Commenting on age dimensions and technological capacity, some respondents stated that the younger Healthcare Providers were noted to be digitally savvy and could operate mobile phones better than the elderly. This is captured below in the following statements:

> "…when you have the young and elderly on duty you see that usually it's the young ones who are operating the phones and they will do the voice call and all those things so yes there's a difference, elderly find it difficult to adopt the phones". (C7D)

> "The young ones are technology savvy than the older even when the desk top came there were those who would not even go near the computer until maybe they were forced to do so" (C5A)

It emerged that Socio-cultural factors expressed in Healthcare Providers' and clients' attitudes and mentally-ingrained habits affected mHealth activities. Healthcare Providers indicated that sometimes patients wanted face-to-face interactions with the doctor rather than through the mobile phone while providers had an affinity for paper-based activities and others. Respondents described socio-cultural issues and effect on mHealth with words such as 'mental models', 'mentality', 'culture' and 'mindset', 'traditional way' and 'attitudinal problem', among others. Providers said that these mental models influenced people to still prefer going to the health facilities rather than consume health services at-a-distance. One respondent's view which summarizes the socio-cultural issues raised is captured in the statement below:

> "The average patient will want to have a one-on-one, eyeball-to-eyeball meet with a physician, either a doctor or a nurse... they'll still want to go to the facility…in the mind of people, you don't want them to go to the hospital." (B7)

A sub-theme of Human Resources challenges that emerged was the issue of *Staff Motivation*. It concerned Healthcare Providers' quest to be compensated for what they saw as 'extra work' or extra-curricular duties brought about by mobile health activities at the lower level. The key challenge was the extra work brought about by the transfer from paper-based data to mobile platforms for submission to superiors. Motivation sought by Healthcare Providers comprised

support for buying phone credit units and the provision of smartphones for health staff, particularly those in remote locations. This view was expressed by respondents who were both mHealth project implementers at the lower level and coordinators at a higher or national level. Project-based or more structured mHealth activities normally were accompanied by incentives such as the provision of credit units for providers but mostly failed to continue after the project completion already discussed. Other respondents were also of the view that some of the activities such as data collection and reporting were normal activities that needed to be performed with or without a phone. The use of the mobile phone, therefore, facilitated their work which should not attract any special compensation.

The provision of credit units was an essential aspect of motivation for staff in mHealth. These incentives ceased when the projects ended. It was thus unsustainable as staff were motivated to perform mHealth activities if there were incentives. The statement from a healthcare provider at the district level on the need for the incentive is stated below:

"Yeah so like the one I'm telling you Zee Project [name hidden] brought; they are going to give Thirty Ghana Cedis worth of credit per month so if you are sure of that then it's an incentive other than that it will be a disincentive". (C5C).

One other sub-theme mentioned by some respondents under Human Resource challenges was *Interference and Stress* which were attributed to the use of mobile phones at the workplace. The mobile phone, according to them interfered with their normal work schedule and also contributed to stress levels of Healthcare Providers. This was worsened by the numerous mHealth projects which come along with phones and different technologies. Due to the lack of

interoperability, staff had to manage and operate different systems, each with its reporting systems and communication devices. Mhealth Staff complained of 'fatigue in adopting new technology', coupled with workload which increased the stress level. The view of an innovation specialist on the issue is stated below:

"there was a little bit of fatigue because there are a lot of different mHealth or technological system being tested out right; and so, as a nurse who is trying to do your work all of a sudden you have three phones that you are using this for early warning, you are using this to update pregnant data and you are using this for that". (B2A).)

Commenting on workload and its effect on staff performance and prolonged patient waiting time, the following statements provide evidence:

"they write it on paper, they keep track of it and then you want them to type it onto a mobile phone and then send it; that's a double work for them and their core work is to deliver care not to do a lot of administrative work and so when the incentives are not aligned well …there are a lot of errors in the data collected". (B2A)

"and then the other thing is the workload they still complain about, so they get tired" (C5B)

Interference and staff addiction to phones were identified as key factors causing such a challenge. Phone interference caused delays in work, reduced work performance, and affected the quality of work. It was noted that the mobile phone if not well controlled in the work environment could be more chaotic and affect our performance. A respondent working in the laboratory setting states:

> "some people have become very addicted to the phone than using it for the intended purpose. They will be at work and still be fidgeting with the phone…As in lab, we must know when to use the mobile phone and when not to use the phone. The phone should not disturb work.". (B8)

Another sub-theme under Human Resources which emerged was *Mistrust in mHealth* which was explained with various descriptions such as unauthenticity of mHealth messages, fake messages, junk mails and clients' and Healthcare Providers' lack of trust in the efficacy of mHealth, untested digital protocols and academic exercise, among others. Some of these mistrusts arose from discrepancies in data between digital and paper sources, network challenges affecting the quick transmission of data, data security, and others. The following statements shed light on the sub-theme:

> "The question is whether the clients had trust issue with the information we are collecting or the health service who were providing" (B2A)
>
> "on the health provider side, there were a couple of trust issues" (B2A)

A sub-theme that also emerged in the interactions with respondents was *Medico-Legal* implications of mHealth activities for Healthcare Providers. Respondents identified the factors that could result in medico-legal issues to include nosocomial (hospital transmitted) infections through mobile phones, uncertified digital clinical protocols, data security and confidentiality, health risks of using mobile phones, and others. A concern expressed by respondents was the risk to Healthcare Providers of Medico-legal flaws which could lead to lawsuits by affected people. The threat of medico-legal suits for using uncertified and untested electronic clinical protocols on health clients are expressed in the statement below:

"Now if you want to use mobile phones or technology for health interventions, you have to look at the electronic clinical protocols that come with it because if you send an SMS to somebody and the person washes his hands, follows everything that we have said, okay, and he or she gets cholera and the person passes away, you should get ready for legal suits…so there are a couple of medical-legal issues we need to address". (B7)

The last sub-theme identified under Human Resources was *Abuse of mHealth* by Healthcare Providers and clients. Providers complained of abuse by colleagues concerning the use of credit units for private communication. Most abuse, according to providers, came from clients which included requests for prescriptions to treat themselves at home without visiting the hospital, utilizing unverified health advice seen on WhatsApp platforms and prank calls to emergency hotlines. Some of the words used to describe the abuse were 'self-medication', 'overuse', 'addicted', and 'misuse'. The following statements provide insight into the challenge:

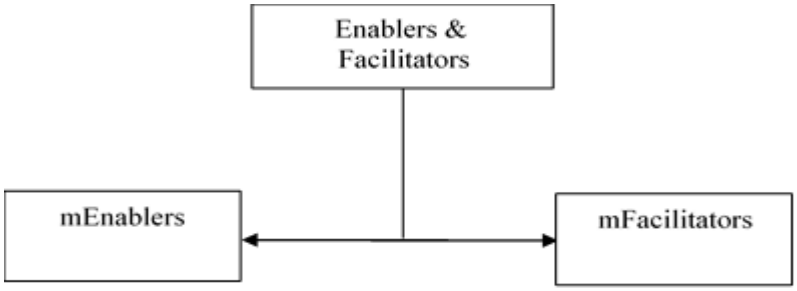
"we have people who may not even visit the health facility at all. And if they have any relationship with any pharmacist, they will call you and tell you all that is worrying them and expect you to give them all the information that you can give on the phone". (C8)

"at times somebody will perceive that this is what is wrong with me and then coming out can just decide you are going to begin the treatment on the phone; can decide let me go and buy it without any thorough investigation and then that will equally lead an abuse" (C7B)

4.5 **Respondents' perspectives on enablers and facilitators for mHealth in cholera prevention and management**

This session presents perspectives of respondents on factors that enable or facilitate mHealth for cholera prevention and management in GAR. These views helped provide answers to research objective three which was '*To explore enablers and facilitators for a viable implementation of mHealth for cholera management.'* Respondents were asked to share their perspectives on what the health sector should put in place to ensure the effective use of mobile phones for the prevention and management of cholera in GAR. In all, two (2) themes emerged comprising mEnablers and mFacilitators. Seven (7) and three (3) sub-themes further emerged under Enablers and Facilitators respectively. It was found that some of the issues which emerged under mEnablers also appeared under mFacilitators but with different dimensions. Figure 4.4 below provides a diagrammatic view of the Enablers and Facilitators.

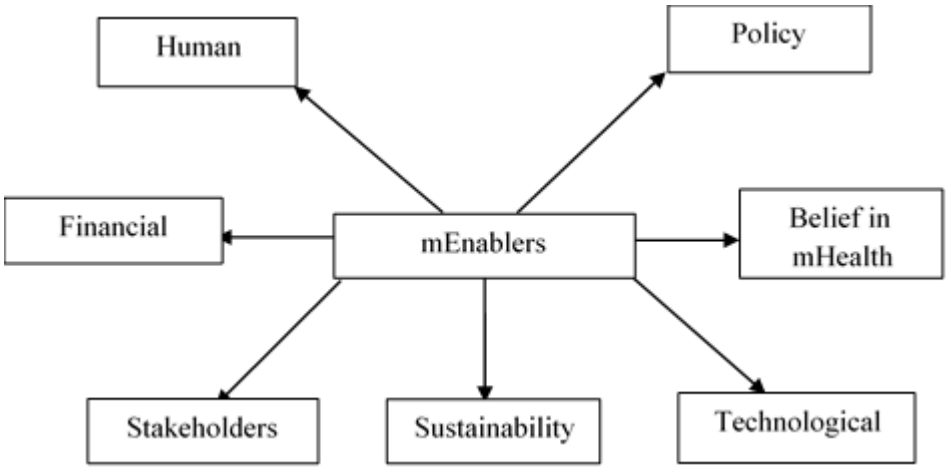
Figure 4.4: Chapter three- Thematic Network (IDIs)



4.5.1 mEnablers

The mEnablers referred to factors that must be present before the implementation of mobile health activities. They were preconditions needed to ensure the success of mHealth and were located upstream of the mHealth chain. The seven (7) mEnablers comprising *Financial, Human, Belief in mHealth, Policy, Stakeholders, Sustainability,* and *Technological* are depicted in the thematic network below.

Figure 4.5: Objective three: Sub-thematic Network of mEnablers (IDIs)



Financial Enablers refer to cash resources provided for investment in mHealth infrastructure. The main financiers were by external (foreign) donors, with limited funding from Telcos and Research Centres and government. Donor Partners provide money for infrastructure, communication costs, and others. The statements below from respondents suggest this view:

"We are being sponsored by Novartis foundation". (B4)

"…Telephone Consultation Centre (TCC), it was Novartis foundation and then with mine, we had donations of the equipment from JMB Medical Supply from the US" (D1C)

"Mobile app was funded by BSIA through Palladium. So, they are the ones who catered for the cost of the mobile application" (B2B)

Financial support for mobile health activities helped to save lives, increase access to services, and served as incentives for Healthcare Providers' willingness to be part of the project as captured in the following statement:

"Noguchi brought…thirty Ghana Cedis [GHC30] worth of credit per month so if you are sure of that, then that is an incentive …a participant wanted to know whether they will be continuously giving the credit and as soon as she said yes it was heart-warming and they applauded". (C5C)

Financial enablers helped to reduce the overall cost of accessing mobile health services and its affordability by the population as stated below:

"Usually we have donors…So basically, the patient does not bear the cost". (D1C)

The second mEnabler was *Human* resources. This concerned the need for the right type of personnel in terms of qualifications, capacity, and numbers needed to support the implementation of mHealth projects. They were seen by respondents as key to the viability of mHealth and put ahead of infrastructure and finance. The importance of human resources for effective mHealth implementation is captured below as expressed by a respondent with experience in designing mobile health application:

> "I'm talking about people, when you have right people, putting I.T and other software together is not difficult but if you have money and you don't get the right people, you won't get the results you want. I.T is all about people". (A4)

The need for information by the population was identified as an opportunity for Healthcare Providers to leverage mHealth. The hunger for information is acknowledged in the following statements:

> "People are really hungry for information". (B6)

> "There are a lot of people who need information". (B2B)

Belief in mHealth by respondents emerged as a dominant sub-theme under mEnablers. Belief in the efficacy of mHealth was essential for its adoption by Healthcare Providers. Respondents' belief in mHealth was because it helped in enhancing quality health service delivery, providing them access to professional advice, coordination of health activities, and sharing of

information. The rest were effective communication among Healthcare Providers, managing epidemics, disease surveillance, and supervision. Expressing their belief in mHealth, two Healthcare Providers made the following statements on some of the reasons for respondents' belief:

"I will say if the question is whether mobile phone is useful in health service delivery, then I will say yes" (C8)

"I cannot see how cholera can be controlled effectively without the use of mobile phones… they are very critical to the control of cholera, yes now the 2014 episode you know that outbreak we made use of mobile phones a lot" (D2)

Another sub-theme identified was *Policy Enabler*. The majority of respondents mentioned the need for an overarching policy framework to govern mHealth activities. As part of establishing a policy framework, respondents also called for a strategic and technical framework to govern mobile health activities. Some of the policies mentioned by respondents as having been developed or needed to be developed were 'hand-held device policy guideline', 'policy guidelines', 'eHealth policy', 'eHealth strategy', 'ICT Policy', 'telemedicine policy', 'guidelines on telemedicine', 'protocol', 'intentional decision' and 'technical framework'. The main aim of calling for a policy was to help guide Healthcare Providers in the efficient use of mobile phones to deliver health services, providing clear objectives, ensuring sustainability, and providing direction, among others. The development of a policy framework was suggested to be a key enabler for the viability of mHealth. Respondents recommended that apart from the

policy formulation, there should be intensive dissemination and training of Healthcare Providers to build their capacity to operate mHealth effectively. The pre-eminence of the policy was suggested by some respondents as follows:

"The policy should come first…the key thing is the policy". (C7C) "We first need a policy". (B4).

Stakeholder as an enabler was identified as impacting on viability. Stakeholders comprised community, government, providers, health partners, and others. These were identified as playing key roles which included financing, management, implementation, and policy formulation. Their shared commitment, involvement, interest, and acceptance were key enablers for effective mHealth implementation.

"Commitment from government, the lower level and even acceptability by the community members…". (C6B)

"…to ensure that top management from the Director General level, GHS, the Ministry of Health, the Technocrats, Chief Directors once they embrace it…it becomes easier and for that matter budget allocation can be made towards this project". (C7A)

Technology emerged as one of the mHealth enablers. The enabling effect of technology on mHealth included its generally high diffusion and adoption by people, affinity to mobile

technology, high healthcare provider adoption, infrastructure provision, digitization of clinical protocols, and opportunities for interoperability. One key technological enabler was the high penetration and adoption of the mobile device, especially smartphones among Healthcare Providers. This was acknowledged by respondents as a necessary condition for mHealth viability. Respondents described penetration and adoption of the mobile phone with words and phrases such as 'ubiquitous', 'everybody accepts', and 'commonplace', among others. The following were some of the answers provided by respondents when they shared their views on mobile technology penetration and adoption:

"Currently smartphones are what most of the people use". (C10C)

"Everywhere almost everybody has a mobile phone, even the remotest area". (C2)

"As for mobile phone, it's like a necessity…everybody is glued to their phones". (C7D)

The need for a 'technical framework' to ensure technical sustainability was mentioned. This was described by one respondent as 'back-end maintenance' which concerned establishing a rigid maintenance regime to manage post-implementation maintenance issues that arise.

"You can't assume that's a one-off investment, no a nurse is going to lose a tablet a nurse is going to break a tablet, a nurse is going to crush it...that's what is called back-end maintenance which is also very important". (B4)

"We need to talk about technical sustainability...technical framework" (B7)

The last mEnabler which emerged concerned *Sustainability factors* which comprised Financial, Governance, and Institutional sustainability. Financial sustainability referred to the need to assess the full implications of post-implementation or end-of-project cost in mHealth to avert viability crisis. Some of the post-implementation costs reported by respondents included communication, hand-held devices maintenance, internet services, and renewal of hosting rights. The following are statements that cover some of the financial sustainability issues:

"About national systems cost that should be addressed right from the beginning...you cannot wait to the end of a pilot...because the money matter will kill it pretty fast" (B2A)

"We need to talk about financial sustainability" (B7)

The second sustainability factor was Governance sustainability. It concerned the leadership, management arrangements needed to be in place for sustainable mHealth implementation and resultant viability. Respondents expressed the view that mHealth projects must fit into existing health structures rather than dismantling or disrupting them and should have buy-in from Healthcare Providers. This view was typical of higher-level stakeholders. The importance of leadership as part of governance was described by a respondent as follows:

"If you have everything and you don't have a good leadership, it will fail". (B9)

The dimensions of governance which included decentralization and structure that aligned with corporate strategies to fit with the existing health system are captured as below:

“I think sustainability lies in the decentralization”. (D9)

"there should be a governance structure in place and all the administrative procedures". (B7)

The third sustainability factor was Institutional sustainability which was described by respondents as including administrative procedures on mHealth, standard project implementation methodology, operational complexities, methods and design, documentation, and general operational issues that ensure the viability of mHealth. The statements below capture key aspects of the institutional sustainability from respondents:

"The methodology that you use in your mobile health is very important... ...during the design, if you don't get things right, that is where things go wrong during the implementation stage". (B9)

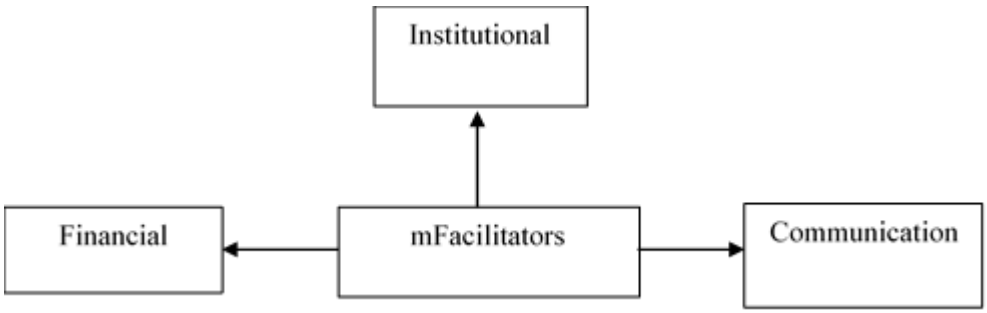
"the institutional structures were not built...all these initiatives are projects and you need to follow standard project implementation methodology...the administrative procedures must also be in place" (B7)

4.5.2 mFacilitators

mFacilitators referred to factors that were necessary for the continuous operational viability of mHealth activities. They were post-conditions for the success of mHealth and located downstream of the mHealth chain. As indicated earlier, some of the sub-themes that emerged in mEnablers (upstream) also emerged in mFacilitators (downstream). Three mFacilitators emerged during interactions with participants which were *Institutional, Communication, and*

Financial. These issues are presented diagrammatically in Figure 4.6 below:

Figure 4.6: Objective three: Sub-thematic Network for mFacilitators (IDIs)



Institutional facilitators included the use of big-data to leverage effective decision-making, the need to operate mHealth within existing structure and system, operation of free health hotline, operational logistics provision, and training and education. The rest is the opportunity that comes with the nascent field of mHealth, partnership with Telcos, and need for planning and budgeting. Big-data was said to facilitate decision-making and crafting of strategies for effective mHealth design and implementation. A respondent provides a representative view on the usefulness of big-data:

> "we have big data...so that you can mine the data and let it support decisionmaking over a long-term period and you know, fashion out strategies out of it". (B7)

Respondents acknowledged the need to continuously operate mHealth within the existing organizational structure and system to help prevent implementation challenges and acceptance by Healthcare Providers. Two respondents made the following statements in support of the foregoing:

> “If you don't get the buy in, you're going to face problems because it has to fit into an already established system...If you end up collecting parallel data, if you end up accruing something different, it will die off”. (B7)

> “The traditional things must stay on, the traditional way of quality care treatment must also go alongside so that we don’t lose” (B3)

Free Health Hotlines were seen by some providers as key in facilitating access to a 24-hour professional mHealth service by the population even under the shortage of trained health professionals as stated below:

> “They can call our call-centre to get information...managed by non-medically trained people who can respond to basic questions”. (B2A)

> “There could be a way of using a toll-free kind of service when it is medical issues, the calls should be free”. (C8)

Provision of logistics or supplies for the running of mHealth activities consisted of powerpacks as electricity back-ups, repair of equipment, mobile phone acquisition, maintenance, and replacements for mHealth services. A respondent expressed his view on the need for acquisition of mobile phones for Healthcare Providers as part of the logistics supplies as follows:

> "Government must have a system of providing mobile phones to health workers especially those who will be involved in managing of outbreaks".
>
> (D2)

The continuous quest for partnerships with Telcos and other relevant stakeholders in support of mHealth activities was identified as important for viability. Others called for a higher-level engagement and more effective coordination between health and telecommunications ministries for concessions on the cost of communication, especially during epidemics as part of the public good. Telcos were also to be engaged on a 'win-win' basis to absorb some or all communication costs of mHealth. These are expressed by two respondents below:

> "I think this that one should be a high-level engagement; the Ministry of Health should engage the Ministry of Telecommunication on that level and get some concessions for health even if for epidemic data they should give us some concessions because it is a public good". (D9)
>
> "We are depending on the Telcos for their corporate social responsibility that they are supporting us but we must be bargaining out from a more all win-win situation" (B4)

One respondent took a more adversarial path by indicating that Telcos should support mHealth because of the risk associated with the emission of radiation and associated brain diseases from their masts. Failure to support should attract a special health tax. He bursts out as stated below:

"We should engage them or they should pool all their monies into something. Because the risk associated with the emission of radiation can be taxed. I think they call it emission risk cost. They should slap it on all the Telcos.". (D7)

Planning and Budgeting emerged as another issue under Institutional facilitators. Planning and budgeting were suggested as one of the key sustainability factors. It helped to prepare for operational costs at various levels of health delivery. Decentralized budgeting for health facilities prepared them to take over mHealth projects after completion and for scale-up. Respondents were also of the view that budgeting generally helped to ascertain the cost of running mHealth services and attracted funding. An ICT specialist at the national level advises on the importance of planning and budgeting as a facilitator of sustainability, which he remarks as below:

> "If you don't budget for it as part of...government of Ghana budgeting procedures, then you'll not make any headway because the project will die with the completion..." (B7)

Finally, a respondent provides a summary of items to be budgeted for in the following statement:

> "...really costing the services...it's a service delivery; you're offering services, who should pay for it? That's basically like we should be able to mainstream it, cost the gadget, the phones, the credit, the service itself that we offer; let's

cost all those, the technical people, IT people, the servicing; all these should be costed well…". (D1B)

Training and Education concerned the capacity development of Healthcare Providers to effectively and continuously manage and operate mHealth technology and services. The population was also educated to make them aware of the availability of the service and the benefits to be derived when used. It was aimed at appreciating and understanding the content of existing mHealth and related policies and guidelines and build the internal capacity of Healthcare Providers to perform. Respondents described training and education in words such as 'orientation', 'education', 'refresher', 'capacity building' and 'advocate', among others. The training helped providers appreciate the need to adopt mobile health and ensure effective usage. Some of the areas for training and education covered capacity needs for telemedicine, cybersecurity, clinical and non-clinical training, and migration from manual to a digital system, among others. The essence of training is captured in two respondents' statements below:

"The first one I think should be orientation or training to help get the essence why we are going that way, why we will want to depart from the norm..." (C7D)

"I mean the objectives, who to report to, which information needs to go outside our normal system...So training I think should be part of anything that we have to do" (C7C)

Key communication facilitators mentioned were the use of non-mobile phone channels and multi-platform opportunities for delivering messages. Non-mobile channels comprised the use

of Television (TV), Radio, and face-to-face public education; while multi-platforms included options such as SMS, Voice, and Social Media. The use of non-mobile phone channels was raised by respondents at the regional level who were responsible for regional coordination of epidemic diseases including cholera management and health promotion. Even though respondents acknowledged that these suggested channels were also important to complement the use of mobile telephony to deliver health messages, they recommended that the health sector should consider owning television and radio stations to help facilitate health promotion for cholera prevention and management. They made this call by noting that even some churches had their TV stations. The following statements support the foregoing:

> "Districts go on their local FM stations to educate the public... It can be forms of talks. Sometimes even at the hospitals' OPD, talks are given while patients are waiting to see the clinician.". (C2)

> "If a church can come out with a TV station...we are bigger than a church so I think we should come out with a TV station, even a radio station...so people who are interested in listening to issues of their health can just tune in to that particular radio station or TV station. A TV station, a radio station won't be bad". (C4)

Respondents acknowledged the opportunities that mobile phones offered for Healthcare Providers in communication such as multiple platforms comprising SMS, Voice, and Social Media. These various options offered flexibility and convenience in mHealth communication. Respondents' ability to combine these various platforms in communication among themselves

and with clients ensured the effectiveness of mHealth. Respondents indicated the use of WhatsApp as the main social media app utilized for communication among Healthcare Providers. WhatsApp groups facilitated communication among providers for effective mHealth services. It has a multi-media advantage with the ability to carry other message formats such as video and pictures. However, the use of any platform by providers depended on convenience, affordability, availability of the platform, and individual preferences and characteristics such as literacy level. The voice platform was used by providers because it facilitated quicker and faster communication. SMS had the advantage of reaching a wider audience and was noted by respondents the most efficient means of sending messages. The following are some statements supporting some of the views discussed above:

"We use all the platforms but I might say that the voice is often used because that is quicker, faster". (C2)

"…now it [WhatsApp] has moved into a different level where the text [WhatsApp) message has become like a video. You don't need to text the person but calling the person the person can see you and you can talk to them given direction". (A2)

Financial Facilitators concerned the funding support for mHealth activities from various sources. Continuous funding after implementation of mHealth was identified by respondents as a key facilitator for its viability. Respondents discussed the funding sources for their mHealth activities as emanating from Healthcare Providers (altruism and volunteerism), IGF, Telcos, and local government. They also suggested that even though the National Health

Insurance Scheme (NHIS) did not fund mHealth activities, it should be considered as an alternative funding source. It was also suggested that patients should pay for the services of mHealth services. Other respondents held the view that more sustainable funding should be sought as the current funding regime based on altruism and volunteerism were not feasible. Funding support from Telcos especially was suggested by respondents as needing serious exploration. Commenting on the need to explore other funding sources to ensure mHealth viability, the following statements were made:

"I think [Telcos engagement] that one should be a high-level engagement. The Ministry of Health should engage the Ministry of Telecommunication on that level and get some concessions for health even if for epidemic data, because it is a public good, and I don't think they would lose anything from doing that". (D9)

"No system can work on people's altruism. It doesn't work that way. Fine, a few people because of religion but it doesn't work that way. For sustainability, that aspect must be taken out" (D1D)

4.6 Focus Group Discussion

4.6.1 Respondents (Discussants) background characteristics

This section provides results of the biodata on respondents of the FGD. The key Background characteristics comprised age, gender, academic qualifications, marital status, and religion. The others were ethnicity, profession, mobile phone ownership, and type (analogue or smart). No respondent age fell within the age bracket of 20-29 years; however, two (2) respondents were

within the age range of 40-49 years; with the remaining three respondents spread equally within the age brackets of 30-39 years, 50-59 years and 60 years and above. Three (3) respondents (60%) were males and the remaining two (2) respondents (40%) were females. Four group respondents, representing eighty percent (80%), had work experience of more than ten (10) years with the remaining one (1) within Up-to 5 years' experience bracket. Concerning religion and ethnicity, all five (5) group discussants indicated being Christians and Akan respectively. Three (3) respondents indicated that they were married while two were single. Two (2) respondents were bachelor degree holders, one (1) Doctor of Philosophy, One (1) Postsecondary, and one (1) Diploma holder. All respondents were equally distributed among the five professions comprising one (1) Health Service Administrator, one (1) Health Planner, one

(1) Administrative Manager, one (1) Transport Manager, and one (1) Public Relations Officer. All participants owned smartphones. The following tables (4.7 and 4.8) below provide a summary of the background characteristics:

Table 4.7: Background characteristics of respondents- Biodata (FGD)

Characteristics			
Age	**No.**	**Work Experience**	**No.**
20-29	0	Up-to 5years 6-10	1
30-39	1	years	0
40-49	2	More than 10 years	4
50-59	1		
60+	1		
Gender	**No.**	**Religion**	**No.**
Male	3	Christianity	5
Female	2	Islam	0
		Traditional	0
		Other	0

Ethnicity	No.	Marital Status	No.
Akan	5	Married	3
Ga Dangme	0	Single	2
Ewe	0		
Guan	0		
Education	**No.**	**Profession**	**No.**
Postgraduate (PhD)	1	Health Services Administrator	1
Postgraduate (Masters)	0	Health Planner	1
Degree	2	Public Relations	1
Diploma	1	Transport Manager	1
Post-Secondary	1	Administrative Manager	1
Secondary/SSS Middle	0		
School	0		

Table 4.8: Background Characteristics-Phone ownership and type (FGD)

Phone Ownership	No.
Yes	**5**
No	0
Phone Type	**No.**
Smart	**5**
Analogue	0

Source: Researcher's fieldwork (2018)

4.6.2 Discussants' technological capabilities and level of digital literacy assessment

Results of the TC & DL show that all group respondents indicated the *ability to make a call, receive a call, text a message, and retrieve a message* under the Primary Digital Literacy level. The percentage score for technological capacity was therefore 100% for all sub-capacities. This was no different from the Secondary Digital literacy level which also reveals that all five (5) respondents indicated the ability to perform the technological functions of ability to use any mobile application such as social media and ability to operate

a social media account such as Twitter, Facebook, and others under Secondary level. concerning the Tertiary level, all five (5) respondents indicated awareness of other uses of the internet on mobile phones aside social media and the ability to conduct searches on the mobile phone. Both Secondary and Tertiary levels also had a percentage score of a hundred percent (100%) for technological capabilities and the entire technological capabilities and digital literacy for all three levels having a percentage average total score of a hundred percent (100%). The summary of the results is presented below in Table 4.9:

Table 4.9: Respondents' technological capabilities and digital literacy scores (FGD)

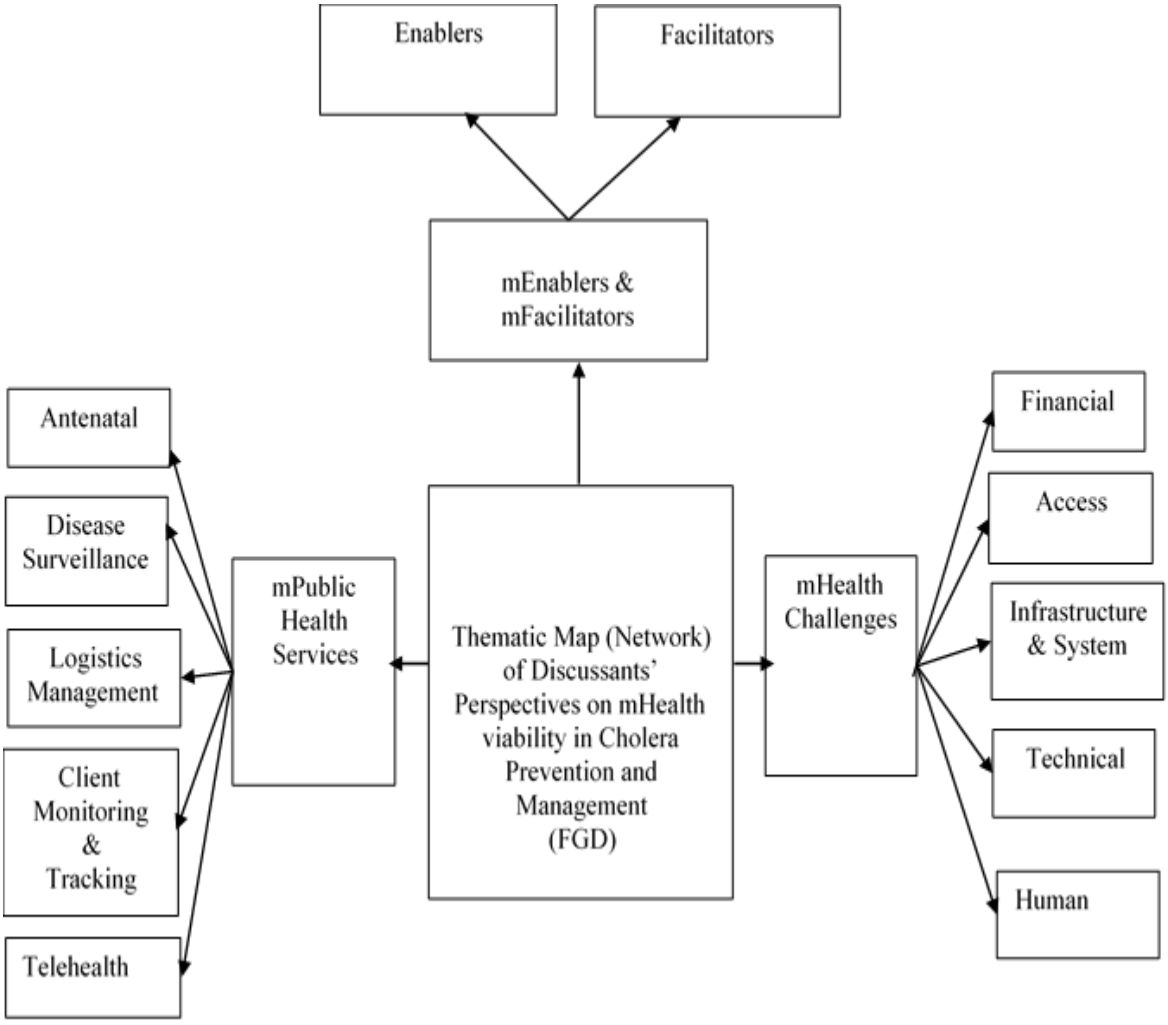
No.	TECHNOLOGICAL CAPABILITIES	LEVEL OF DIGITAL LITERACY	YES	NO	(%) SCORE FOR TECHNOLOGICAL CAPACITY
1	Ability to make a call		5	0	100
2	Ability to receive a call		5	0	100
3	Ability to text a message	PRIMARY	5	0	100
4	Ability to receive/retrieve a text message		5	0	100
5	Ability to use any mobile application such as social media	SECONDARY	5	0	100
6	Operating of social media account such as Twitter, Facebook, etc.		5	0	100
7	Awareness of other uses of the internet on mobile phone aside social media	TERTIARY	5	0	100
8	Ability to conduct searches on mobile phone		5	0	100
9	**% AVERAGE TOTAL SCORE**				**100**

Source: Researcher's Fieldwork (2018)

Overview of perspectives of focus group discussantsFigure 4.7 below provides a Thematic Network presentation of the themes and their related sub-themes that emerged during the FGDs. The themes covered all the objectives of the study as already mentioned. The subthemes that emerged under objective one (mPublic Health Services) were *Antenatal Services, Disease Surveillance, Logistics Management, Client Monitoring, Tracking,* and *Telehealth.*

The sub-themes for mHealth Challenges (Objective Two) were *Financial, Access, Infrastructure and System, Technical* and *Human Resources*. These sub-themes were arranged into an acronym termed 'FAITH' Challenges. Four Enablers and three Facilitators emerged under Objective Three. These themes are presented in Figure 4.7 below.

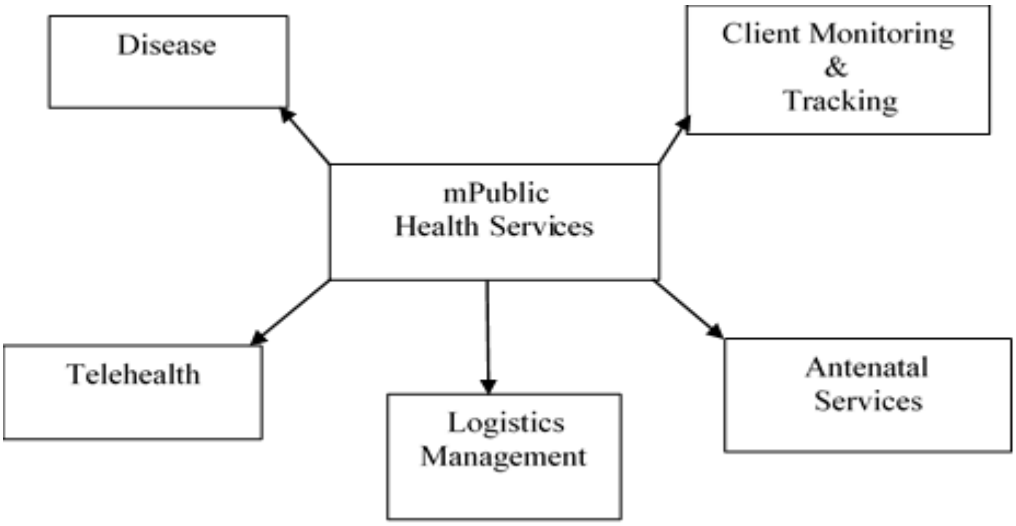
Figure 4.7: Thematic map of perspectives of FGD



4.7 Discussants' perspectives on public health services that are delivered through mobile phones

This session presents the collective views of focus group participants on public health services that are delivered via the mobile phone. These collective views were provided in response to questions asked on what their perspectives were on the mobile phone's role in delivering public health services. The themes that emerged from the discussion were *Antenatal Services, Disease Surveillance, Logistics Management, Client Monitoring and Tracking, and Telehealth*. These themes are presented diagrammatically in Figure 4.8 below:

Figure 4.8: Objective one: Thematic Network (FGD)



4.7.1 Antenatal Services

Antenatal services provided by Healthcare Providers through the mobile phone covered text message prompts to expectant mothers of the next appointment dates, nutrition advice, and general health promotion for pregnant mothers and unborn children. One participant states:

> "Those pregnant women the very first day they get to the hospital, they have to be registered and they will be put on the platform or added to the platform. And they get messages that prompt them that when they are due, they have to visit the antenatal care and the kind of food that they have to take. We also help them to improve on their health". (FGD3)

4.7.2 Mobile-based disease surveillance

Disease surveillance as a sub-theme mainly covered the collection of various health data with the help of the mobile phone. The diseases mentioned by discussants that they had experiential

knowledge of were Malaria, Tuberculosis, and HIV/AIDS. Diseases that were reported to be monitored with the help of the mobile phone were routine surveillance data of disease threats.

Potential epidemics were detected, reported, and tracked with the phone. Mobile digital platforms were used to collect transactional data on patients at the community level and reported on. The statement below typifies some of the disease surveillance activities performed with the aid of the mobile phone:

> "It has played some role in the sense that because of the mobile phone at least we have the various reporting officers who have been told that if there are some of these diseases that if you pick, you do not have to wait till the end of the week to be able to report weekly... immediately send a text...we have seen a suspected cholera case here so it alerts the headquarters of whatever is happening". (FGD1)

4.7.3 Logistics Management

Logistics management issues discussed covered the use of mobile phones to report stock-outs and monitor essential commodities availability, effective coordination of resources such as transport, protecting the integrity of the vaccine supply chain, mobilization of other health supplies, and staff to the field, especially during a cholera outbreak. A participant explains the role of the mobile phone in logistics management below:

> "We have been using or piloting for mobile health devices for service delivery especially in the area of logistics management where we use 'SMS for Life' which was basically to look into stock levels at the community level so that essential commodities that are meant for providing health services do not stock-out". (FGD2)

4.7.4 Client Monitoring and Tracking

This theme referred to Healthcare Providers' quest to ensure a continuum of care even after clients had been discharged or hospital treatment had been completed. It helped to ensure treatment adherence, regular clinic visits, and a higher treatment success rate. Chronic diseases such as TB, HIV/AIDS, and endemic ones such as malaria were mentioned as needing monitoring and tracking for the reasons already adduced above. The statement below by a discussant provides insight into the role of mobile phones in monitoring and tracking of health clients:

> "It tries to do whatever possible to ensure that we don't have defaulters. So, what they do is whatever means you can do to follow up the client to make sure that the client is on the right medication at all times and that brought in the idea of realizing that the mobile phone could be very helpful. (FGD1)

4.7.5 Telehealth

Telehealth emerged as another theme, of which the issues discussed by participants comprised tele-information sharing and tele-consulting among Healthcare Providers. Tele-information sharing referred to the sharing of health information (mostly urgent) on social media, SMS, and other platforms with Healthcare Providers, and the public such as friends, church members, media, others. Tele-consulting primarily involved Healthcare Providers consulting one another to seek opinions and discuss options for effective management of cases for optimal output. Commenting on tele-consulting among Healthcare Providers, the following statement was made by one discussant:

> "As service workers we share ideas among ourselves. So that whatever resources we are using to manage the care of the patients, we get optimal output from it. So, with the use of mobile hand-held devices, I can just call a colleague about a challenge or a situation that I am managing and try to share ideas with the person as to how best to solve it". (FGD2)

Also commenting on tele-information sharing, discussants remarked that it afforded quick information distribution, sharing of important health information and helped build mutual trust between health providers and patients as stated below:

> "We have an experience of this outbreak of cholera. As transport, the unit mostly was the first place to receive such information from the disease control unit...so they quickly send us information...to our WhatsApp platform and quickly we arrange...". (FGD5)

> "Anytime I receive health tips on my phone, I always send it across to my friends and the church too as well because I belong to an organization that they need to be educated" (FGD3)

4.8 Discussants' perspectives on challenges encountered with the use of mobile phones for cholera management

This session discusses participants' views on challenges encountered with the use of mobile phones. In all, five themes emerged consisting of *Financial, Access, Infrastructure and System,*

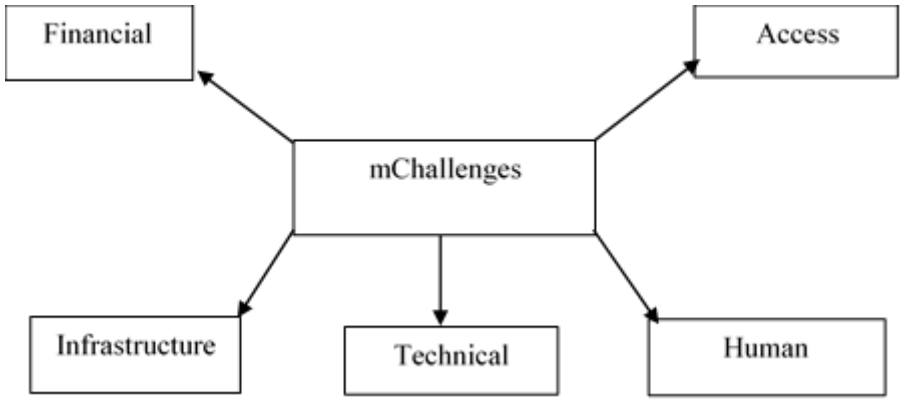
Technical, and Human resources challenges. To aid memory, these themes were arranged using the first letters of the five themes to form an acronym called 'FAITH' challenges. The acronym is illustrated in Table 4.10 below:

Table 4.10: FAITH Acronym

Financial	Access	Infrastructure & System	Technical	Human Resources
F	A	I	T	H

Figure 4.9 below provides a diagrammatic view of the FAITH themes.

Figure 4.9: Objective two- Thematic Network (FGD)



4.8.1 Financial challenges (Cost)

One theme identified by discussants as a challenge was *Financial cost*. This referred to all costs that constrained the viability of mHealth in cholera management and prevention. Some of the cost streams were incurred before the implementation of mHealth while others were after implementation. The main issue mentioned by participants was the cost of credit units for data, voice, and text. Participants expressed concern for the personal cost incurred in buying their credit units for official work. Participants indicated that they would hesitate to use their units for official purposes. There was an alternative view that the cost of communication units should be a shared responsibility. One participant supporting the need to support providers afford communication cost remarked in the statement below:

> "I have bought my data on my phone, when I like I call. When I prefer, I want to share or not share?" (FGD5)

Conversely, the same discussant also held an alternate view that it was in the interest of Healthcare Providers to buy their units to facilitate their work, without which they may not perform satisfactorily.

> "I buy my credit. People know me very well and for somebody to come and point out that I'm not performing, why don't I provide those things for me to perform. So, I bear the cost. So that's my solution". (FGD5)

4.8.2 Access challenges

One other theme that emerged in the discussion was Access challenges. Access covered mobile phone ownership and confidentiality which restrict access to only authorized persons. Participants expressed concern about the need to properly handle patients' data and health status. They discussed data capture, storage, and transmission and the general integrity of client information which called for restriction in access to such information. These issues were expressed by a respondent in the statement below:

> "There is also an element of confidentiality which is very important when it comes to health. Whom do I disclose my health status to and how is the data transferred through the mobile phone being captured and stored? Who at the

other end will have access to it? Security and confidentiality is very important". (FGD2)

Concerning Phone Ownership, participants mentioned the high rate of ownership among health staff as well as the ability to use them. They also discussed types of ownership such as government, project, and private. However, they drew attention to the fact that the ability to operate the phone did not necessarily translate into the ability to use it for health service delivery. There was a need to target mobile phones and leverage them as a tool for health service delivery. Participants, therefore, recommended a purposive decision to use mobile phones for healthcare delivery. Discussing the high phone ownership among health staff but sub-optimal use for mHealth and the need to leverage its use, the following statement was made:

"Mobile phone usage in general is high among health staff. Don't think we have any health staff who does not know how to use phone but coming to its use for service delivery that is where there is a challenge. There is more room to explore how we can leverage mobile hand-held use among health service staff". (FGD1)

4.8.3 Infrastructure and system challenges

Infrastructure and system challenges referred to the availability of these resources for smooth operations of mHealth. The lack or the inadequacy of them constrained the efficiency and effectiveness of mHealth. The main issue raised by participants bordered on Network Quality and Coverage. The key challenges discussed included internet availability and reliability even

though network availability was also mentioned. The following statements summarize some of the dimensions of network coverage:

> "Sometimes it's network issues when you want the thing to be timely...Yeah data. X Network [name hidden] is not really working at that side of the place... you can call but using the internet is not there.". (FGD4)

> "Information don't get to us early because of where we are and that can also pose a challenge to mobile phone users" (FGD3)

4.8.4 Technical challenges

Another theme that emerged under challenges was Technical. Participants expressed concern with the quality of some of the phones, battery power, and effects on operating longevity, power sources while on the field and others. A discussant explains the challenge as follows:

> "Let's start to look at the quality of type of phone we are going to use. Because for example the battery of the phone cannot last for three hours and you are on the field which you cannot have access to charge the phone. So, we should look at the quality of the phone as one of the challenges we can face". (FGD5)

4.8.5 Human resources challenges

The last challenge was Human Resources which covered people's lack of interest or failure to read messages sent to them, mistrust in accepting messages due to the challenge of fake and junk news, medico-legal issues, education, and implications for staff and health clients. The

failure to read messages was a concern particularly for social media which resulted in receivers failing to take necessary action or receive important information.

> "Challenges we've encountered by using this social media, especially WhatsApp is that, sometimes they don't read...then later you are inviting them for a programme. Let's say you send them reminders later. They will say 'really?', 'what programme?', 'where?'". (FGD4)

It was also reported that failure to read messages stemmed from lack of understanding due to 'ambiguities' in the message which made it difficult to understand and illiteracy.

> "The challenges in using the mobile phone is that ambiguity of words. Sometimes when you read some of the messages you don't really understand it so you tend to ignore it because you think it's not relevant to you". (FGD3)

Education referred to the need to disseminate relevant policy guidelines on mobile health on issues such as data collection, storage, analysis, and security of data. Education also referred to the need to sensitize staff and educate them on technical issues such as epidemic preparedness, response, and public health management. This education was irrespective of people's educational status in the field. A discussant's view is provided below:

> "We have the mobile hand-held devices policy which is supposed to guide how mobile health devices are used to collect data, analyze and security issues among others but it is not being properly disseminated". (FGD2)

> "It also depends on their level of education in the field...you might have PhD and the rest, but the area of epidemic response, preparedness and managing of public health, you might not know". (FGD2)

Another issue that emerged was Fake News. The threat of Fake News affected people's trust in Healthcare Providers' information to the public. This was much more so as the source of some of the messages were difficult to ascertain and the source unknown. This was exacerbated by the flurry of unverifiable information that is put out on social media, especially. Reliability and authentic source were key factors that reduced the concern of the Fake News phenomenon. The statements below summarize the foregoing:

> "Social media is one of the easiest platforms that people are using to share ideas, communicate...but when it comes to that too, we also talk about reliability of the information that is passed across because we have fear". (FGD2)

> "By sharing the information, it prevented speculation and some of them when they receive some messages that are not sent by you, they even call or they try to find out, is it from your outfit? (FGD4)

The medico-legal implications of mHealth were raised by discussants. One of them was the legal implications of patients experiencing adverse reactions from prescriptions sent via mobile

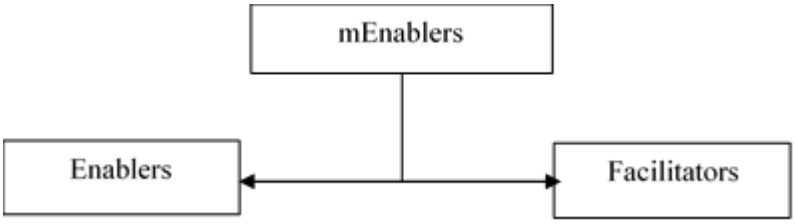
phones. Thus, the issue of ethics was raised and there was a recommendation that Healthcare Providers should be guided by the ethics that guide their various professions. It was stated:

> "Then another thing that comes to mind is the legal implications that come with using the hand-held devices in health care delivery. If for instance on telemedicine, a prescription that I received and then I used a particular type of drug and developed some particular allergies, what legal issues can I bring to the prescriber? Then also, there is the element of ethics. We know as service providers we have ethics that guide our profession. So, the use of mobile devices should go with the ethics that we have outlined for ourselves". (FGD2)

4.9 Discussants' perspectives on enablers and facilitators for a viable implementation of mHealth for cholera management

This session presents perspectives of discussants on factors that enable or facilitate the viability of mobile health in the prevention and management of cholera in GAR. They were asked to share their perspectives on what the health sector should put in place to ensure effective mHealth viability. Their answers were categorized into two (2) themes which were termed as mEnablers and mFacilitators. It was also found that some of the issues which emerged under mEnablers also appeared under mFacilitators but with different dimensions and focus. Figure 4.10 below provides a diagrammatic view of the Enablers and Facilitators.

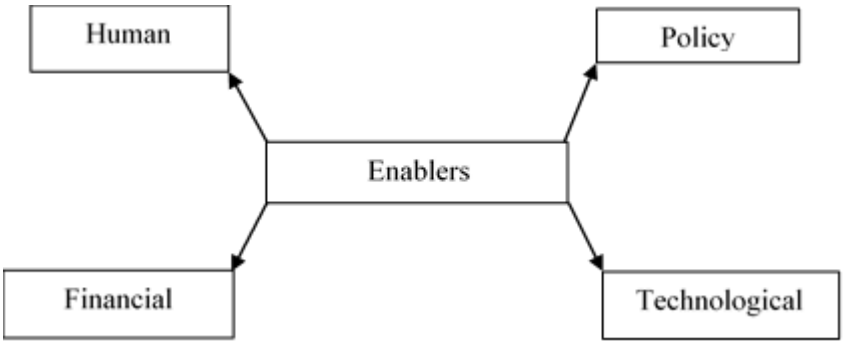
Figure 4.10: Objective three: Sub-thematic network (FGD)



4.9.1 Enablers

Four Enabling themes consisting of *Financial, Policy, Human, and Technological* emerged as depicted in the thematic network below.

Figure 4.11: Thematic network for mEnablers (FGD)



Participants discussed the need to budget for resources under Financial Enablers. They advised that mHealth managers should budget for equipment such as hand-held devices and communication costs for health staff.

> "In the area of cost, at least for now, we should also budget for it. I think that some of the programmes it's because we've not budgeted for such activities. we've assumed a lot.". (FGD1)

Under *Human Resource*s, participants suggested the need for training and education for users of mHealth in medico-legal and ethical issues on mobile health, building their capacity and resourcefulness, among others. They used words such as 'capacity building', 'resourcing' and 'educate' to describe the phenomenon. The need to enforce training was also stressed. Expressing this view, a discussant comments on the importance of education in the statement below:

> "So proper education and enforcement at the end of the user. It comes with capacity building. It comes with resourcing them...So this is also very essential…Then we need to also educate people on the legal framework...". (FGD2)

Policy formulation, review and dissemination on various issues such as the use of hand-held devices, handling of patient data, confidentiality, scoping of mHealth coverage, and ethics were discussed. The need for a legal framework governing mHealth and its ethics and norms were suggested. Discussing the need for a Policy, some discussants mentioned that it serves as a guide for mHealth-based management and security as well as implementation or enforcement as indicated in the following statements:

> "Even though there is a policy that is being reviewed, we have the mobile hand-held devices policy which is supposed to guide how mobile health devices are used to collect data, analyze and security issues among others...". (FGD2)

> "we need to develop a policy. In Ghana here when policies are developed, they are kept on shelves. And when we develop policies and they are kept on shelves, we don't get the full benefits of the policies" (FGD2)

It was also suggested that the policy framework should cover legal, ethics, scoping of mHealth package of services by functions and levels to be delivered. They state:

> "if we scope by levels and by functions then we will be able to do much more targeting in the use of hand-held mobile phone devices... we need to actually define which of the areas of cover that we want to use the mobile hand-held devices for". (FGD2)

Technological Enablers discussed by participants covered mobile phone adoption and use, network availability, indigenization of technological systems, and provision of logistics. Discussants mentioned that there was a high adoption of the mobile phone by Healthcare Providers. It was stated thus by one discussant:

> "Mobile phone usage in general is high among health staff. Don't think we have any health staff who does not know how to use phone…". (FGD2)

A discussant noted that there was no barrier for many people, even for illiterates, as nowadays the social media could carry video and audio. Even concerning text, there were Apps for

language translation. These different platforms and applications could be used to further improve the adoption and use of mobile phones. He states:

> "The social media can use audio, video then the text. In fact, there is nothing like a barrier to most people besides maybe those who are maybe physically handicapped in a way but if you consider let's say, people who are illiterates, you can translate almost everything into all languages. You can watch videos and you understand". (FGD1)

The provision of necessary resources for the effective functioning and operation of mHealth was suggested by discussants to include logistical inputs such as mobile handsets, hosting, web services and software. The following statements summarize the logistics inputs required to facilitate mHealth services:

> "By resources...the inputs that are required...mobile phone...software...hosting, web services... hand-held equipment...buying data". (FGD2)

> "...procure a lot of hand-held equipment for staff to use...buying data or providing the minimal amount of data to use." (FGD1)

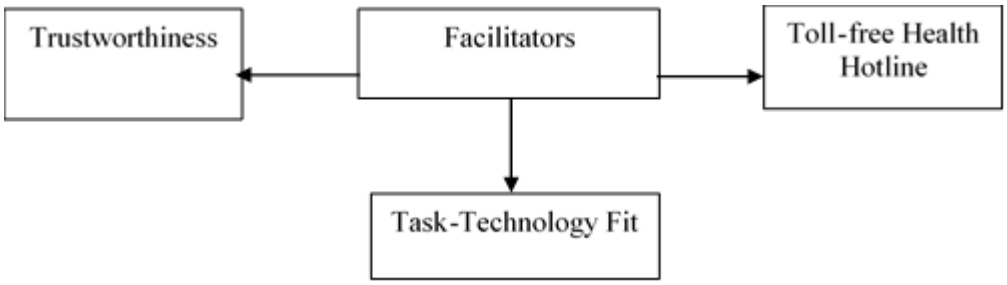
Discussants also called for the need to indigenize technological systems to fit into existing local systems. It was also suggested that there was a need to also employ local developers to develop software for the local systems as part of indigenization.

"We need to explore local developers for some of these systems. And I like it when we are using some of these local developers than the external or expatriates to come and develop these systems for us". (FGD2)

4.9.2 Facilitators

Three Facilitators emerged from the discussion comprising *Trustworthiness of Information, Toll-free Health Hotline,* and *Task-Technology Fit.* These were described as 3Ts of FGD Facilitators. These issues are presented diagrammatically in Figure 4.12 below:

Figure 4.12: Objective three: thematic network for mFacilitators (FGD)



Discussants argued that there was a need to remove all doubts about the authenticity of the origin of messages. The simplicity and easy-to-understand message also helped remove misunderstanding which may lead to mistrust. This required Public Relations (PR) professionals in the health sector reformulating the technical information received from technical divisions into *'a common man's language'* for public consumption. A discussant with such experiential knowledge stated:

"We collaborate with the public health; they give you the information and we try to put it in a way that everybody will understand...so you reach out to them rather than they speculating the wrong information". (FGD4)

The need for a Toll-free Hotline was suggested by discussants and noted to help in quick dissemination of information on cholera and offered the public the channel to also call in for information. Toll-free Centres were suggested for Ambulance Service and Hospitals. This was also to help overcome challenges with those using non-smartphones and would not be able to receive social media and other messages which could be accessed on only smartphones. A discussant comments on the foregoing as follows:

"For those who don't use the smartphones, who use analogue phones I think we should device a system whereby they could call like the way we call the telecommunication people for assistance...". (FGD4)

Task-Technology Fit (TTF) concerns the ease with which Healthcare Providers used the mobile phone to support their routine tasks and the productivity and utility it provided for them. Some of the productivities reported by discussants were a reduction in cost, helped to reach a larger population, enhances time efficiency and ensuring optimal output. Two discussants describe some of TTF's productivities as follows:

"how it fits into our work as health service personnel...operational efficiency...we get optimal output from it". (FGD2)

"...to cut down cost...reach a larger population ...saves time...getting everyone at the same time...". (FGD1)

4.10 Chapter Summary

This chapter presented the findings of the IDIs of forty (40) participants and a five-member FGD. Results were presented based on the three research objectives and then on themes that emerged under each of the objectives. Table 4.11 summarizes the various themes that emerged during the IDIs and FGD.

Table 4.11: Summary of themes (IDIs and FGD)

No.	Objective	Area of Focus	Themes (IDIs)	Themes (FGD)
1	One	Public Health Services through Mobile Phones	Data Collection, mLibrary and mLearning (Digital learning), Public Health Emergencies, Preventive and Promotive Services, Telehealth and Clinical Services.	Disease Surveillance, Logistics Management, Client Monitoring and Tracking and Telehealth.
2	Two	Encountered Challenges by Using Mobile Phones	Management and Leadership, Financial, Access, Infrastructure and System, Technical, and Human resources	Financial, Access, Infrastructure and System, Technical, and Human resources
3	Three	Enablers and Facilitators ensuring mHealth viability	Financial, Policy, Human, and Technological	Trustworthiness of Information, Toll-free Health Hotline and Task-Technology Fit

As presented in Table 4.11 above, there were six (6) IDI themes and four (4) FGD themes that emerged under objective one, six (6) IDI themes and five (5) FGD themes under objective two and four (4) IDI themes and three (3) FGD emerged under objective three. The next chapter discusses the meaning and implications of the results.

CHAPTER FIVE

5.0 DISCUSSION OF FINDINGS

5.1 Chapter Introduction

The preceding chapter presented the results and analysis of the fieldwork. This chapter covers the objectives of the study, a summary of the key findings, and provides a critique of the implication and importance to similar studies. It also presents the limitations of the study, contribution to knowledge, and finally suggests areas for further research.

5.2 Objectives of the Study

The study objectives were three. The first was to identify public health services that are delivered through mobile phones to prevent and manage cholera in the GAR. The second was to explore challenges encountered with the use of mobile phones which may affect the effective implementation of mHealth for cholera management in the GAR. The third was to explore options (enablers/facilitators) for a viable implementation of mHealth for cholera management. Questions were asked participants alongside these objectives.

5.3 Summary of key findings of study

5.3.1 Findings of respondents' biodata (Summary)

A total of 40 IDI participants and 5 FGD discussants were recruited to provide perspectives on the research questions. These IDI respondents represented twenty-one (21) professions with majority profession being Public Health Doctors and FGD discussants were from five (5) professions. The topmost age bracket for IDI respondents was 50-59 years with thirteen (13) respondents and 60+ years being the least with one (1) respondent. Approximately 73% of respondents were males and 100% of all respondents indicated that they were Christians.

Twenty-nine (29) out of 40 respondents (IDI) were married. Eighty-four (84%) percent of IDI respondents and 60% of FGD had a bachelor's degree and above. All 40 IDI respondents and 5

FGD discussants owned mobile phones with 95% (IDI respondents) and 100% (FGD discussants) using smartphones.

5.3.2 Summary of key findings for in-depth interviews

Six themes emerged under objective one, which covered Data Collection, mLibrary, and mLearning (Digital learning), Public Health Emergencies, Preventive and Promotive Health Services, Telehealth and Management, and Logistics. Six thematic challenges emerged under objective two which was structured into an acronym called 'MFAITH'. These were Management and Leadership, Financial, Access, Infrastructure and System, Technical, and Human resources challenges. Seven Enabling themes emerged under objective three which comprised Financial, Human, and Belief in mHealth, Policy, Stakeholders, Sustainability, and Technological. The Facilitators which emerged under objective three were Institutional, Communication and Financial.

5.3.3 Summary of key findings for FGDs

Five themes emerged under objective one, which covered Antenatal Services, Disease Surveillance, Logistics Management, Client Monitoring and Tracking, and Telehealth. Five themes emerged under objective two comprising Financial, Access, Infrastructure and System, Technical, and Human resources challenges. Under objective three, four Enablers consisting of Financial, Policy, Human, and Technological emerged. Three Facilitators comprising Trustworthiness of Information, Toll-free Health Hotline, and Task-Technology Fit also emerged under objective three.

5.4 Discussion of findings

5.4.1 Public health services delivered with mobile phones for cholera prevention and

management

Portions of literature report the use of mobile phones for data which includes data collection and reporting, analysis and feedback for various health activities and diseases. Collection of data and reporting with the mobile phone included spatio-temporal data of population movement and infectious diseases such as cholera during earthquake disasters and Hajj pilgrimage in Haiti and Senegal respectively (Bengtsson, et al., 2015; Overney, 2016); and facilitating disease surveillance and reporting of cholera outbreak and control in Cameroon (Ngwa, et al., 2016). Mobile operator data is posited as a likely data source for improving cholera preparedness and response efforts during cholera outbreaks as it is suggested to be a good predictor. Mobile phones were also successfully used for the collection of data and reporting of other diseases such as Ebola, Influenza, Syphilis, and Filariasis (Adokiya & Awoonor-Williams, 2016; Dassah, Adu-Sarkodie, & Mayaud, 2016; Issah, et al., 2015; Vroom, 2017). Data collection in the literature mostly covered the exploration of the use of mobile phones to collect disease surveillance data, particularly infectious ones. The use of mobile phones to collect data was reported as quite easy for Healthcare Providers who even did not have prior knowledge in the use of smartphones (Diwan, Agnihotri, & Hulth, 2015). Some of the benefits of mobile phone-based data collection and disease surveillance were reported as effective case detection, and accuracy in analysis, increase rate and timeliness of reporting, among others (see Pascoe, Lungo, Kaasboll & Koleleni, 2012; Mwabukusi, Karimuribo, Rweyemamu & Beda, 2014; Yang, Yang, Luo & Gong, 2009).

These findings are similar to that of the study as Healthcare Providers use the mobile phone to undertake data collection of health activities including disease surveillance as was reported by discussants in the FGD. Both IDI participants and FGD discussants indicated the use of the

mobile phone for data collection in health interventions not only in cholera prevention and management but others such as disease surveillance, immunization, Adolescent Health, Maternal and Child Health. Healthcare Providers use mobile phones to collect and report on cholera threats when identified by them on the field or primary healthcare clinics that offered public health services. The departing line was that the study reveals Healthcare Providers mostly undertook such data collection as part of routine work rather than as specially established mHealth project contrary to much of the literature which similar findings were evaluations of formal mHealth projects, some having control groups (see Chi & Stringer, 2010; Lester et al., 2010). Supervisors also demanded the submission of routine public health reports and staff activities from the lower health facilities through the mobile phone to help facilitate easy and quick reporting.

Senyo (2015) Leon, Schneider & Daviaud (2012) report the use of the mobile phone for mLibrary and mLearning respectively. While Senyo discusses the use of medical Apps on mobile phones for clinical decision-making by junior doctors in the GAR; Leon, Schneider, & Daviaud (2012) report opportunities for distance education for Community Health Workers (CHWs) in community-based health services delivery. CHWs were offered distant education which was evaluated through distance quizzes. Continuing training was conducted through regular electronic updates and access to reference material by CHWs on their phones which offered opportunities for self-improvement. The findings of this study support extant literature as respondents in the IDIs also report that increasingly they use their mobile phones for mlibrary and mlearning. These were either pre-installed if mobile phones were provided for a mobile health project. Healthcare workers also indicated that they referred to various online resources available on the internet on their private phones whenever necessary to support their work on

the field or when encountering any health challenges such as cholera. However, respondents in the IDI further reported that their managers installed or created mlearning platforms for which they could study and take quizzes towards continuing professional education which could help them achieve professional points for promotional purposes. Managers with mHealth experience also reported that Healthcare Providers who were particularly involved in mHealth projects had their phones installed with religious, social and physical education materials to help support rural Healthcare Providers' knowledge and wellbeing. One motive was to help motivate them to stay in a rural setting and avoid boredom. This revelation of mLearning may be useful for designing mobile health projects and activities on an expanded scale aimed at increasing access to rural healthcare services for cholera management and prevention.

Using the mobile phone for managing health emergencies have been reported variously such as being used to report the threat of infectious diseases during earthquakes in China (Yang, Yang, Luo, & Gong, 2009), monitoring threat of cholera for Islamic pilgrimage in Senegal, use of emergency toll-free telephone services (WHO, 2011), helped in an early response to cholera in Haiti (Bengtsson, et al., 2015), among others. Results (findings) of this study also reveal the use of the mobile phone in the management of emergencies in cholera management. The key reported use of mobile phones in emergency management of cholera was in the areas of management of referrals during such emergencies and Healthcare Providers' interactions with affected public through health hotlines. As suggested by Yang et al. (2009), mobile phones were useful in the management of emergencies, especially reporting. Even though Yang et al.'s study concerns the reporting of general infectious diseases, it is relevant for this study as cholera is classified in the same category. Even though respondents also mention the use of mobile phones to report cholera cases, they also outline a planning framework for an effective mobile phone-

based epidemic management of cholera. According to these respondents, much of the emergency services delivered through the mobile phone consists of the provision of health information to the affected community and the general population. This helps them to take preventive measures and empower them in self-prevention (home management) of cholera and the sharing of health data and information among Healthcare Providers on the epidemiology of the disease.

This study also has a unique finding which is in the use of the mobile phone to support general administration, planning, and management and support services such as health logistics aimed at effective management of cholera. Effective management of an epidemic, especially cholera, requires pre-planning and effective staff coordination and administrative efficiency and efficient logistics management. Supervising Healthcare Providers at the district level used the mobile phone to conduct remote monitoring, coordination and supervision of staff activities, assignment of schedules, and organizing for logistics for delivery of health activities towards effective disease surveillance and management. This was aimed at effective management and prevention of cholera and other infectious diseases. Monitoring and supervision on the mobile phone aided quick dissemination and sharing of information, tracking health staff, ensuring productivity and green administration as there was a reduction in paper usage in reporting and help address early warnings, among others. These were done as part of routine work involving the use of the mobile phone whether they were Healthcare Providers' own private or official phones. It was observed that the high adoption and use of mobile phones among Healthcare Providers contributed to this work ethos.

Literature suggests that three key communication platforms used comprised SMS, Voice and Social Media, with SMS being the default platform due to its ease of use, efficacy, universality,

cost, and popularity (Belzer, 2013; Lim, Hocking, Hellard, & Aitken, 2008; Gleason, 2015). Literature posits that despite the efficacy of SMS in mHealth, it works under a set of enablers such as rate of frequency of texts sent, personalization of messages, wording, and content (Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). The use of SMS in mHealth however were in the areas such as behaviour communication change (Orr & King, 2015). WHO conducted a study in the efficacy of sending mHealth messages to participants through SMS to help enhance healthy behaviour. It was noted that while the impact was moderate, there exists potential health benefits for the population. Other SMS studies were on HIV/AIDS patients' adherence and uptake of Anti-Retroviral Therapy [ART] (Chi & Stringer, 2010; Lester & Karanja, 2008) and Treatment Adherence through SMS reminders by Kenyan Health Workers (KHWs) (Zurovac, et al., 2011) and others. The studies generally report a favourable impact on public health outcomes with some limitations.

This study also confirms the use of these three key communication platforms. Healthcare Providers used these platforms to communicate among themselves and with clients. Even though SMS was still prevalent and a default platform for communication, the study finds that social media, particularly the use of WhatsApp is even more prevalent among Healthcare Providers. The reason for this trend might stem from the fact that most of the studies were undertaken much earlier when social media Apps had not yet been developed or become prevalent and the growth of smartphones and their high adoption by Healthcare Providers as evidenced in the TC & DL Assessment results. WhatsApp also offers a multiplatform which allows digital texting, an unlimited number of characters, multimedia such as pictures, videos and others. It also had the advantage of group communication and real-time interaction. The study reveals that Healthcare Providers had formed various WhatsApp groups based on levels

of healthcare, professional affiliations, facility, and others which helped them to share quick information on cholera and other activities. Supervisors created WhatsApp groups of district staff, hospital staff and others to aid supervision and coordination of activities and emergency management of cholera. The study identified different types of communication models enabled by the three platforms mentioned. These were based on the direction of Healthcare Providers' communication interactions. They were one-to-one, one-to-many, many-to-one, and many-tomany communication models enabled by the different platforms which are used in various combinations. These were further classified into horizontal and vertical communication (refer to Table 4.5, section 4.3.6 for details).

5.4.2 Explore challenges encountered with the use of mobile phones for health services

Empirical literature mentions the challenges of access to wireless telecommunication infrastructure development. Even though it posits that this infrastructure has seen growth, there exist access gaps particularly for data in rural and poor settings of the world in LMICs (Hunting, et al., 2015; ITU, 2013; Leon, Schneider, & Daviaud, 2012; Mtema, 2013). Wireless communication infrastructure is crucial for uptake of mHealth services (Mechael, et al., 2010) and their non-availability also affects mobile health. The findings of this study generally reveal the opposite. Respondents acknowledged that there exist pockets of wireless infrastructure challenges that affect mHealth services particularly data; there was consensus that the study area generally had the good infrastructure for voice and data communication. The challenges with infrastructure were reported to be in parts of the rural setting but generally not a major constraining factor for uptake of mHealth services. The reason for this finding might be because the study sites are in the GAR which is the capital region of Ghana

and has appreciable wireless infrastructure development even for peripheral communities. It is also generally a low-lying region with regards to topography which facilitates wireless communication.

One key challenge with mobile phone adoption from the literature concerns language. The multiplicity of languages within countries is suggested as a key challenge to the delivery of mHealth services via the mobile phone. It affects the distribution of a standard set of information to target populations (Skaria, 2013). Literature suggests that even though few languages have become international languages such as English, French and Spanish, populations still prefer communicating in their local language instead of an adopted language which may not be their mother-tongue (Bigna, Plottel, Kouanfack, & Koula-Shiro, 2014; Brian & Ben-Zeev, 2014). The challenge of multiple languages is suggested to constrain effective design and implementation of mHealth interventions and affects the ability to reach all targeted population, especially rural setting. It also has implications for n of messages, trust, and cost (Leon, Schneider, & Daviaud, 2012; Mechael, et al., 2010; Medhanyie, et al., 2015). Mechael et al. (2010) suggest that the implication is that there is the need for a more complex and tailored messaging system targeted at individual clients and the language challenge must be considered in mHealth design, especially during mHealth scale-up programmes (Awoonor-Williams, et al., 2012; Mechael, et al., 2010).

The study also noted that language was a challenge for delivering of mHealth services. The challenge of the multiplicity of languages was identified to be an issue only when Healthcare Providers were communicating with clients or the general population but not among themselves as they normally communicate with the official language of English. The challenge of multiple

languages was linked to illiteracy of some of the clients which affected their ability to read and write in the official language of English. This presents a challenge for Healthcare Providers with having the ability to speak multiple languages and had implications for formulating mHealth messages in various local languages. This was a challenge particularly in the rural and peripheral settings and experienced more by first-line Healthcare Providers. The study also finds that despite the challenge of multiple language communication, the ability of most clients and Healthcare Providers to speak the Twi (Akan) dialect which is a common local language moderated the magnitude of the challenge and reduced the need to learn various languages. It was stated by a respondent that:

> *"Fortunately, almost everybody can speak Twi even the Gas can speak Twi...". (D2).*

Another dimension of the challenge of illiteracy according to the empirical literature concerns the uneducated (without formal education). Two types of illiteracy (actual) and digital are suggested by the literature. Actual illiteracy refers to those without formal education, while digital illiteracy refers to those that cannot understand and manipulate technological products (Khatuna, Heywood, Ray, Bhuiya, & Liaw, 2016). The younger population has been suggested to be more digitally savvy. According to Prensky (2001), digital literates are described as 'digital natives' and digital illiterates are 'digital immigrants'. Digital immigrants are said to speak the digital language with a 'foreign accent' and with a deeper 'accent' corresponding to the level of illiteracy. This, therefore, presents two digital divides that have implications for mHealth adoption and delivery of services. Illiteracy (actual and digital) is suggested to constrain SMS communication, affects adoption and use of mHealth services (Dicianno, et al., 2015; Mechael, et al., 2010). It is also suggested to affect

individuals' capability to operate and use the intricate functions of the mobile phone, particularly smartphones (GSMA Intelligence, 2016). A study by Senyo (2015) on the use of medical mobile Apps among junior doctors in the GAR reveals that they were willing to use these Apps on the smartphone which also had universal ownership among the group. It was reported that the majority of these Healthcare Providers considered themselves to have a moderate to a high level of digital capability with a high prevalence of smartphone apps used for clinical decision-making.

The findings of the study generally support the literature by revealing that Healthcare Providers were well educated and had the high digital capability. The educational background of respondents shows that 82.5% of Healthcare Providers (IDI) and 60% of discussants (FGD) responded that they had a minimum of a bachelor's degree with none being illiterate. The technological capabilities and digital literacy assessment test also reveal a high score with a total average score of 97.5% (IDI) and 100% (FGD). Thus, both types of illiteracy suggested by the literature did not appear to be a major issue in the study. This might be due to the facts adduced above and that most illiteracy challenges suggested in the empirical literature concerning studies of the population's illiteracy challenges for which this study did not focus on but rather on the provider-side of the mHealth chain. Even though Senyo's work surveyed only junior doctors, this study interviewed not only doctors but other healthcare workers. However, the findings on technological capabilities and level of digital literacy are similar in that both studies indicate high digital literacy among Healthcare Providers in general and universal adoption of the smartphone. Despite the high level of digital literacy, this study found that younger Healthcare Providers were seen as more digitally savvy than older colleagues as suggested by the findings of Prensky (2001) and Senyo (2015).

Related to the above is human physical limitation and effect on mobile phone adoption and use which is suggested by literature to include age-related challenges in areas such as slowing motor, cognitive and sensory reflexes, among others. These factors were identified as barriers to mHealth adoption by the elderly demography who are said to be less skillful in the use of technology compared to other younger people (Chi-Ping, 2015; Fletcher & Jensen, 2015). Literature suggests a generational gap to the disadvantage of the elderly in the use of social networking sites (Sippl, Imminger, Geissel, Bohm, & Isemann, 2017), and that age affects the functionality of a person. Older users of technology are said to encounter more challenges in utilizing intricate IT, which affects their ability to adopt new technologies (Mallenius, Rossi, & Tuunainen, 2007). Mohadis & Ali (2014) posit that physical functionality challenges and lack of interest in using high-end technology are some reasons determining the elderly's preferences for specific types of phones (feature and smartphones) and phone functionalities (SMS, multimedia, etc). This study did not encounter any such age-related findings apart from the distinction that the younger Healthcare Providers were more technology savvy to older colleagues; however, the technological capabilities and level of digital literacy show a high level of digital capability among Healthcare Providers in general. There was no finding of physical limitations among Healthcare Providers as affecting their adoption of mobile technology for delivering health services. This might be because this study focuses on provider-side with more than half of respondents for both IDI (24) and FGD (3) indicating an age less than 50 years; while much of the literature focuses on demand-side where participants were specifically the elderly or older population being studied.

It is suggested by a section of the empirical literature that the healthcare sector is relatively slow in adopting technological innovation including mobile phones as a result of concerns for privacy, safety, malpractice, ethics, the complexity of the process, risk and conservativeness

of Healthcare Providers (Christensen & Dahlia, 2009; Poon, et al., 2006; Aslani & Naaranoja, 2013; Quarshie, 2016). Healthcare is said to be evidence-based which requires a scientific basis for adopting any innovation. Even where evidence is shown elsewhere there is still a challenge of acceptance for replication elsewhere. Healthcare organizations' slow adoption of technology is attributed to their lack of entrepreneurial culture and unclear financial benefits to the huge cost to be incurred (Omachonu & Einspruch, 2010; Ostrovsky & Barnett, 2014; Poon, et al., 2006). The findings of this study are not consistent with the literature in that it found that there is high adoption and actual use of mobile phone technology among Healthcare Providers as already revealed in the number of smartphone ownership and use of it for service delivery. This might be due to the high adoption of mobile phones among the general population and the fact that considerable time has elapsed since some of the earlier findings.

Security, safety and privacy are identified as key challenges that limit Healthcare Providers' willingness to adopt the mobile phone for health services. Breach of these inter-twined factors may compromise provider and patient safety, with its medico-legal issues. There is therefore the responsibility of providers to protect clinical records and data to help engender trust which is important in a provider-client relationships (Isabel, Nunes, & Simões-Marques, 2015; Khatuna, Heywood, Ray, Bhuiya, & Liaw, 2016). Security, safety, and privacy have been posited as key mHealth challenges that should be considered in the adoption and use of mobile phones as they affect confidentialities in mHealth (Christensen & Dahlia, 2009; Vallespin, Cornet, & Kotzeva, 2016; Vodafone Global Enterprise, 2013). It has been posited that mobile phone-sharing which is still reported as existing in parts of rural Ghana (Awoonor-Williams, et al., 2012) affects privacy and security, leading to confidentiality problems (Kaplan, 2006).

These findings are consistent with the literature in that it also found that Healthcare Providers were concerned with privacy and security issues arising from illegal or unauthorized access to mobile phones, whether official or private ones. Their key concerns of breaches of privacy and confidentiality were in phone thefts, misplacement, left unattended to, and sharing of phones with unauthorized people. Respondents were concerned not only for breaches of clients' records but also for Healthcare Providers' data and safety. They also acknowledged that such breaches cause a serious breach of trust between providers and clients which could expose the former to legal suits. They also made similar suggestions that the security of data should be taken seriously by all Healthcare Providers. One other finding is the threat of fake (junk) news and its effect on both Healthcare Providers' and clients' trust of mHealth services. This phenomenon is worsened by social media which is a source of unverified messages and claims. However, one departing point from the existing literature's view is that privacy and confidentiality of patients' data may not be protectable during emergencies such as in cholera management as information needs to be passed on to others for quick action and saving of lives which could result in inadvertent breaches of confidentiality.

Culture was reported by a limited section of literature as being a limitation to mHealth. Reported cultural factors included belief systems of some societies and female gender access to mobile phones. Limitations of female access to mobile phones have been noted as a key constraint in access to mHealth interventions because mobile phones were controlled by their male partners. This has implications for mHealth design aimed at improving male partners' involved in the mHealth programme (Awoonor-Williams, et al., 2012; Leon, Schneider, & Daviaud, 2012). Skaria (2013) posits that mHealth design and implementation is more complex in a culturally diverse population and therefore it is important to take into

consideration the cultural context in developing mHealth interventions, especially in LMICs (Mechael, et al., 2010).

Even though biodata of respondents revealed four different ethnic affiliations and one religion (Christianity), the study did not find any gender-related challenges with mHealth provision among Healthcare Providers as findings show there are high adoption and use of mobile phones. This is because the study focused on perspectives of provider-side only to the exclusion of demand-side which concerns the general population. However, socio-cultural issues raised by Healthcare Providers concerned clients' attitudes and mentally-ingrained habits affecting demand for mHealth services. Providers expressed concern with clients' preference for face-to-face interactions to consume services rather than consumptions of services through the mobile phone. Providers still had a strong affinity for paper-based mHealth activities despite the ability to perform them on the mobile phone. These were described as 'mental models' by Healthcare Providers which were attitudinal rather than an established societal norm enforced on individuals.

Empirical works on cost as a barrier to mobile health are quite significant (The PLOS Medicine Editors, 2013; Fletcher & Jensen, 2015). Most mHealth costs are picked up by project financiers and therefore disguise the actual cost of scale-up and eventual affordability. Thus, the affordability of mHealth is not conclusive (Aranda-Jan, Mohutsiwa-Dibe, & Loukanova, 2014). Several studies have however reported that SMS-based mHealth interventions have been cost-effective (Orr & King, 2015; Rodrigues, Bogg, Shet, Kumar, & Costa, 2014), while others posit that it is not cost-effective and presents a key barrier to mHealth adoption (Fletcher & Jensen, 2015; Katz, Mesfin, & Barr, 2012). It is suggested that SMS is relatively inexpensive; however, the cost of infrastructure presents a financial

challenge in utilizing this technology (Poon, et al., 2006; Senyo, 2015). Financial challenges affect mHealth sustainability and scalability (Leon, Schneider, & Daviaud, 2012). The cost of mHealth is borne by all stakeholders of mHealth such as Healthcare Providers, users, donors, and Telcos, among others (Tamrat & Kachnowski, 2012). Financial incentives for the provision of mobile handsets, phone credits and per diem for mHealth activities have been suggested (Gibson, et al., 2017; Xeuatvongsa, et al., 2016).

Findings of this study support previous literature on financial challenges (cost) of mHealth albeit with some extra dimensions. The costs identified in the study generally confirm that of literature but with more in-depth results. This study attempts to improve on analyzing mHealth costs by providing a framework for a better understanding of mHealth cost structure by categorizing all costs into upstream and downstream costs to aid ease of understanding and analysis; with upstream costs being all initial cost outlay while downstream costs emerge after mHealth implementation to ensure its continuity in operations, maintenance and sustenance. Findings on upstream costs included the cost of applications and software, infrastructure, and mobile phone handsets. Application costs were further identified as consultancy fees, Apps development including updates, licensing, security and support. The cost of acquiring mobile phone handset was similarly identified by the study as a key upstream communication input cost for effective mHealth management of cholera.

One finding of the study from Policy-makers and top leadership concerns the daunting cost of acquiring official mobile handsets for all healthcare workers while lower-level Healthcare Providers suggested that there was the need for such phones to be purchased for them for the sole use for mHealth activities. Senior-level healthcare managers recommended that Healthcare Providers should use their private phones for mHealth activities. Related to this

issue is the management of phones for delivery of mHealth services. One finding of the study which the empirical literature seems not to have focused on is the burden of managing the large deployment of official mobile phones for mobile health and its concomitant effect of maintenance and replacement costs. Despite the concern of the daunting cost of mHealth expressed by the literature, the study found that Healthcare Providers, especially policy managers and top leadership were of the view that it was relatively not herculean and that health managers just needed to budget for the cost of mHealth services to enable arrangements for funding by the various stakeholders comprising central government, donors, local government and from IGF of health facilities.

Existing literature expresses concern on interoperability which is different IT infrastructure and systems which fail to communicate with one another. It is important for digital integration and helps reduce the overall cost of mHealth operations (Gleason, 2015; Tomlinson, Rotheram-Borus, Swartz, & Tsai, 2013). Lack of interoperability is a key technological challenge that is worsened by the proliferation of different IT systems and standards (The PLOS Medicine Editors, 2013). The challenge of interoperability is also attributed to the substantial donor-funding of mHealth interventions which is described by a section of literature as 'Pilotitis' which refers to the numerous mHealth pilot projects that fail to go beyond scale (Shuchman, 2014). Pilotitis has been posited to be a barrier to the potential growth of mHealth and constrains its universal implementation which further worsens the quest for interoperability (Gleason, 2015). The findings of this study are consistent with the literature in that respondents expressed concern on the numerous mobile health projects in the region with various funding sources but have failed to go beyond the scale. They indicated that in part it was a waste of resources and nothing but an academic exercise. Notwithstanding this view, some policy managers were also of the view that it was necessary to serve as

learning points for effective scale-up. A new term, 'Projectitis' was coined in addition to that of the literature which is 'Pilotitis', to describe the mHealth proliferation phenomenon as findings of the study reveal the implementation of several mHealth projects by different financiers which have wound-up or are on-going but failed to go beyond scale-up. Similar to the findings of existing literature, this study also found that Projectitis-Pilotitis syndrome was caused by over-reliance on foreign donor support for mHealth activities with little coordination from the top, leading to disregard for country peculiarities and misalignment with national needs and objectives. To help resolve some of the challenges of ProjectitisPilotitis leading to interoperability concerns, similar recommendations made by the literature were also provided by respondents to the effect that governments should aim at improving the regulatory environment for mHealth which will also help overcome the medico-legal challenges of security and privacy breaches. The study however found that most of the respondents, particularly those at the lower level were not aware of existing regulations and guidelines on eHealth in general and mHealth in particular. A key finding was that despite the existence of some policy direction on eHealth and telemedicine, there was no clear-cut policy on mHealth. Apart from formal mHealth projects which had some structure and form until their expiration, the study found that mHealth implementation is essentially informal and unstructured. This has implications for the effective management of cholera as mHealth activities may only be triggered during the threat of cholera.

5.4.3 Enablers and Facilitators for a viable implementation of mHealth

Empirical literature suggests various factors that facilitate mHealth services which include training and education for providers and users, the need for a supportive policy environment, evidence of mHealth efficacy and cost-effectiveness, interoperability improvement,

smartphone penetration, among others (Akter & Ray, 2010; Leon, Schneider, & Daviaud, 2012; Mechael, et al., 2010; Senyo, 2015). Study findings are also consistent with the recommendations by the existing literature concerning facilitators of mHealth. The study also identified some factors that serve as facilitators for mHealth. However, it went further to categorize the factors that support mHealth growth into enablers and facilitators. Enablers were identified to include all upstream factors that must be present before mHealth implementation while facilitators consisted of all downstream factors that must be available after implementation of mHealth activities. Enablers ensure a successful initial implementation while facilitators ensure the continuous implementation and sustainability of mHealth. This classification is the result of an abstracted number of individual factors into broad themes that tend to subsume some of the factors reported by the literature. This is envisaged to form a framework to aid a more holistic analysis of the various factors supporting the growth and effectiveness of mHealth at the strategic level. It was however noted that some factors that support mHealth success served as enablers as well as facilitators.

Table 5.1 below provides a framework for mHealth Enablers and Facilitators from the study.

Table 5.1: Framework for Enablers and Facilitators of mHealth

No.	**mHealth Enablers** **(IDI & FGD)**	**mHealth Facilitators** **(IDI & FGD)**
1	Financial	Financial
2	Policy	Communication
3	Human Resources	Institutional
4	Technological	Trustworthiness of Information
5	Stakeholders	Task-Technology Fit
6	Belief in mHealth	Toll-free Health Hotline
7	Sustainability	

Findings from the study confirm the call by Akter & Ray (2010) for a supportive policy environment. The need for an overarching policy framework to be established and disseminated to guide mHealth operations and give direction was made by respondents. The study finds that policies and regulatory documents exist such as eHealth policy, eHealth strategy, ICT Policy, and telemedicine policy, but that for mHealth is virtually non-existent apart from the mention of a hand-held device guideline which is to help Healthcare Providers on the safe use of the mobile phone.

5.5 The relevance of findings to the theoretical literature

This section explores the meaning and relevance of the study's findings concerning the theoretical literature. This study was conducted on the Technology Acceptance Model (TAM1) and Task-Technology Fit (TTF) theories.

TAM attempts to predict the factors that contribute to people's and organizations' adoption of technology and how the adoption enhances productivity (Bianchi & de Figueiredo, 2017). TAM suggests that people do not undertake a venture or use a resource for its own sake but usually have the intended motive driving them. Hu et al. (1999) suggest that an unutilized or underutilized technology may not be effective despite its advantages and utility it offers. Thus, user acceptance and use of the technology is posited as important factors in the adoption of technology. TAM has been tested in various fields to ascertain how cultural and social settings, gender differences, religion, and profession influence people's technological acceptance and use.

This study is generally consistent with the theoretical literature. Mobile phone technology is widely accepted and being used for health provision by Healthcare Providers. The study

shows that respondents' (IDI and FGD) ownership of a mobile phone was 100% and smartphone usage was also 95% for IDI respondents and 100% for FGD discussants. This reveals a high level of mobile phone acceptance by Healthcare Providers as the technology's adoption is determined by the level of its ownership. From the work of Prensky (2001), Healthcare Providers can be described as digital natives due to the high general digital literacy reported in the study and are therefore native speakers of the digital language which is an enabler for the viability of mHealth for cholera prevention and management.

This is also corroborated by findings from the IDIs and FGD which reveal the use of mobile phones among Healthcare Providers to be pervasive. This is consistent with key findings from mHealth studies in Ghana which reveal high acceptance and willingness to use the mobile phone for health activities (Senyo, 2015; Vroom, 2017). Healthcare Providers seem to take the advice of Hu et al., (1999) by taking advantage of the utilities the mobile technology offers by its high adoption among them. Healthcare Providers also provide some reasons for the adoption of the mobile phone such as cost-effectiveness, ease of work, providing access to healthcare by the population. It is however suggested that individual, technological and organizational factors, among others, play a key role in ensuring the success of any technology adoption. Venkatesh & Morris (2000) report that different factors and motives influence women and men in the adoption of new technological software. While men were influenced more strongly by PU of technology, women were more influenced by PEOU and subjective norm. This study finding indicates that both women and men interviewed did not identify any difference if there exist in the two major independent beliefs of TAM. The TC & DL score shows no difference between both genders as the score for IDI shows a percentage average total score of 97.5% and 100% for at least primary TC & DL. FGD responses had a 100% overall average total score for both women and men. Venkatesh & Morris' research

participants were however of a different professional background. Other individual factors such as religion, ethnicity, professional background, and work experience were not identified or reported by respondents as forming any differential basis for individual acceptance and use technology. Even though age was not a key factor determining Healthcare Providers' acceptance and use of technology, there were few references to younger healthcare professionals being more technologically savvy which make them adopt the technology more quickly.

The TAM constructs of PU and PEOU are suggested to be key predictors of Behavioural Intention to Use (acceptance) technology leading to actual use (Davis, 1989; Rho, Choi, & Lee, 2014). PEOU concerns an individual's view that using technology will be effort-free or will require less effort while PU concerns job enhancement or performance arising from the use of technology. PU has been suggested to be a good predictor of Healthcare Providers' intention to use technology due to the rational approach to healthcare delivery where the usefulness of technology is a paramount consideration (Hu, Chau, Sheng, & Tam, 1999). Literature, therefore, describes Healthcare Providers as conservative and having an attitude of slow adoption of technology, which is attributed to their quest for pragmatism in technology use (Omachonu & Einspruch, 2010). The study findings are consistent with these two predictive constructs espoused by the theoretical literature. respondents' view on PU was that mobile phone technology helped them to leverage their work in the areas of effective remote supervision, mobile data collection, and ensuring green administration by the reduction of paperwork. It also revolutionized communication and interaction among Healthcare Providers for the prevention and management of cholera. Other PU of technology were identified during the study as cost-effectiveness in operations, facilitates mobilization of Healthcare Providers during emergencies and remote access to health services by clients via mobile phones, among

others may serve as the basis for PU. Thus, Healthcare Providers across the levels of healthcare, profession, age and religion were of this view which invariably contributes to the high intention to use (acceptance) and actual use of the mobile technology among them.

Concerning PEOU, the study found that Healthcare Providers view the mobile phone as generally easy to use. Background data results on TC & DL show high technical capability scores (95% and above) for Healthcare Providers (IDI and FGD) in the areas of *Ability to make a text message* (primary capability), *Ability to use any mobile application such as social media* (secondary capability) and *Ability to conduct searches on a mobile phone* (tertiary capability). These default capabilities show high levels of PEOU with tertiary capabilities representing the highest effort required for operating the mobile phone technology, in which Healthcare Providers still responded with a high score.

The literature argues that even though individuals' adoption and use of the mobile phones is important, their continuance in usage may be impacted by the level of technological fit with their tasks they apply the technology to (Cooper & Zmud, 1990; Goodhue & Thompson, 1995). Goodhue & Thompson (1995) therefore suggest the need for technology to fit into people's task to help encourage the continuance in the use of the technology. This is linked to TAM's PU which is the utility and performance that technology provides. There is therefore the need to combine the two streams of utilization and performance of technology which provide a stronger predictor of intention to use and actual use of technology. Key independent constructs affecting TTF are derived from task characteristics and technology characteristics. Tasks are defined as the activities carried out by individuals when translating inputs into outputs. The TTF model relates to the fit between a user's task needs, their capabilities, and the functionality of the technology to support the work.

The study findings are broadly consistent with that of the theoretical literature despite some challenges reported by Healthcare Providers with the use of the mobile phone. It finds Healthcare Providers hold the perspective that the mobile phone fits well into their public health activities for the prevention and management of cholera. Some of the key task requirements of Healthcare Providers include communication among themselves and with clients, quick sharing of information with colleagues, subordinates and supervisors, reduction in paperwork, portability of information, quick data transmission, and cost-effectiveness, among others. A number of these tasks are simple routine activities for which the mobile phone is viewed as effective in supporting their performance. Mobile phones help to report on cholera threats, the transmission of routine disease surveillance reports to supervisors, and remote monitoring of subordinates without travelling to their locations. Other activities that mobile phones help to perform include effective referrals of clients, logistics, and human resources mobilization. The overall utility effect of these is the achievement of costeffectiveness, enhanced access to healthcare, and effective service delivery. The resultant effect is that it ensures usage continuance by Healthcare Providers as theorized by Goodhue & Thompson (1995). The capabilities of users have been discussed elsewhere in this study to the effect that Healthcare Providers have high TC & DL which enhances their effective utilization of the mobile phone. Findings on the functionality of the mobile phone to support the tasks show that the mobile phone was functional in respect of tasks performed by Healthcare Providers. This is due to the utility it provides when applied to Healthcare Providers' activities carried out. Findings, however show that there are still formidable challenges that may affect its effective functionality such as poor network availability, cost of communication, theft, and multiple language use.

Technology characteristics have been suggested to include system reliability, output quality, compatibility, system adaptability, and processing speed (Gebauer & Shaw, 2012; Tariq & Akter, 2011). These functions support and enhance the performance of tasks by individuals that provide the utilities discussed above. The more such technology supports the tasks performed, the more the fit between them, which further results in adoption, continuance in usage, and performance. Some of the findings of this study are consistent with the theoretical literature on TTF. The smartphone is reported to be one of the latest generation mobile phone technologies which have higher speedy processing and storage capacity. Findings from both methods of data collection revealed high ownership of smartphones with the majority (95%) of IDI participants and 100% of FGD discussants owning and routinely using the device to perform public healthcare activities for cholera prevention and management. Healthcare Providers took advantage of the speed of processing and storage capacity of smartphones to collect data, perform mlearning and mlibrary activities which some of the mobile technology characteristics identified in the literature support and have a high fit with these health activities. Findings show that system reliability and network accessibility were generally reported to be satisfactory and enhance continuance usage even though few respondents expressed concern of network reliability in limited parts of the study sites.

Goodhue (1995) suggests individual characteristics have a differential effect on the extent of fitness between task and technology which include self-efficacy, position experience, relevant training and demographics, among others. The study finds that demographics as revealed in the background characteristics of the respondents show no such differential effect on TTF regarding their educational level. Respondents at the policy (national), tactical (regional) and operational (district) levels all utilized and saw a good fit between the tasks to be performed and the role of the mobile phone in helping to perform them. The findings are revealed in the high scores for

primary, secondary and tertiary levels of TC & DL. Even though findings indicate that some of the younger Healthcare Providers were more digitally savvy compared to older colleagues, there was generally no significant differential. This finding is also like that of other demographics such as experience, profession, and religion. Thus, the heterogeneous background characteristics still produced a homogenous finding of fit of task and technology. This may set the stage for effective roll-out of mobile health activities and possible scale-up for the prevention and management of cholera. It was however found that not all tasks fit the mobile technology such as some healthcare provision that requires physical examination by a healthcare provider and ingrained mental models that still motivated clients to seek physical contact rather than care at a distance.

The findings of the study also show that Healthcare Providers who were formally trained on mHealth were those who were recruited to be part of a formal mHealth project. It was found that most Healthcare Providers who were involved in informal and unstructured use of the mobile phone to deliver or perform health activities in general and cholera, in particular, were not trained in the effective use of the mobile phone. This might be the reason for their call for training and education aimed at ensuring the effective application of the mobile telephony to deliver healthcare.

5.6 Synthesis of research findings in relation to the empirical literature

Table 5.2: Synthesis of key research findings versus empirical literature

Research Objective	Findings from Research	Findings from Empirical Literature

Objective One (mHealth Services)	Data collection, mLibrary & mLearning, Disease surveillance, Immunization management, Management & Logistics Management, Administrative supervision, Maternal and Child health services, Telehealth, Remote client monitoring, Referral management, Health education	Communicable diseases management, Disease surveillance, Managing Immunization, Maternal and Child health services, Behaviour change communication
Objective Two (mHealth Challenges)	Management of Official Mobile Phones, Projectitis and Pilotitis, Financial costs, Security, Privacy and confidentiality, Network coverage and quality, Lack of interoperability, Multiple language, Illiteracy, Abuse, Job Interference and stress, Mistrust, Socio-cultural, Staff capacity and medico-legal, Technical limitations, Policy and regulations, Electricity supply and stability	Network coverage and quality, Multiple language, Pilotitis, Illiteracy, Security, Privacy and confidentiality, Socio-cultural, Financial costs, Lack of Interoperability, Technical limitations, Human limitations, Policy and regulations, Electricity supply and stability
Objective Three (mHealth Enablers & Facilitators)	Planning & Budgeting, Funding, Policy and regulation, High mobile phone adoption, Training and education, Human resources, Belief in mHealth efficacy, Stakeholder	High mobile phone penetration, Supportive policy environment, Efficacy of SMS, Cost-effectiveness, interoperability, Training, High smartphone penetration
	management, Infrastructure provision, Governance, Partnership with Telcos, Trust, Efficacy of social media	

Source- Synthesis by author from research findings and empirical literature

5.7 Synthesis of research findings in relation to theoretical literature

Table 5.3: Synthesis of research findings versus theoretical literature

No.	**Key findings from research**	**Key findings from the theoretical literature**

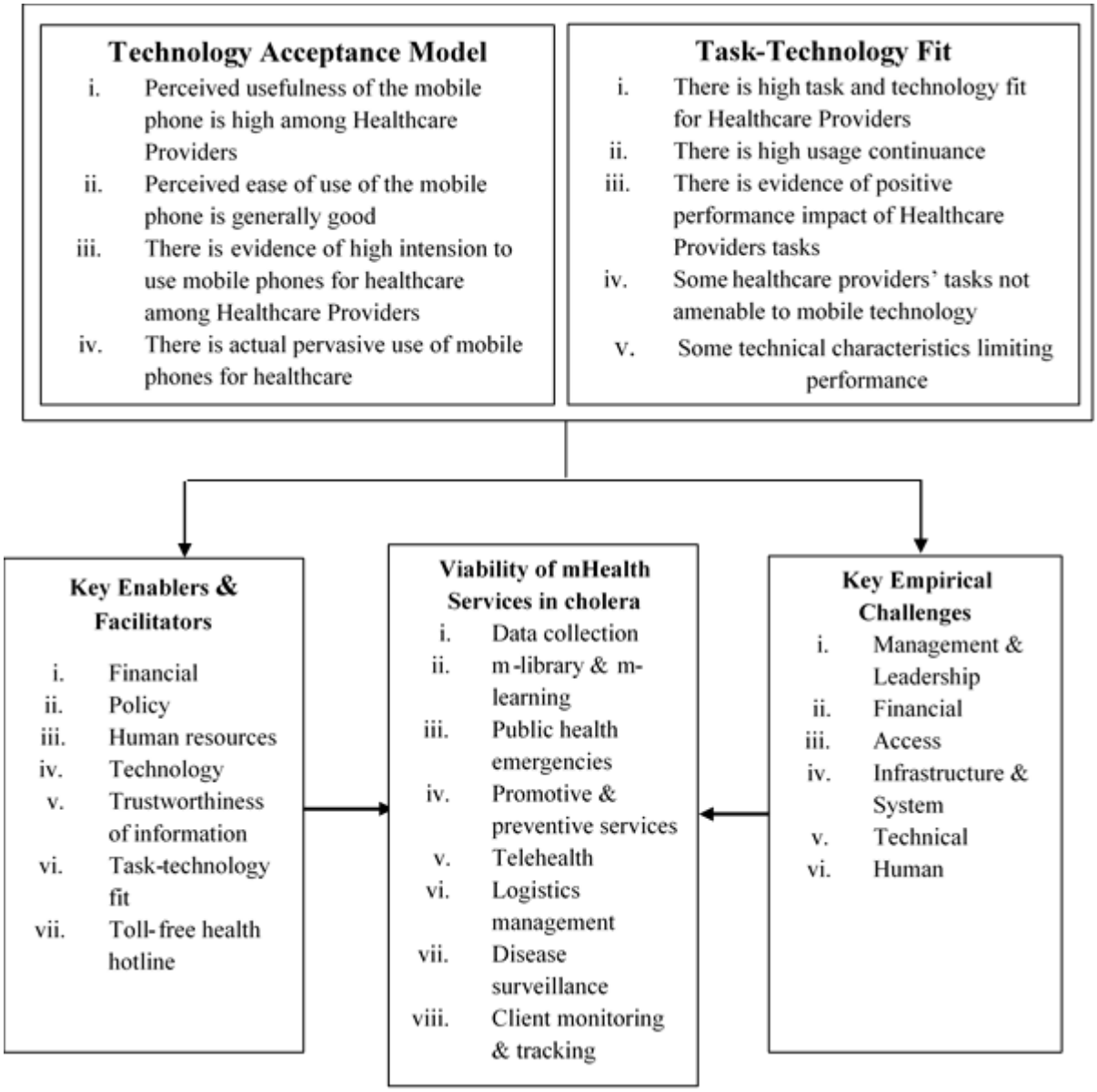
1	Healthcare Providers scored high marks in the TC & DL assessment which presented as an indicator of Perceived Ease of Use of the mobile phone Findings reveal that Healthcare Providers viewed the mobile phone as useful in helping them to perform their assigned individual tasks There is therefore high intention to use and actual use as found from views of Healthcare Providers and the high mobile phone ownership (100% for both respondents of IDIs and FGDs)	Perceived Usefulness and Perceived Ease of Use of technology are good predictors of intention to use technology and actual use
2	Findings show a good fit of healthcare tasks and the mobile phone technology which leads to its high utilization and effective performance of healthcare activities	When tasks of individuals fit well with the technology, it leads to utilization and performance impacts
3	Even though findings reveal that younger Healthcare Providers were more digitally savvy than older colleagues, there is no major finding of individual background characteristics influencing TTF and the resultant effect on utilization and performance	Individual characteristics such as age, sex, profession, religion, others influence TTF
4	The tasks of Healthcare Providers involve mostly routine data collection, submission of reports and information sharing. There is interdependence of tasks as healthcare provision involves diverse providers as reported in the background characteristics of respondents which show 22 different professional specializations of the 40 IDI respondents	Task characteristics such as routineness or non-routineness, interdependence of tasks and others influence TTF
	Healthcare Providers viewed the mobile phone as a reliable	Technology
5	technology for performance of a number of individual tasks such as sharing information, data collection, and others Even though the study did not measure the output quality of the mobile technology, compatibility with other technologies, adaptability for delivering mHealth services and processing speed of smartphones were acknowledged	characteristics influence TTF

Source- Synthesis by the researcher from research findings and theoretical literature

5.8 Review of conceptual framework in relation to study findings

The conceptual framework depicted in the figure below has three main constructs comprising two independent constructs (Challenges and Enablers /Facilitators of mHealth) and one dependent construct which is the viability of mHealth services in cholera prevention and management. The two independent constructs act as drivers and constraining factors on the dependent construct. While the Enablers and Facilitators act as driving forces, the mHealth challenges act as constraining factors on the dependent construct. The impact of these two independent constructs is influenced by the two theoretical foundations of the study which are TAM and TTF.

Figure 5.1: Review of conceptual framework based on empirical findings



Despite some challenges, the empirical findings show that there is generally enabling and facilitating factors of TAM (adoption and use) and TTF (usage continuance and performance), which act as good drivers for the overall viability of mHealth for the prevention and management of cholera. Some of the favourable variables are high PU and PEOU leading to the actual use of the mobile phone for healthcare. The high fit of task with mobile technology and usage continuance results in effective performance utility. concerning the Challenges construct, some of the empirical challenges, which constrain mHealth viability

were identified to include management and leadership, financial and access. Relating to Enablers and Facilitators, empirical findings reveal financial, policy, trustworthiness of information, and human resources are drivers for mHealth viability. The interplay of these Enablers and Facilitators construct on one side and the mHealth Challenges construct on the other hand act to impact on the viability of mHealth services provided such as data collection, digital learning, managing public health emergencies, logistics management and disease surveillance. Thus, the viability of the mHealth services for the prevention and management of cholera provided by Healthcare Providers is impacted by enabling and facilitating factors and challenges of mHealth.

5.9 Chapter summary

This chapter discussed the research findings as reported in chapter four. It deliberated on the key findings in relation to empirical and theoretical literature and shows the areas of similarities and dissimilarities between the findings and existing literature. It identified several findings that helped answer the research questions and realization of its objectives. Based on the foregoing, it summarizes the entire research and proffers conclusions and recommendations in the next chapter.

CHAPTER SIX

6.0 SUMMARY OF FINDINGS, RECOMMENDATIONS AND CONCLUSIONS

6.1 Chapter introduction

The chapter recaps the key findings of the study and presents overall conclusions. It provides contributions to knowledge for empirical, theoretical, methodological, policy, and practice. It finally provides some limitations to the research and key recommendations for future studies.

6.2 Summary of key findings

The majority of respondents were male (72.5%) with regards to IDIs. Eighty-nine percent of respondents were 30 years or more in age. The work experience of respondents, in general, was long, with 33 (82.5%) having more than 10 years' experience. All 40 IDI interviewees were Christians with more than half (54%) of them being of Akan ethnicity, the majority (29, 73%) were married. The educational status of respondents shows that the majority (82.5%) of respondents had a bachelor's degree or above. Healthcare Providers had varied professional backgrounds which were 22 in total. All 40 respondents owned a phone with 95% of phones identified as smartphones. The results of respondents' TC & DL over the three capability tests returned a generally high technological capability and literacy of respondents. The overall average total percentage score for the eight technological capabilities assessed was 97.5%.

Some of the conclusions from the findings of the background characteristics are summarized below:

First, there is an appreciable professional experience among Healthcare Providers which may have a satisfactory impact on the delivery of mHealth services. Second, respondents' educational status can be described as high with the majority having a bachelor's degree Third, mobile phone ownership, including smartphone use, is high among Healthcare Providers. This is one pre-requisite for mHealth viability as, without a high adoption of mobile phone technology, mHealth is constrained as it is the main tool used. Fourth, there is also a high level

of technological capacity and digital literacy among providers which is necessary for adoption and usage continuance of mobile phone technology. Thus, PEOU can be described as good among providers.

The study sought to find answers to the public health services that Healthcare Providers used their mobile phones to deliver towards the prevention and management of cholera**.**

First, Healthcare Providers use the mobile phone to collect and report on various health and administrative data to supervisors up the healthcare delivery chain. Supervisors also used the mobile phone to feedback, disseminate information, and monitor activities of staff at the lower level. Even though it was acknowledged that it facilitated work for Healthcare Providers at the lower level in the areas of reduction in the need for spatial mobility to submit routine reports and allowed quick dissemination of information, especially during emergencies such as cholera, lower-level providers particularly complained of increased workload as they had to fill data and reports both on the phone and on paper. They thus called for the institution of some form of allowances for the increased workload, particularly for structured mHealth activities. It was noted that the collection and submission of data were both structured and unstructured. Mobile phones were used to capture data such as pictures, video recordings and at least asynchronously reported to supervisors for their information and direction. Structured form emanated from those who were part of a formal mHealth project which had established a systematic system for collection and reporting of data to project supervisors to help achieve project objectives. The unstructured form concerned the need to collect and send data via the mobile phone for routine operations or during emergencies ahead of the hard copies to help in taking quick action. Second, Healthcare Providers used the mobile phone as a form of digital library and learning platform. It was found that the delivery of public health services was mostly conducted in the

off-site communities. There was therefore the need to make references to digital treatment protocols and education resources on disease management and education such as cholera infection and prevention. The utilities of the smartphone allowed mlibrary services for which the phone ownership by respondents indicates almost 100%. It also afforded mlearning activities by remote providers who could not take advantage of face-to-face CPDs. This served as motivation for serving in the rural or remote locations for which some of the respondents experienced. Third, the mobile phone played a critical role in health emergencies which included public health emergencies such as the detection of a cholera outbreak, management of referrals during emergencies, and the use of health hotlines to interact with the affected public. Information provision on the epidemic to affected communities on ways of prevention and management was paramount. Healthcare Providers shared health data and information on the disease and used the mobile phone as a tool for mobilization of human resources for health and logistics. Despite these efforts, it was found that some Healthcare Providers were not aware of such efforts during cholera emergencies which were attributed to limited effort to educate providers on its management during outbreaks. Fourth, the mobile phone had become a tool for supporting planning, general administration, and management. Supervisors, particularly those at the district level used the mobile phone to conduct remote monitoring of staff, coordination and supervision of staff activities, assignment of schedules, and organizing for logistics for delivery of health activities. They used WhatsApp groups and text messages to support these mPlanning, mAdministration and mManagement activities towards the delivery of healthcare at the district level. It was realized that this resulted in green administration as it led to a reduction in the use of paper due to the sending of letters via

WhatsApp, reduced frequency of physical monitoring travels, and constant communication.
Discussion on healthcare activities was sometimes discussed on various WhatsApp groups. It was however found that these mobile phone-based activities were neither structured nor

emanating out of a nationally adopted mHealth policy but Healthcare Providers adopted the technology due to the benefits and utilities it provided such as efficiency and effectiveness in operations. It was also noted that these activities were not necessarily carried out with cholera management in focus but for the prevention and management of all public health activities. However, such efforts are refocused on the prevention and management of cholera when there was an outbreak. This shows the integrated system of disease prevention and management established for public health services.

Fifth, Healthcare Providers used the mobile phone to perform aspects of public health services such as disease surveillance, health promotion, and education. Even though the mobile phone did not play a role in the entire spectrum of services of the above health issues, providers used it to support the parts which were amenable for mobile health such as data capture of surveillance threats, receiving confirmation of laboratory results on cholera via mobile phones and tracking and tracing confirmed cases through spatio-temporal tracking systems in partnership with Telcos to determine movement, spread, pattern and population clusters during cholera.

Sixth, two main communication models among Healthcare Providers and with population were identified as vertical and horizontal. The directions of these models of communication included one-to-one, one-to-many, many-to-one, and many-to-many. These were found under the telehealth theme. These communication models were leveraged by staff towards general healthcare provision and cholera prevention and management.

Major conclusions from the findings of public health services provided with mobile phones are stated below:

First, the practice of using the mobile phones to deliver aspects of public health is high among providers of healthcare. This practice is either voluntary (unstructured) or involuntary (structured) which is mostly instituted during mobile health projects. Findings reveal that even though there is pervasive use of mobile phones by Healthcare Providers, its use is not exclusive to the management and prevention of cholera but for all other public health concerns. The technology is however leveraged to respond to cholera when there is an outbreak or a threat of it. Second, cholera education is targeted indirectly through the delivery of other public health services. In the management of maternal and child health services through mobile phones, cholera education is also provided for such mothers and pregnant women during threats of the epidemic to ensure they adopt practices to prevent and effectively manage cholera for themselves, their children, or pregnancy. The major application of the mobile phone in cholera prevention and management is communication, information sharing, and dissemination of the disease among Healthcare Providers.

The research sought to explore perspectives of respondents and discussants on the challenges they encountered with the use of mobile phone in the prevention and management of cholera. They were also to share any challenges encountered in using the mobile phone in similar public health activities which might be of relevance to the research. First, management and leadership challenges in mHealth were identified which included the huge burden of management of officially deployed phones and Projectitis and Pilotitis. Challenges of deploying, keeping data, maintenance, and replacement of numerous official mobile phones for mHealth activities are a herculean task. This concern resulted in respondents having different views on official and private use of phones. The proliferation of numerous mHealth projects and over-reliance on non-government support leads to coordination challenges and affected sustainability and the ability to scale-up, among others. This also affected interoperability as various mHealth projects

operated different technologies and used different Telcos services. Second, financial costs were identified to broadly comprise upstream and downstream. Upstream costs included development, licensing, security and support and infrastructure. Key downstream costs were communication such as recharge units. Phone costs included the need for replacements due to misplacement, theft, and maintenance. Funding such costs were borne by mHealth projects and staff which makes it unsustainable.

Third, access challenges included illegal or unauthorized access to mobile phones of Healthcare Providers. The main concerns for access breaches were security, privacy, and confidentiality which present serious breach of trust leading to medico-legal challenges. Fourth, infrastructure and system challenges encountered were the provision of structures, equipment, organizational architecture, and technological services. Some of these broad challenges were further identified to comprise network quality, electricity availability and reliability, and technological infrastructure. Network coverage and quality were generally found to be satisfactory apart from few rural locations. Apart from internet quality issues, voice and text services were not found to be a major challenge. Human resources challenges included socio-cultural factors such as ingrained mental habits by some Healthcare Providers and clients' attitudes to mHealth. Healthcare Providers' motivation for mHealth was affected by extra workload it generated, stress, and provision of credit unit for communication. Some clients preferred face-to-face interactions with providers. Illiteracy was not found to be a challenge among providers but there were limitations in operating the mobile phone device, lack of understanding of basic techno-technical issues concerning mobile health and IT staff's ill-knowledge of health issues were found to be a key human resources challenge.

Major conclusions from the challenges encountered by using mobile phones to deliver public health services are:

First, one of the key sustainability concerns is the cost of downstream activities such as communication cost which is the cost incurred in buying credits for communication. The current funding regime where there is over-reliance on project funds and Healthcare Providers to support the official communication needs of Healthcare Providers may not make mHealth viable. Second, 'pilotitis' and 'projectitis' is still a major challenge as reported by the literature (see Gleason 2015; Shuchman). This has dire implications for scaling-up and viability of mHealth for the future. Third, the role of Telcos in mHealth is limited and passive even though they are a key provider of mHealth services through the technological backbone offered. The provision of infrastructure for mHealth and network availability and quality are satisfactory in the study sites which is a good foundation for the deployment of mHealth services. Fourth, even though there are policies and guidelines on eHealth and telemedicine practice, there is no overarching policy framework governing either the structured or unstructured practice of mHealth by Healthcare Providers. This worsens interoperability challenges, further encouraging the proliferation of mHealth projects and misalignment with organizational objectives and strategies and together affects the overall viability of mHealth.

Based on the public health services offered via the mobile phone and challenges faced in its usage to deliver mHealth, respondents and discussants were asked to provide their views on factors that may enhance the delivery of these services and/or reduce the challenges encountered in using them. Their responses were not necessarily to identify the challenges and provide remedies but to offer any factor that should be in place to either prevent the challenge from occurring or help reduce its effect on mHealth viability. The findings were identified as provided below.

First, some of the key enablers were found to be financial, human resources, policy, effective stakeholder management, provision of technological resources. To help reduce the burden of

financing mHealth services on foreign donors, other sources of finance is to be explored to ensure sustainable financing for mobile health services. Financial support was necessary to save lives, increase access to services, and serve as incentives for Healthcare Providers. There is therefore the need for effective planning and budgeting for mHealth activities for funding. There is the need for the provision of the right type of personnel such as qualifications, capacity, and numbers of human resources to support mHealth activities for cholera. Their education and capacity development are necessary for mHealth viability. An overarching policy framework to govern mHealth activities was found to be a key mHealth enabler and provided a strategic guidance to Healthcare Providers at the high levels of care and technical direction for the lower level to ensure mHealth efficiency and effectiveness for which policy-makers must pursue.

Effective stakeholder management is necessary to overcome 'pilotitis and projectitis' issues. There is the need for the management of a host of mHealth stakeholders who comprise the community, government, Healthcare Providers and health partners with varied roles. Mhealth stakeholders shared commitment is found to be key enablers for effective mHealth in cholera. The role of the central government as the key driver of the mHealth discourse is found to be critical for the overall viability of mHealth. The need for the government to engage Telcos to expand their limited role to help become a major stakeholder in funding and for technological support for mHealth should be noted. Organizations should use big-data to leverage effective decision-making.

The main communication facilitators for delivering messages found included the use of nonmobile phone and mobile phone channels. Non-mobile channels comprised the use of Television (TV), Radio, and face-to-face public education; while mobile channels comprised SMS, Voice, and Social Media. Findings show that WhatsApp is a major social media app

utilized among Healthcare Providers to deliver mHealth services particularly, information sharing and inter-provider interactions. Major conclusions derived from the enablers and facilitators enhancing mHealth are:

First, the development of a policy framework to govern mHealth practice is noted as a key enabler for viability. Even though literature (see Sun, Guo, Wang, & Zeng, 2016; Tamrat & Kachnowski, 2012) mentions the need for policy framework, this research finding amplifies the pivotal role of mHealth policy in ensuring its sustainability. Second, social media, especially WhatsApp is emerging as a major communication platform for mHealth delivery. Third, mobile phones as a channel for mHealth delivery may not achieve the full results required for cholera prevention and management and this calls for using both non-mobile and mobile channels alongside each other for delivering mHealth services. Fourth, the role of Telcos and their impact on mHealth is limited to their Corporate Social Responsibilities (CSR) which is revealed in their anecdotal involvement. Their interest in mHealth ceases when funds allocated for CSR are used-up. Findings show that they are more interested in sustainable business models or opportunities in mHealth services which may have to be explored for longterm involvement to ensure financial sustainability. Table 6.1 below shows a numerical summary of the themes:

Table 6.1: Numerical summary of themes under methods and objectives

No.	Method of Data Collection	Objective One	Objective Two	Objective Three	Total Themes by Method
1	IDIs	6	6	7	19
2	FGDs	5	5	7	17
3	Total Themes by Objective	11	11	14	36

Source: Compiled by the researcher based on thematic coding results

6.3 Contributions of the research

Contribution to knowledge concerns originality in a study in various strands such as context, empirical, theory, practice, policy, and other new knowledge (Phillips & Pugh, 2010).

6.4.1 Contributions to the empirical literature

The empirical literature on mHealth is quite substantial and covers LMICs and other disease interventions. However, cholera-specific studies are few (see Bengtsson, et al., 2015; Teng, et al., 2014; Ngwa, 2016; Overney, 2016) and limited geographic contexts such as Haiti, Senegal, and Cameroon. Three of these studies used secondary meta-data for analysis revealing limited primary studies on cholera. Mhealth studies in Ghana are revealed to be relatively few (see Adokiya et. al., 2015; Adokiya & Awoonor-Williams, 2016; Senyo, 2015; Vroom, 2017). These studies also focused on non-cholera disease interventions such as Disease Surveillance, Maternal Care, Ebola, and Lymphatic Filariasis. The study, therefore, contributes to the empirical literature within the Ghanaian context. It provides new knowledge and validates existing ones in a nascent mhealth geographic context and cholera disease intervention area (Tariq & Akter, 2011; Lund, 2012; Watterson et al., 2015, Labrique et. al., 2013), thereby extending the empirical frontier of mHealth.

6.4.2 Contributions to the theoretical literature

The research combines two theories which are TAM and TTF which helped provide a holistic picture of how the two interact to explain acceptance, usage continuance, and performance (Davies, 1989; Goodhue & Thompson, 1995). While TAM predicts Behavioral Intention to use and Actual use of technology, TTF predicts Usage Continuance and Performance. Thus, using only one (either TAM or TTF) would only partly answer the phenomenon. DOIT and UTAUT were not considered as they did not fit into the aim and objectives of the study. The study

focuses on healthcare providers' adoption and use of the mobile phone to deliver public health services, which TAM predicts but not the process by it is adopted and communicated over time among a population as for espoused by DOIT. UTAUT was not also considered appropriate due to its inability to predict utilization and performance as done by TTF but predicts the use of technology, which TAM takes care of. Thus, coupling the two theories apart from being novel, also provides a seamless theoretical bridge for a complete understanding of the phenomenon. This helps improve the theoretical depth of mHealth studies (Labrique et al., 2013; Shuchman, 2014; Watterson et al., 2015).

6.4.3 Contribution to methodology

Literature suggests that mHealth studies need improvement in methodological rigour as most are simple evaluations of completed mHealth projects or having a limited number of participants to ensure the validity of conclusions (Labrique et. al., 2013; Shuchman, 2014). Methodological rigour is also noted to cover studies in different research settings, types of health intervention and level of analysis (Forrest, et al., 2015). First, the study was conducted in three study areas with varying backgrounds, data collected at macro, meso, and micro levels of healthcare on a new health intervention. The study used two data collection methods (IDI and FGD), a questionnaire instrument for assessing the digital literacy of healthcare providers, and three study areas/sites, which helped improve data triangulation and resultant trustworthiness of the collected qualitative data (Guba E. G., 1981). Using IDI and FGD helped to provide two sets of data on the same guide to help ascertain any similarities and dissimilarities in findings, which further deepens the credibility of the qualitative data. The extra data collected on digital literacy and healthcare workers' technological capabilities provided an understanding of the prevalent use of mobile phones for public healthcare provision. There was a fuller understanding of the phenomenon due to this data triangulation

strategy. Second, an original Conceptual Framework was developed that provided understanding of how theoretical and empirical constructs interacted to determine mHealth viability. This framework may help guide similar mHealth studies that involve other disease interventions. Third, as indicated a Technological Capability and Level of Digital Literacy instrument was developed to measure the technological capabilities of healthcare providers and informed their ability to operate the mobile phones for mHealth services. These contributions help improve the methodological rigour needs of mHealth studies (Tariq & Akter, 2011; Labrique et. al., 2013; Shuchman, 2014; Watterson et al., 2015,).

6.4.4 Contributions to health policy and management

The findings of the study provide new knowledge for policy and management information.

First, 'Projectitis-Pilotitis syndrome' has shown that it served as a major limiting factor to mHealth scale-up. Second, the absence of mHealth policy led to poor coordination of mHealth activities, leading to financial wastage. Third, the role of Telcos in mHealth was found to be limited to only their corporate social responsibility support. Fourth, social media was emerging as a key and effective mHealth platform. Fifth, a new analytical framework (MFAITH Framework) was developed to aid policy analysis of mHealth programmes/investments. This new knowledge has policy and management implications for health policymakers and serves as a good contribution to health policy and practice.

6.4 Research limitations

Despite the extensive and intensive research work conducted with varied findings, the study identifies some limitations to the study. However, these limitations do not affect the authenticity or trustworthiness of the findings. First, the study focused on the provider-side (supply-side) of

mHealth to the exclusion of the demand-side. It thus interviewed only healthcare and ancillary mHealth providers but did not include the general population which demands mHealth services. The perspectives and findings are therefore only referable to providers of mHealth services which may be different from that of the demand-side perspectives. Second, the study is only limited to the GAR and three of its selected sites. Even though the sites were selected purposively to represent varied background characteristics relevant for the research, its findings and generalizations may be only limited to the study sites.

6.5 General Recommendations

Based on the major findings, conclusions, and contributions to knowledge, health policy, and practice, some general recommendations are proffered as follows:

i. First, healthcare leaders must take advantage of the power of mobile technology by providing clear direction and integration into the healthcare system as an alternative or supplementary health delivery channel ii. Second, there is the need to develop an overarching policy framework to provide an effective governance environment that will help redress some of the challenges of mHealth project proliferation to ensure effective interoperability, cost-effectiveness, and fit with organizational objectives. This will also help formalize and bring structure in mHealth for public health delivery in general and cholera prevention and management in particular. Health policymakers must consult all stakeholders to ensure acceptance iii. Third, with the emerging importance of social media (e.g. WhatsApp messaging) as a key emerging communication platform, there is the need for mHealth projects to configure their systems to utilize this new platform for enhanced communication

iv. Fourth, healthcare policy-makers must engage Telcos as key partners of mHealth in Ghana on a mutually rewarding partnership. To ensure the financial and operational viability of mHealth, planning, budgeting, and training must be undertaken or instituted.

6.6 Conclusions

The central phenomenon of this study was to explore the viability of using the mobile phone for the delivery of public health services aimed at preventing and effectively managing cholera. The research examined the mobile health services in public health, the challenges encountered by using the mobile phones to deliver such services, and the enablers and facilitators that are available to enhance the general viability and effectiveness of these services.

The study shows the prevalence of using mobile phones to deliver public health services in general and aspects of it applied for cholera prevention and management. Mobile health practice is, however, largely unstructured or informal apart from that which is established by a special project. The implication for this finding is that even though favourable conditions exist for the up-take of mHealth, the Ghanaian health sector was yet to leverage this opportunity due to its informal nature. The absence of a policy framework further constrains the ability of healthcare policy directors to maximize the good role mHealth could play in the prevention and management of cholera. The passive involvement of Telcos in mHealth provision may deprive the health sector of taking advantage of the financial leverage of these stakeholders to strengthen mHealth.

Some of the key outcomes of the research are that Healthcare Providers have a high adoption of mobile phones and high TC & DL. These have good implications for adoption and usage continuance of the mobile phone for healthcare delivery, which are key prerequisites for

mHealth viability. mHealth practice is largely informal and not necessarily targeted only for cholera prevention and management but all diseases. It is however leveraged for cholera management when there is an outbreak. Despite the challenges reported in this study, findings show that Healthcare Providers see mHealth as a useful complement to their traditional model of healthcare such as face-to-face services. The mobile phone is reported to have a good tasktechnology fit for the delivery of public health services. This provides a good motivation for healthcare providers to continue using the mobile phone to deliver services for the prevention and management of cholera. The overall effect is that despite the reported challenges of mHealth, prevailing enabling and facilitating factors provide good grounds for the viability of mHealth for cholera prevention and management. Policy managers must, therefore, leverage the mobile phone technology to enhance healthcare provision which invariably may help contribute to cost-effective access to public health services.

6.7 Suggestions for future research

As indicated under research limitations, the study only interviewed the supply-side of mHealth and therefore there may be the need for future research on the demand-side or comparative studies (supply-side versus demand-side) to help match both sides for a holistic perspective on the phenomenon (Vallespin et al., 2016). Second, studies in other regions of the country may be conducted to help build on existing knowledge and cover more grounds on the mHealth space, particularly in Ghana and LMICs in general (Lund, 2012). Third, Other theories may be explored to further improve on the theoretical depth of mHealth studies (Labrique et al., 2013).

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APPENDICES

Appendix A1- Background Characteristics

SECTION A: Interviewee Profile

1. Name:
2. Age in Years: [ ]
3. Gender: Male [ ] Female [ ]
4. Marital Status: Married [ ] Single [ ]

5. Highest Education: No Education [ ] Primary [ ] JHS [ ] SHS [ ] Post Sec Certificate [ ] Diploma [ ] Degree [ ] Masters [ ] PhD [ ] 6. Religion: Christian [ ] Moslem [ ] Traditionalist [ ] Atheist [ ] Other (Specify)……..
7. Ethnicity: Akan [ ] Ga-Dangme [ ] Ewe [ ] Mole-Dagbani [ ] Other (Specify)…….
8. Profession: Public Health/Medical Doctor [ ] Bio-Med Scientist [ ] Health Director/Manager [ ] Health Info/Tech Manager [ ] Health Technologist/Technician [ ] Nurse [ ] System Analyst [ ] Software Engineer/Developer [ ] Computer Hardware Engineer [ ] Telecom Manager/Executive [ ] Telecom or Network Engineer/Technologist [ ] Electronic Engineer/Technologist [ ], Project Analyst [ ] Project Coordinator/Manager/Director [ ] Finance/Budget Officer [ ] Research Officer [ ] Project Designer/Planner [ ] Other (Specify) ……
9. Number of Years in Profession: [ ]
10. Title of Position Currently Occupied: ……
11. Phone Ownership: Owns a phone [ ] If Owns a phone, is it a Smart/Analogue [ ] Does not own a phone [ ]
12. Mobile Number: [ ]

Appendix A2- Tool for Assessment of Technological Capabilities and Level of Digital Literacy of Healthcare Providers

SECTION B: Assessment Tool for Technological Capabilities and Level of Digital Literacy

No.	Phone Function	Capability	Yes/No
1	Voice call	Can you make a call?	
2		Can you receive a call?	
3	Texting	Can you text a message	
4		Can you receive/retrieve a text message	

5	Applications	Can you use any mobile application such as social media?	
6		Do you have any social media account such as Twitter, Facebook, etc	
7	Internet	Are you aware of other uses of the internet on mobile phones aside social media?	
8		Do you use any of these searches on your mobile phones?	

Appendix A3- Interview Guide for Health Providers and Surveillance Managers

SECTION C: Interview Guide

Objective One: *To determine public health services that are delivered through mobile phones to prevent and manage cholera in the GAR.*

1. Do you believe in/accept the use of mobile phones in the delivery of public health services?

2. Are you aware of any use of mobile phone in the delivery of public health services in the country?
3. If you are aware of such mobile health public health projects, can you briefly describe at least one?
4. In spite of the above, are you aware of any use of mobile phones in Integrated Disease Surveillance (IDS) for cholera prevention and management?
5. In your view, which aspects of the IDS chain *(Detection, Registration, Confirmation, Reporting, Data Analysis & Interpretation, Epidemic Preparedness, Response & Control, Feedback)* can mobile phones be more effectively used for disease surveillance of cholera?
6. Can you describe any specific role(s) mobile phones can play in the IDS activities you have identified?

Objective Two: *To explore challenges encountered in the use of mobile phones which may affect effective implementation of mhealth for cholera management in the GAR*

7. Can you mention any barriers or potential challenges to be encountered in the use of mobile phones to deliver public health services and particularly for the prevention and management of cholera in GAR?

8. Among these challenges mentioned, which of them do you think may present the greatest challenge on the viability of mobile health for management of cholera in the GAR?

Objective Three: *To explore enablers and facilitators for a viable implementation of mHealth for cholera management*

9. In your opinion, what should the health sector do or put in place to ensure an effective and viable use of mobile phones to help overcome these challenges identified?
10. In your view, which one of these suggested facilitators or enablers is key to ensure smooth implementation of mobile health for the management of cholera in GAR?

Appendix A4- Interview Guide for Healthcare Providers, Health Policy Managers and Administrators

SECTION C: Interview Guide

Objective One: *To determine public health services that are delivered through mobile phones to prevent and manage cholera in the GAR.*

1. Do you believe in/accept the use of mobile phones in the delivery of public health services?
2. Are you aware of any use of mobile phone in the delivery of public health services in the country?
3. If you are aware of such mobile health public health projects, can you briefly describe at least one?
4. What public health services in your opinion could be delivered over the mobile phone towards the prevention, control and management of cholera in GAR?
5. In your opinion, are there any public health services that may not be possible to be delivered through the mobile phone?

Objective Two: *To explore challenges encountered in the use of mobile phones which may affect effective implementation of mhealth for cholera management in the GAR*

6. Can you suggest challenges encountered in the use of mobile phones to deliver public health services for the prevention and management of cholera in GAR?
7. Among these challenges mentioned, which of them do you think may present the most formidable challenge on the viability of mobile health for the management of cholera in the GAR?

Objective Three: *To explore enablers and facilitators for a viable implementation of mHealth for cholera management*

8. In your opinion, what should the health sector do or put in place to ensure an effective and viable use of mobile phones to help overcome these challenges identified?
9. In your view, which one of these suggested facilitators or enablers is key to ensure smooth implementation of mobile health for the management of cholera in GAR?

Appendix A5- Interview Guide for Telecom and Software Providers

SECTION C: Interview Guide

Objective One: *To determine public health service areas that could be delivered through mobile phones to prevent and manage cholera in the GAR.*

1. Is your organization supporting or providing telecom/application services for any project using mobile phones in the delivery of aspects of public health services in the country?
2. Can you briefly describe at least one such mobile health project particularly in public health you are aware of?
3. In spite of the above, are you aware of any use of mobile phone-based telecom/application for the prevention and management of cholera in the GAR?
4. What health (public) services in your opinion could be delivered over the mobile phone towards the prevention, control and management of cholera in GAR?

Objective One: *To explore challenges encountered in the use of mobile phones which may affect effective implementation of mhealth for cholera management in the GAR*

Can you suggest potential challenges likely to be encountered in the use of mobile phones to deliver health (public) services to the public for the prevention and management of cholera in GAR?

5. Among these potential challenges mentioned, which of them do you think may present the most formidable challenge on the viability of using mobile phones for management of cholera in the GAR?

Objective Three: *To explore enablers and facilitators for a viable implementation of mHealth for cholera management*

6. In your opinion, what should the telecom/apps development sector do or put in place to ensure an effective and viable use of mobile phones to help overcome these challenges identified?

7. In your view, which of these suggested facilitators or enablers is key to ensure smooth implementation of mobile health for the management of cholera in GAR?

Appendix A6- Interview Guide for mHealth Financiers and Non-Governmental Organizations Implementing mHealth

SECTION C: Interview Guide

Objective One: *To determine services that are delivered through mobile phones to prevent and manage cholera in the GAR.*

1. Are you aware of any projects/programs using mobile phones in disease prevention and management within the GAR?
2. Can you provide a brief description of any of these mobile health project(s) your organization is financially supporting or providing technical services in the country?
3. Have you provided technical support or aware of any funding involving the use of mobile phones specifically for the prevention and management of cholera?

Objective One: *To explore challenges encountered in the use of mobile phones which may affect effective implementation of mhealth for cholera management in the GAR*

4. Can you mention any barriers or challenges likely to be encountered in funding of mobile health projects for the prevention and management of cholera or any epidemic in GAR?
5. Among these potential challenges mentioned, which of them do you think is strong enough to greatly affect the viability of mobile health for management of cholera in the GAR?

Objective Three: *To explore enablers and facilitators for a viable implementation of mHealth for cholera management*

6. In your opinion, what will you recommend to help overcome identified challenges to ensure sustainability, feasibility and viability of mobile health projects or interventions for prevention and management of cholera in GAR?
7. In your view, which one of these suggested facilitators or enablers is key to ensure smooth implementation of mobile health for the management of cholera in GAR?

Appendix A7- Interview Guide for Focus Group Discussants

Objective One: *To determine public health services that are delivered through mobile phones to prevent and manage cholera in the GAR.*

1. Are you aware of any use of mobile phone in the delivery of public health services in the country?
2. If you are aware of such mobile health public health projects, can you briefly describe at least one?
3. What public health services in your opinion could be delivered over the mobile phone towards the prevention, control and management of cholera in GAR?
4. What other public health services are difficult to be delivered over the mobile phone for surveillance of cholera?

Objective Two: *To explore challenges encountered in the use of mobile phones which may affect effective implementation of mhealth for cholera management in the GAR*

1. Can you describe or mention any encountered challenges with the use of mobile phones to deliver public health services for the prevention and management of cholera in GAR?
2. Among these encountered challenges mentioned, which of them do you think may present the greatest challenge on the viability of mobile health for management of cholera in the GAR?

Objective Three: *To explore enablers and facilitators for a viable implementation of mHealth for cholera management*

8. In your opinion, what should the health sector do or put in place to ensure an effective and viable use of mobile phones to help overcome these challenges identified?
9. In your view, which one of these suggested facilitators or enablers is key to ensure smooth implementation of mobile health for the management of cholera in GAR?

Appendix B- In-depth interview participants and codes

NO.	CATEGORY	SECTOR	INDUSTRY	ORGANIZATIONS/ PROFESSION	CODE
1	A	Telecom/Engineering Industry	Network Providers	Mobile telecom companies	A1
2			Retailers	Mobile Phone Retailers	A2
3			Manufacturers	Mobile phone Manufacturer/Assemblers	A3
4			Regulator	National Communication Authority/NITA	A4
5	B	Financiers & MHealth Proeject Implementers	Health Partners	mHealth financiers	B1
6			MHealth Project Implementers	Telehealth/mHealth Projects	B2
7		Health	National	A Policy Expert	B3
8			National	A Policy Expert	B4
9				Disease Surveillance Officer	B5
10				Health Promotion Specialist	B6
11				ICT Specialist	B7
12				Laboratory Specialist	B8
13				Health Information Officer	B9
14	C		Regional	Public Health Officer	C1
15				Disease Surveillance Officer	C2
16				Health Administrator	C3

17				Health Promotion Specialist	C4
18			District	Health Director	C5
19				Disease Surveillance Officer	C6
20				Medical Director	C7
21				Pharmacist	C8
22			Community	Community Health Officer	C9
23				Community Health Volunteer	C10
24	D	Wildcards	Special mHealth key Informants	Telehealth Doctor	D1
25				Environmental Health Officer	D2
26				Mobile Apps Developer	D3
27				Ambulance Manager	D4
28				Public Health Officer	D5
29				Physician Assistant	D6

Appendix C- Focus group discussants and codes

FOCUS GROUP DISCUSSANTS AND CODES

NO.	PROFESSION	CODE
1	Health Administration	FGD1
2	Health Planning	FGD2
3	Administration	FGD3
4	Public Relations	FGD4
5	Transport Management	FGD5

Appendix D- Research Consent Form

Research topic: mHealth as a viable solution for the prevention and management of cholera in the GAR of Ghana - perspectives of provider-side stakeholders

Thank you for agreeing to participate in this study. I shall be grateful for your invaluable view on how mobile phones can be used to help prevent and manage cholera in the GAR. Please feel

free to read this consent form for an informed decision to decide on your participation in the interview/FGD. The key information for consent (extracted from the main guide) is stated below:

- The information you give me is completely confidential, and I will not associate your name with anything you say in the interview/focus group in the final report.
- I would like to record the interview/focus group so that I can make sure to capture your thoughts, perspectives and ideas. No name(s) will be attached to the interview/focus group quotes
- You may refuse to answer any question or withdraw from the study at any time.
- I understand how important it is that any information provided is kept private and confidential. You shall be assured of anonymity in the collection, analysis and presentation of data. Your view(s) will be respected at all time.
- You may feel free to ask any question(s) for clarification or concerns at any time of the interview/group discussion.
- You may tick Yes and sign to show you agree to participate in this interview/focus group or No to decline.

I have read the consent form and guide, understood and agree to participate in the interview/FGD and to be audio-taped.

YES:….. NO:…….

Name: ……

Sign/Thumbprint: …….Telephone: Date:

Appendix E- University of Ghana ethical approval letter

UNIVERSITY OF GHANA ETHICAL APPROVAL LETTER

UNIVERSITY OF GHANA
ETHICS COMMITTEE FOR THE HUMANITIES (ECH)

P. O. Box LG 74, Legon, Accra, Ghana

24th March, 2017

My Ref. No.....

Mr. Alex Hammond
Department of Public Administration and Health Services Management
University of Ghana Business School
University of Ghana
Legon

Dear Mr. Hammond,

ECH 107/16-17: MHEALTH AS A VIABLE SOLUTION FOR THE PREVENTION AND MANAGEMENT OF CHOLERA EPIDEMIC IN GREATER ACCRA REGION OF GHANA - PERSPECTIVES OF STAKEHOLDERS

This is to advise you that the above reference study has been presented to the Ethics Committee for the Humanities for a full board review and the following actions taken subject to the conditions and explanation provided below:

Expiry Date:	14/03/18
On Agenda for:	Initial Submission
Date of Submission:	13/02/17
ECH Action:	Approved
Reporting:	Bi-Annually

UG.ISSER.ECH VALID UNTIL 14 MAR 2018 APPROVED DOCUMENT

Please accept my congratulations.

Yours Sincerely,

Rev. Prof. J. O. Y. Mante
ECH Chair
CC: Dr. Justice Bawole, Department of Public Administration and Health Management

Tel: +233-303933866
Email: ech@ug.edu.gh | ech@isser.edu.gh