A FRAMEWORK FOR ENHANCING ADOPTION OF HEALTH CARE SERVICES IN RURAL AREAS USING MOBILE HEALTH TECHNOLOGY

CASE STUDY: MOYO DISTRICT

A dissertation presented to

FACULTY OF SCIENCE

in partial fulfillment of the requirements for the award of the degree

Master of Science in Information Systems

UGANDA MARTYRS UNIVERSITY

KAYENY Teddy

2017-M132-20011

Supervisor: Muganji Julius

September 2025

DECLARATION

UGANDA MARTYRS UNIVERSITY

DIRECTORATE OF GRADUATE STUDIES, RESEARCH AND ENTERPRISE

Master's Dissertation

Declaration

I have read the rules of Uganda Martyrs University on plagiarism and academic honesty, and hereby state that this work is my own.

It has not been submitted to any other institution for another degree or qualification, either in full or in part.

Throughout the work I have acknowledged all sources used in its compilation.

I finally grant Uganda Martyrs University permission to store and reproduce this dissertation, in whole or in part, in any manner or format, which Uganda Martyrs University may deem fi

Researcher's name: KAYENY TEDDY

Researcher's signature: 

Date of submission: 11th /09/2025

Submitted to the Directorate of Graduate Studies, Research and Enterprise

APPROVAL

UGANDA MARTYRS UNIVERSITY

DIRECTORATE OF GRADUATE STUDIES, RESEARCH AND ENTERPRISE

Master's Dissertation

Approval

This dissertation has been produced under my/our supervision and submitted for examination with my/our approval as the appointed academic supervisor/s.

Name of Supervisor (1): MUGANJI JULIUS

Signature of Supervisor: 

Name of Supervisor (2): _____

Signature of Supervisor: _____

Date of submission: 12/09/2025

Submitted to the Directorate of Graduate Studies, Research and Enterprise

DEDICATION

This project is dedicated to my best friend Mr. Abdalah Ikule who has stood with me both financially, morally and most of all during the trial moments of my life and to my other friends (Aunt Ester and Uncle Innocent) for the spirit of encouragement and counselling offered to me during the compilation of this work. To my beloved children (Karmelle Zillah Alaboth, Rapheal Eugune Mungudit & Mary Kaylee Viola Mugisa) for the utmost love and patience showed to me.

To Mr. Brian and Mr. Julius for their utmost determination through the compilation of this project and all friends and course mates who supported through this course.

ACKNOWLEDGEMENTS

I take this opportunity to acknowledge the extraordinary understanding, approval and assistance of Mr. Kasozi Brian and Mr. Muganji Julius; my supervisor who accepted to bear my endless phone calls, confusions, emails even at all hours, the several phones calls he made while following me up to have the study completed in time. Your determination, encouragement to see me through this challenge can't be taken for granted, am sincerely grateful. I also wish to thank my family members for the financial support without them I wouldn't have been able to reach this far.

I equally want to express my sincere appreciation to my lecturers in the faculty of science and course mates who helped me in one way or another during the course of my study. I appreciate Mr. Kasozi Joseph Brian, Mr. Julius Muganji and all others who have played an instrumental role in this study. I thank Dr. Liberty Amanzuru for Moyo mission Health centre for his tremendous support during the course and development of this project.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS

Initial	Full Text
PDAs -	Personal Digital Assistants
WHO -	The World Health Organization
NCDs -	Non-communicable diseases
IQA -	Interrelated Question Analysis
NIST -	National Institute of Standards and Technology
MFA -	Multi-Factor Authentication
MHSSP -	Mobile Health System Service Provider
SMS -	Short messaging service
TRIMI -	Train, Restructure, Incentivize, Mandate, and Integrate
mTrac -	Mobile Tracking System
UTAUT -	Unified Theory of Acceptance and Use of Technology
MFA -	Multi-factor authentication
MPI -	Master Patient Index
MHSSP -	Mobile Health System Service Provider
EHRs -	Electronic health record systems
HMIS -	Health Management Information Systems

ABSTRACT

This research proposes to design a framework for enhancing the adoption of healthcare services in rural areas through the use of mobile health (mHealth) technology. The research conducted as a case study in rural health centers within Moyo district with the aim of exploring the implementation, adoption and acceptance of mobile health technology solutions in improving healthcare delivery and accessibility to healthcare services and reducing healthcare disparities in resource-limited rural communities of Moyo district. A number of research methods such as survey questions, interviews and focus group discussions among others were used to collect data for analysis and understanding of the impact of mobile health in the district. The study identified key factors affecting the wide adoption of mHealth services among healthcare providers and patients. However; challenges such as limited infrastructures and connectivity, digital literacy, reluctant government policies and usability of the mobile systems have affected the adoption in these areas, poor mobile network coverage, poor road networks and poverty in the location of Gbwari and Afogi among others within Moyo district significantly impacted on communication and mHealth effectiveness. Additionally, responses to interviews were slow in these locations that were more affected and adoption of mHealth among some respondents was limited. Despite the identified challenges, the research findings highlight the potential of mobile Health technologies in bridging healthcare barriers, improving service delivery and health outcomes where feasible. This framework emphasized the need to address infrastructure and connectivity, prioritize user training and centered approaches and other adoption barriers for policymakers and healthcare providers with the aim of leveraging mHealth in rural communities in Uganda.

CHAPTER ONE

INTRODUCTION

1.1 Introduction

Mobile health technologies' usage in management of health has gained widespread global (Zhang and Ayse, 2022). The rapid advancements in mobile technologies are transforming the practice of healthcare. The World Health Organization's (WHO) global survey suggests that mHealth may significantly change health services worldwide. Additionally, the World Health Organization envisions that acceptance and usage of mobile health (mHealth) technologies will revolutionize healthcare to help people globally (Zhang and Ayse, 2022). Mobile devices are used in messaging, calls, in sharing communication on patients which has improved access to health care services and reduction in costs of transportation to health centers, increasing patients' health awareness, and has bridged a gap between the medical practitioners and the clients (Zhou et al., 2021). The World Health Organization has defined mobile health as a medical and public health practice where mobile devices, like mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices are used in management of patients. In a review article conducted by (Williams et al., 2020) on Mobile Health Technology (mhealth) used in Combating COVID-19 Pandemic: they looked at the demand for effective prevention of the spread of the virus and development measures to cure COVID-19. Mobile health technology was considered the best answer during the pandemic. It has become an essential part of the Health System and infrastructure, and is by its nature, dynamic and fast changing, majorly boosted by the electronic payment system in Uganda which increased over the years, facilitating a smooth and timely flow of goods and services.

1.2 Background

1.2.1 Mobile Health Innovations in Global Health: A comprehensive overview

Mobile Health (mHealth) innovations have become a transformative force in public health, revolutionizing healthcare services delivered and monitored globally. The review presented a detailed overview of the advancements in mHealth technologies, focusing on their roles in soliciting and utilizing health feedback on a global scale (Okolo et al., 2024). The electronic payment systems, smartphones and mobile applications have paved the way for novel approaches to healthcare delivery, monitoring, and data collection. Leveraging the ubiquity and connectivity of mobile

devices, mHealth initiatives have facilitated communication between healthcare providers and patients, ensuring real-time monitoring of healthcare services, adherence to treatment regimens, and quick payment for services and timely interventions. The solutions have demonstrated significant promise in overcoming barriers to healthcare access in underserved and remote communities. Delivering of health information, diagnostic tools, and remote consultations through the use of mobile devices, innovations have expanded the need for essential healthcare services, hence bridging gaps in healthcare delivery and improving health outcomes on a global scale (Okolo et al., 2024). Mobile Health technology has played a vital role in creation of awareness and information dissemination as a means of curtailing the spread of the coronavirus from person to person, tracking of infected persons, and reduction of person-to-person contact, virtual screening and remote monitoring of patients, remote payment for health services. The challenge of cost, potential of fraud, system failures, consumer protection, information privacy, lack of licensing criteria for those who intend to enter the mHealth ecosystem and less knowledge of the application of mHealth remains. This affects the realization of a safe and efficient national mobile health system in Uganda. It is therefore recommended that the potential of low-cost mobile technology be maximized, laws and regulation as regard to privacy and confidentiality be set, funds be made available by the government and a framework be established to provide an ecosystem that offers a seamless access to medical aid through mobile technology (Jia et al., 2015). A framework design for the mHealth system for self-management promotion is seen as a novel technology that supports self-management to improve healthcare outcomes, integrating technologies of electronics, sensors, mobile computing, communication, payment systems and medical services, and it's considered an excellent opportunity for health care, widely accepted in developing countries. Mobile Health enables continuous health monitoring at home, Health self-management, fewer hospital visits, and seamless payment for health services and lower health care cost for patients of chronic disease or experience inadequate health services, benefiting the most from a health care system.

Mobile health (mHealth) apps gained significant popularity over the last few years due to their tremendous benefits, like lowering health care costs, ease of payment for health care services and increasing patient awareness. The sensitivity of health care data makes the security of mHealth apps a serious concern. Lack of security knowledge and practices on the developers' side leads to vulnerabilities in mHealth apps (Aljedaani and Babar, 2021). The integration of multifarious technology increases complexity of functionality and the user interface, ordinary users, in particular the elderly, illiterate women and men may have difficulty in operating the mHealth system, which

results in obstacles in dealing with self-management (Jia et al., 2015). Inadequate health professionals in rural areas are a motivator for mobile technology adoption. The security of mobile apps has become a primary concerns and are more vulnerable to attacks (Aljedaani and Babar, 2021). Mobile apps collect, process, store, and transmit user, device and transactional data over various networks which compromises the confidentiality, integrity, and availability of data leading to severe consequences, fraud and financial loss. Security is a significant concern due to health-critical data privacy and integrity that is associated with the service.

As of 2024, approximately 60.42%, or about 4.88 billion people globally own smartphones, China taking global lead with 974.6, India with 659 and USA with 272.14 million users respectively. 132 million users in USA spends 5 to 6 hours daily on their smart phones (Gill, 2025). Additionally, the 2024 National Population & Housing Census in Uganda has revealed that 43 percent of individuals aged 10 years and above (13.6 million persons) in Uganda owned a mobile phone as of May 2024 (when the census was conducted). The report adds that 56.7% of the population doesn't have a mobile phone (Senyonyi, 2024). Global health progress based on SDGs; Be Healthy, Be Mobile, has empowered communities and nations through mobile technology, and this has provided access to relevant information and services hence addressing the prevention and control of non-communicable diseases. The deployment of mobile and wireless technologies with the potential to transform the face of health service delivery across the globe. There are over 7 billion mobile telephone subscriptions worldwide. Over 70% are in low- or middle- income countries where in some places people have access to mobile telephones than clean water. This has helped in improving information on treatment and behavior changes, enabling effective prevention and management of NCDs. According to Global health progress and IFPMA, (2012), empowering people, communities and nations through mobile technology provides access to relevant information and services which addresses the prevention and control of non-communicable diseases.

1.3 Problem Statement

Non-communicable diseases (NCDs), basically chronic diseases are long-lasting conditions resulting from genetic, environmental, and behavioral factors like cardiovascular diseases, cancers, chronic respiratory diseases and diabetes**.** The prevalence in most rural areas has been intensified by limited accessibility and adoption to healthcare services resulting into disparities in healthcare, delayed diagnosis and monitoring of patients, worsening disease progression due to inadequate treatment, increasing the risk of complications eventually affecting the well-being of individuals

and communities, leading to poor health outcomes. The burden on rural communities necessitates immediate investigations, examination, routine monitoring, care services and strategies for cost-effective prevention and treatment.

Developing countries have increased the deployment and adoption of mobile health systems in the management and treatment of non-communicable diseases with the aim of enhancing healthcare services through real-time monitoring, diagnosis and bridging accessibility gaps with healthcare professionals however; despite the significant potential in improving healthcare access and outcomes, the adoption and usage in Uganda and in particular the rural settings have encountered obstacles, with the 2024 National population census report showing that only 43 and 56.7 percent have and don't have mobile phones respectively. The economic disparity in Uganda has led to limited device availability, technological literacy, limited infrastructures, unreliable network coverage, lack of internet access and electricity for charging of these devices, system failures, transactional and transfer failures, price hikes, skimming of payments, systems being interoperable and un-integrated, unavailability of standards and procedures, poor or no recourse mechanism, weak complaints, queries, and dispute resolution mechanisms and lack of licensing criteria for those who intend to enter the mobile health ecosystem hence negatively impacting on the beneficiaries of these innovations.

To bridge the existing gap of adoption of Mobile Health systems in Uganda and in particular the rural communities, the research proposes to design a Framework for enhancing adoption of mobile health technology to improve access and reduce disparities in healthcare service delivery in the Health Sector.

1.4 Main Objective of the study

To design a framework for enhancing adoption of healthcare services in rural areas using mobile health technology with the aim of improving accessibility to healthcare services and reducing healthcare disparities in communities.

1.4.1 Specific objectives of the study

1. To carry out needs assessment and identification of requirements and challenges faced by rural communities in adoption of mobile health technology.
2. To design a framework for enhancing the adoption of healthcare services in rural areas using mobile health technology and integrate the remote diagnosis and telemedicine in management of the diseases.

3. To validate the design framework for enhancing the adoption of healthcare services in rural areas using mobile health technology.

1.5 Significance and justification of the study

The result from the research when shared will benefit the Uganda's National health sector and entire community of rural areas and health facilities alerting the government to scale up health technological resources to meet the identified needs in transforming the healthcare services in the rural communities.

The designed framework for enhancing adoption of mobile healthcare technology will become a support foundation for the enactment of a Mobile Health System laws and establishment of a clear understanding of roles and responsibilities of the Mobile Health system stakeholders, ensuring accountability for guaranteeing the safety of all mobile health systems, foster an environment that supports innovation and development, enhance accessibility to healthcare services, improve remote diagnosis, treatment, monitoring and bridging of the economic disparities amongst the underserved communities leading to better disease management.

1.6 Scope of the study

The scope of the study focused on three areas, that is; content, geographical and time.

1.6.1 Content scope

The research was focused on designing a framework to enhance the adoption of mobile healthcare services in rural communities through the use of mobile health technologies like mobile phones. It looked at the nature and application of these technologies in Moyo district and the results were translated to other communities in Uganda as a country.

The research focused on non-communicable disease management in the rural communities, how the mobile health technology adoption can enhance diagnosis, telemedicine and bridge communication between stakeholders.

1.6.2 Geographical scope

The study on mobile healthcare technology was conducted in Moyo district. The district is located in the West Nile sub-region, bordered with River Nile and Adjumani to the East, Yumbe to the West, Kajo Keji Central equatorial state of South Sudan to the North and Obongi to the South. The district was created in 1956 before Uganda's independence. The 2024 National Housing and Population Census indicates that the population of Moyo District is 109,572 in the different parishes and villages that benefited from the study. The population provided a greater opportunity of getting

respondents including medical officers, HMIS officers, Pharmacists, clinicians, Laboratory technicians, Nutritionists, Nurses, District Health team members, supervisors, Sub County Health Officers, local leaders and patients of Moyo district.

1.6.3 Time scope

The study was gender sensitive on both health practitioners, patients and attendants in the different health facilities who were deployed from 2021-2025 and was conducted under the Moyo general hospital and the defined health outreaches to ascertain the requirements.

1.7 Target Population

The research aimed at the most vulnerable individuals in the rural areas, persons with chronic illnesses, elderly persons, and the demographic breakdown by age cohort and gender in the rural areas in Uganda.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter basically looked at the different design frameworks on mobile health technologies in management and control by healthcare services in the communities, the wide use of mobile health in health disciplines, medicine and public health. Mobile health is seen as the means of health services and information delivered via mobile technologies, reducing travel time and transport costs and promoting remote healthcare services in the community. This chapter looked at the global perception of mobile health and the views of Uganda in embracing the technology.

2.2 Existing frameworks in Uganda

2.2.1 Mobile Health Access and Utilization in Uganda

In accordance to (Mercy Takuwa et al, 2023) a research article published online on 01 June 2023, on Mobile Health Access and Utilization in Uganda: Knowledge, Attitudes and Perceptions of Health and Veterinary Workers, The increasing contribution of mobile health globally. Despite its strong growth in many parts of the world, mobile health access is still limited in low- and middle-income countries. There are several factors affecting the implementation of mobile health in developing countries, including the lack of information security, inadequate evidence to support sensitization, and user acceptance of the system. Insufficient evidence has been obtained on current practices, perceptions, and user acceptability. The study aimed at evaluating the knowledge, attitudes, and perceptions of the community in the usage and acceptance of mobile health among health workers and veterinary officers in Uganda. A cross-sectional study was carried out, aiming at health practitioners in health centers, hospitals, and veterinary laboratories/clinics using a structured questionnaire and Google survey forms to collect data. Identified health workers were interviewed; focus group discussion was held with different groups. A target of 120 health practitioners, of which a total of 80 health workers and 7 veterinary practitioners participated in the study. 46 percent and 54 percent were men and women, respectively. A large population of health workers knew about the m-health but had never accepted and used it, 15 practitioners earlier used but for other purposes not for disease diagnosis in hospitals though some of them used it to order medicine online, patient consultations, interpretation of medical results, women tracking their menstrual cycles, assessment for tuberculosis patients. The practitioners expressed significant interest in mobile health to address critical challenges of managing patient data and long patient

queues, which enhanced service delivery in the community. The community has continued to express their uncertainties on accessibility since most persons lack smartphones and stable internet.

2..2.2 Enhancing the Implementation and Integration of mHealth Interventions in Resource-Limited Settings: A Scoping Review;

According to (Wilson Tumuhimbise et al., 2024), in a review of article enhancing the Implementation and Integration of mobile Healthcare Interventions in Resource-Limited Settings. Mobile health (mHealth) is defined as a healthcare delivery system conducted through the use of mobile devices to enhance accessibility to healthcare services and support the performance of health workers. It facilitates remote access to previously hard-to-access specialized healthcare services. Mobile apps are among the most often used mHealth interventions which provides users with reliable and affordable high-quality evidence-based health information. The number of mobile phone subscribers in developing countries has continued to increase, with over 6.91 billion users as of 2021, surpassing the total population of 6.61 billion people in low-middle-income countries (LMICs). This exponential growth in subscription offers an opportunity for the utilization of mobile applications (apps), short messaging service (SMS) reminders, or wearable devices (smartwatches, armbands) in mobile-based interventions.

The acceptance and adoption of mHealth interventions in routine care remains minimal, especially in low-resource settings with inadequate interventions. This can be attributed to short-term pilot studies funded by donors and limited understanding between key stakeholders, taxation, and a perceived lack of evidence among donors and governments about the effectiveness of mHealth. Additionally, mHealth intervention utilization is still limited by evolving technologies due to the frequent release of new devices and platform incompatibility issues that affect proper functionality. Several other factors, such as upgrades on these platforms, are beyond the developer's control and affect the stability of these interventions. The selection of mobile phones on which these interventions run raises several questions of whether to provide users with phones to use the intervention or to install an intervention on the user's phones; the former may be costly in terms of procuring new mobile devices, and the latter might face incompatibility issues and might decrease the frequency of usability. All these issues present unique requirements for the deployment of mobile Healthcare interventions in comparison to alternative interventions.

The complexity in healthcare systems, characterized by busy schedules dealing with patients in addition to limited or no motivation, fatigue in working in rural settings, can lead to life-changing interventions, hence improving healthcare outcomes. Healthcare systems, especially in LMICs, are

characterized by disorganized leadership structures, a high doctor-to-patient ratio (1.3 per 1000 compared to the WHO-recommended 2.5 per 1000 and an already overburdened health sector. Moreover, additional requirements for the implementation of mHealth interventions can potentially increase technological fatigue and extra workload for healthcare workers. The development of interventions that do not address the factors highlighted above may render mHealth interventions useless due to a lack of uptake and implementation.

To scale up the implementation, the article developed sets of domains such as the TRIMI (Train, Restructure, Incentivize, Mandate, and Integrate). The TRIMI framework proposes that for the sustainable implementation and integration of mHealth interventions to occur, intervention users must be trained, the usability environment should be restructured, users should be incentivized and mandated to use the intervention, and the intervention should be integrated within the routine workflow. Failure to meet these criteria may compromise the successful implementation and integration of the intervention.

2..2.3 Adoption of Mobile Health in Uganda Health Facilities: A Case Study of Mobile Tracking System in Kayunga.1

According to Ejiri et al. (2016), the Mobile Tracking System (mTrac) is a mHealth system in Uganda that was implemented in all government-owned health facilities to provide information on epidemic disease outbreaks and drug stockouts of essential drugs. Despite its implementation in all government health facilities, there is some evidence of low reporting rates by end users. The study investigated the factors that influenced the adoption of the mTrac system in Kayunga district health facilities. A total of 90 respondents were trained to use the mTrac system. These use questionnaires for data collection, performance expectancy, facilitating condition, social influence, and effort expectancy were the results that positively influenced the adoption of the mTrac system in Kayunga district health facilities while the costs of mobile devices negatively impacted its adoption.

Despite the implementation of mobile health systems in Uganda, there are various challenges and barriers that affect their success being a new health technical innovation. Albabtain and AlMulhim, and his colleagues noted that there are a number of challenges in Uganda to allow effective use of mHealth. Poor network reduces effectiveness, unreliable, expensive internet, and inaccessibility of

[1] *American Scientific Research Journal for Engineering, Technology, and Sciences (ASRJETS)ISSN (Print) 2313-4410, ISSN (Online) 2313-4402© Global Society of Scientific Research and Researchers, Factors Influencing the Adoption of Mobile Health in Uganda Health Facilities: A Case Study of Mobile Tracking System in Kayunga.*

electricity remains a major challenge. The purpose of this paper, therefore, is to investigate the factors that influence the adoption of the mTrac system in Kayunga district health facilities.

There is little literature concerning the adoption of the mTrac system. The study provided useful information to the Ministry of Health on the adoption of the mTrac system in Kayunga district, and the results for generalization to other districts with similar characteristics in Uganda and other developing countries. The study provides new insights to policymakers on the policy issues that need to be addressed to improve the adoption and usage of the mTrac system in rural districts of Uganda. The study further supports researchers through the contribution of literature on mHealth adoption and the barriers to its adoption in Uganda as a developing country.

2.2.4 Mobile Health in Uganda: A Case Study of the Medical Concierge Group2

In article by Louis H. Kamulegeya et al. (2019), the integration of digital technologies in health-care delivery in Uganda has gained momentum in past decade, coinciding with increased access to the Internet across the country. Mobile phones provide an ideal means of targeted health information dissemination because of their portability and ubiquity. Short messaging service (SMS) functionality is used in disease surveillance and patient notifications to remind people about health facility appointment dates or to take their medications – all as means of improving public health outcomes.

Interventions relying on mHealth have also been implemented to improve health worker performance; for example, during Malaria Consortium's programme implementation in the northern and eastern parts of Uganda, text messaging was used to increase awareness and improve coverage of intermittent preventive treatment for malaria among health workers. Additionally, mobile phones have been used to facilitate remote consultations among health workers.

Mobile phone approaches have also been used for the timely delivery of medical laboratory test results. A study done in southwestern Uganda revealed a high level of acceptability of text messaging as a mode of delivery for laboratory investigation results among a cohort of HIV-positive clients. Mobile technologies have also been used for data and information collection by the Uganda Ministry of Health on tuberculosis and malaria monitoring. The limitations of these interventions in low-income countries include inaccessibility to mobile technology and the Internet. TMCG's

[2] *Tue, 26 Mar 2019 in East Africa Science,Mobile Health in Uganda: A Case Study of the Medical Concierge Group Louis H. Kamulegeya ,Joseph Ssebwana,Wilson Abigaba,John M. Bwanika,Davis Musinguz*

mHealth clients are disproportionately distributed in urban areas, particularly in Kampala and Wakiso.

2..2.5 Investigating the Adoption of an Integrated Hospital Information System in Rural Uganda: A Case of Kisiizi Hospital3

According to Amos Baryashaba et al. (2019), Electronic Medical Records (EMRs) have been proposed to enhance the quality of services in healthcare organizations. However, sometimes, the design contexts of these systems tend to be different from the use contexts. This and other factors were reported to cause failures of EMR adoptions. Focus is on factors influencing the Unified Theory of Acceptance and Use of Technology (UTAUT) model, we use interviews and questionnaire as data collection instruments to study the adoption of an EMR which was locally developed in rural Uganda; to generate lessons that would sustain the use of the EMR. We found out that all of the following factors, from the UTAUT model, significantly affected the usage of the system and, consequently, facilitated the adoption of the EMR at Kisiizi Hospital: expected improvement in job performance, the easiness with which the system is learnt and used, support and influence from management and peers, and the availability of organizational and technical infrastructures supported the use of the system. All of these were largely due to the fact that physicians from Kisiizi Hospital initiated and drove the system development and implementation processes, making sure that correct requirements were captured, and championing the system use by staff at the hospital. Several factors affected the acceptance and usage of the locally developed EMRs in low-income settings in rural Uganda. The following factors, mainly attributed to users 'initiatives and continuous involvement, were found to have largely affected the adoption of the EMR: expected improvement in job performance, the easiness with which the system can be learned and used, support and influence from management and peers, and the availability of Organizational and technical infrastructures supported the use of the system. Part of our future work is to evaluate the adoption of the system with large numbers of users, and from all of the five hospitals that are using the system; to generate more insights on the effectiveness of locally developed EMRs in low-income settings.

---

[3] **Investigating the Adoption of an Integrated Hospital Information System in Rural Uganda: A Case of Kisiizi Hospital**

April 2019, IFIP Advances in Information and Communication Technology, DOI:10.1007/978-3-030-19115-3_26In book: Molecular Logic and Computational Synthetic Biology (pp.316-325). Authors:Amos Baryashaba, Mbarara University of Science and Technology, Angella Musiimenta, Mbarara University of Science and Technology, Samuel Mugisha ,Mbarara University of Science and Technology, Leonard Peter Binamungu, The University of Manchester

2.3. Existing frameworks globally:

2.3.1 The adoption of mobile health applications by physicians during the COVID-19 pandemic in developing countries: The case of Saudi Arabia.[4]

The article by Sultan Alsahli et al. (2024), pointed out that the rapid evolution of mobile health applications (mHealth apps) in healthcare management has become increasingly important in enhancing healthcare delivery, this was noted during the COVID-19 pandemic where mobile technologies played very critical role in management and control of the disease, The acceptance and adoption rates among physicians in developing countries like Saudi Arabia that were relatively low equally improved during the pandemic. They called for measures to explore the determinants for acceptance and full usage of the system in management of all type of diseases. The need to identify key factors that would influence physicians' acceptance and adoption of mHealth apps during the COVID-19 pandemic based on the unified theory of acceptance and use of technology.

Google online survey forms were deployed to ensure accurate data collection and all the responses would be extracted and analyzed. The results from the analysis would be used as a basis to influence four primary constructs, namely, performance expectancy, effort expectancy, social influence, and facilitating conditions, on the physicians' behavioral intention to adopt these technologies. The key findings would be a basis for investing in infrastructural enhancements, user training programs focused on integrating mHealth technology into medical practice. By drawing attention to influencing factors, this research provides critical insights for policymakers and healthcare managers to enhance the adoption of mHealth apps. This enhancement, in turn, can help improve healthcare delivery and patient outcomes during and beyond health crises. Finally, this study not only sheds light on the adoption dynamics prevalent in a developing context but also serves as a valuable guide for implementing similar technologies in other global regions.

2.3.2 Leveraging mobile phones to attain sustainable development.[5]

Billions of people globally have access to mobile phones which has enable relatively cheap and efficient communication and easier access to vital information and services on healthcare,

---

[4] *International Journal of Information Management Data Insights Volume 4, Issue 2, November 2024, 100289, The adoption of mobile health applications by physicians during the COVID-19 pandemic in developing countries: The case of Saudi Arabia,Author links open overlay panelSultan Alsahli [a] [b], Su-yin Hor [a] https://www.sciencedirect.com/science/article/pii/S2667096824000788*

[5] *Leveraging mobile phones to attain sustainable development, Valentina Rotondi https://orcid.org/0000-0003-0879-7635 valentina.rotondi@sociology.ox.ac.uk, Ridhi Kashyap https://orcid.org/0000-0003-0615-2868, Luca Maria Pesando https://orcid.org/0000-0002-1690-7163, +1 , and Francesco C. Billari https://orcid.org/0000-0003-4717-6129Authors Info & Affiliations, Edited by Barbara Entwisle, University of North Carolina at Chapel Hill, Chapel Hill, NC, and accepted by Editorial Board Member Mary C. Waters April 6, 2020 (received for review May 30, 2019) June 1, 2020117 (24) 13413-13420, https://doi.org/10.1073/pnas.1909326117*

education, society, and the economy at large. Context-specific evidence on the impact of the digital revolution provides empirical support for the idea that mobile phones are crucial for sustainable development at the global scale. It's done through assembling a wealth of publicly available macro- and individual-level data that explore a wider range of demographic and social development outcomes leveraging a set of methodological approaches. Major analyses of over 200 countries reveal that mobile-phone access is associated with lower gender inequality, higher contraceptive uptake, and lower maternal and child mortality. This is due to constant interaction with health experts using mobile communication and information sharing which reduces the level of mortality and enhance services. Individual-level analyses of survey data from sub-Saharan Africa, combined with detailed information show that women who own a mobile phone are better informed about sexual and reproductive health services and empowered to make independent decisions as compared to those who lack these mobile devices. Payoffs are larger for least-developed countries those disadvantaged ones. The entire findings suggest that boosting mobile-phone access and coverage across the globe closes digital divides among women which is a powerful tool in attaining sustainable development goals, a significant effort in poverty reduction and enhancement of population health and well-being.

2.4 Frameworks:

2.4.1 Australian mHealth Apps Assessment Framework, Development and Validation of the Framework.

The Australian mHealth Apps Assessment Framework was developed by the Australian Digital Health Agency to address the challenges consumers and healthcare professionals face in selecting credible mHealth apps. It provides a comprehensive set of criteria for evaluating the quality, safety, and effectiveness of these apps. The development process requires extensive consultation with stakeholders, including government bodies, academic institutions, and industry experts, ensuring a broad representation of perspectives and expertise.

In 2023, a validation study was conducted as part of the project to test and validate the Framework's efficacy and applicability. This involved a targeted approach, engaging key stakeholders from government and industry to develop an initial baseline of test results. The study, supported by Deakin University and a team of independent assessors, evaluated a selection of mHealth apps against the Framework's criteria, providing valuable insights into its practical application and areas of possible refinement. To implement the refined Framework, the development of a clear and

standardized assessment procedure and an online system for recording assessment data is a consideration. This would facilitate a more streamlined and efficient assessment process for app developers and other stakeholders. Additionally, establishing a governing body to oversee the Framework's ongoing refinement and application is crucial for ensuring its sustainability and relevance.

2.4.2 A framework for designing persuasive mobile healthcare applications.

This research presents a framework for designing persuasive mobile healthcare applications. The aim of the proposed framework is to help the analysis and design of mobile healthcare apps. Two versions of the framework are presented. A study was conducted with experts in order to test the framework and also to provide suggestions for it. The test with the experts showed that the framework was able to help identify the strengths and weaknesses of the applications and proved to be effective. The proposed framework will help designers and programmers to design and analyze mobile applications with a persuasive character, and thus assist users in changing and maintaining healthy behavior.

2.5. Research Gap.

The research gap identified in the provided literature in the use of Mobile Health technology was the need for a generalized framework tailored to towards the identified challenges of the Mobile Health system in Uganda. As witnessed from the multiple research studies made about Mobile Health technology, there's lack of a framework that comprehensively addresses the restricting factors of implementation of the service right from the lack of information security, insufficient evidence base, low sensitization, user acceptance, low-resource settings where the majority of suggested interventions were not scaled up as expected.

The research gap identified in the provided literature in the use of Mobile Health technology was the need to design and framework tailored to towards the identified challenges of the Mobile Health system in Uganda. As witnessed from the multiple research studies made about Mobile Health technology, there's lack of a framework that comprehensively addresses the restricting factors of implementation of the service right from the lack of information security, insufficient evidence base, low sensitization, user acceptance, low-resource settings where the majority of suggested interventions were not scaled up as expected.

The theory of Acceptance and Use of Technology (UTAUT) model, was used to understand the generalized challenges were identified as key factors that influence the adoption of

Figure 1: Conceptual framework for generalized mobile health systems

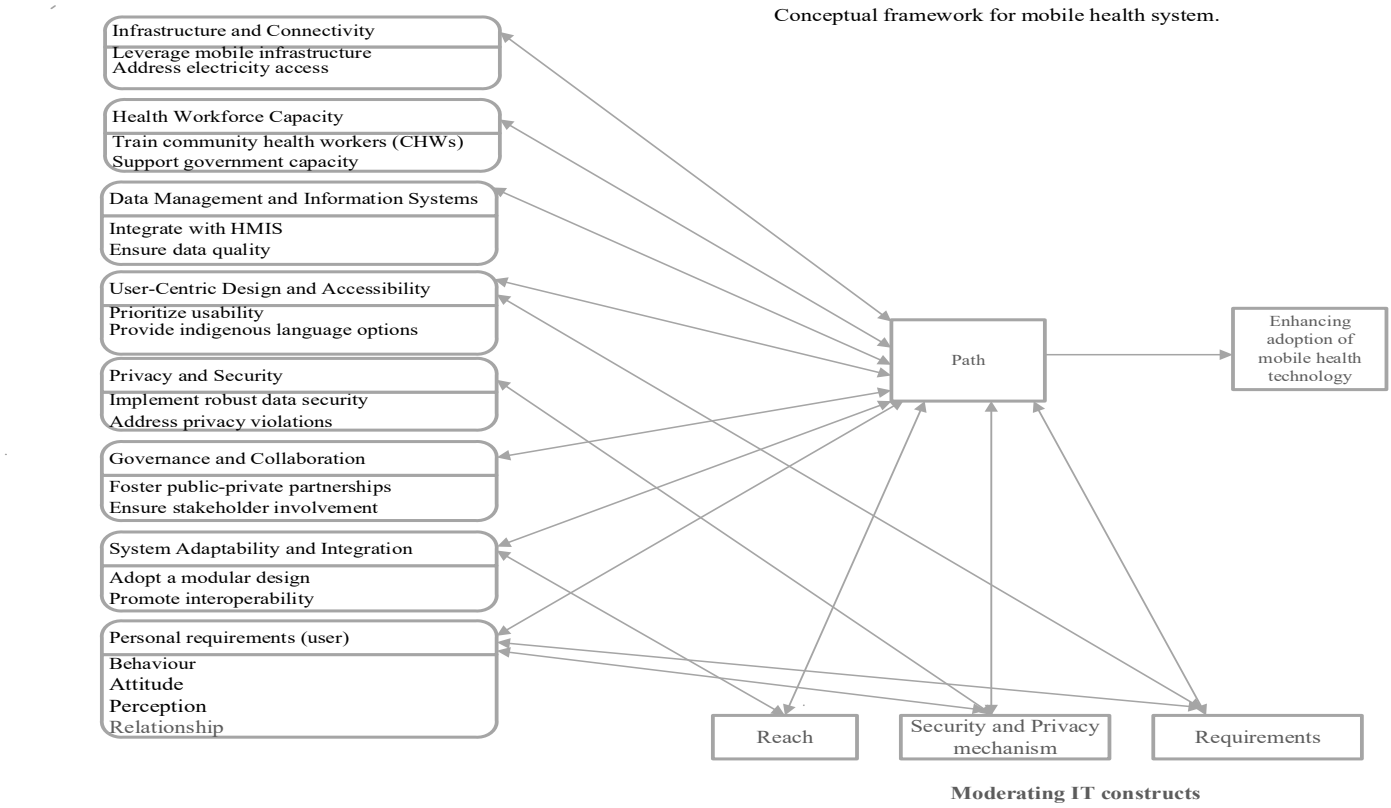

Table 1: The generalized framework of mobile healthcare systems and proposed solution to adoption of mobile health services in enhancing accessibility to healthcare services

Identified challenges	Description of challenges	Framework component	Proposed Solution
Inadequate infrastructures	Unreliable, limited internet connectivity, limited access to electricity, solar power, limited device availability, poor road networks that hinder adoption of mhealth in Moyo district rural areas.	Infrastructure and Technology	Expansion of reliable internet access across the community and increase electricity distribution in low resource areas in Moyo district to enhance digital health tools and adoption by the community. Design simple and easy to understand interfaces to allow harmonized communication
Workforce concerns	Inadequate qualified health profession living in the rural areas, poor staff accommodation, welfare, limited training on digital technology tools, those trained are in other fields, not on mhealth, acceptance and usage reduce system effectiveness.	Workforce development	Ensure enhanced literacy on digital tools, provide training to healthcare professionals and community healthcare workers (CHW) on how to use and interprete the tools. Provide support capacity building initiative to enhance skills for health workers, improve accommodation to motivate and keep them.

Data management and security of information system	Poor quality of data storage and management of health records, late reporting, limited data capture from community, inadequate health record from private and community healthcare providers	Data management and information systems	Improve quality of data through mechanism of accuracy and completion, timely submission and reporting in the mobile health systems. Data collection on all health facility like private and community.
Policy and Regulations	Lack of clear National framework for health and its limited implementation, the government policies are not clear on the adoption and usage of mhealth. Records are limited track and implement.	Governance and Policy	Enhance multi-stakeholder coordination's and collaborations to promote partnership between government, community and private sectors to ensure resources and experiences are put together to increase outcome.
Financial concern	Inadequate funds / resources to sustain the health sectors, models for mhealth initiatives have affected person's adoption due to increase cost that has been left on patients.	Financial sustainability	Government to provide strong and effective policy regulatory and strategic guidelines aimed at sustainable digital health system.
Accessibility and equity	Inadequate mhealth services reach people in rural areas of Moyo. Accessibility has been affected by increased cost and infrastructure's, inadequate awareness programes.	Accessibility and equity	Extension of services nearest to many persons with the aim of improving transport cost by doing community outreach so that services are in the community, where everyone can easily have access to the system to interact with it.
User Engagement	Inadequate training provided to the users/community health workers (CHW)on the tools, to ensure mhealth tool as user-friendly, relevant to the and builds trust in the community among the CHW which is vital for adoption and usage.	User and community involvement	Deploy multi approaches such as SMS, voice calls to ensure effective communication and builds trust amongst users. Provision of training to users on tools and making the system user-friendly to enable adoption and ease of accessibility to the system
Privacy and Security	Indequate security and provide measure in place to ensure unauthorize access to the system which compromises the quality of data recorded.	Privacy and Security	Provision of policies that guide the use of access control, introduction of multi-factor authentications (MFA), biometric to ensure secure login to system and protect data form malicious loose.
Personal attributes	Poor attitude and perception on the need to adopt and use the mobile health system, the behaviour of individuals in response to mobile health services is still poor	Personal attributes	The personal requirement of each user such as behaviour, attitude and perception and relationship, where they need to change their perception and appreciate the introduced initiative of mobile health services, enhance relationship between

	The relationship between medical personal and patients not adequate to enhance adoption of the system in place.		doctors and patient on face-to-face interaction, so that when they are on virtual communication, then are able to interact with ease. This can be through capacity enhancement of the participants
Path	This is a mediator factor or dependent entity/variable that must be fulfilled, in this case, that for the rural areas of Moyo district to adopt and use the mobile health system, then is need for the community to have solved number of challenges identified that negatively impacts on them.	Path	The several identified gaps must influence path to achieve the desired need. The identified challenges can not meet adoption if they are not solved, such as enhance electricity distribution to enable charging of mobile devices, internet services etc
Reach	Geographical barriers prevent many patients from accessing traditional healthcare in rural areas of Moyo	Reach	Mobile health systems bridge the identified gap by bring services directly to the patients and by passes the geographical barriers.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter outlined the methodology employed to design a framework for enhancing adoption of healthcare services in rural areas using mobile health technology. The Onion theory represented a multi-layered approach to investigation and analysis, undertaken to meet the requirements of the study. Just as an onion has multiple layers that need to be peeled back to reveal its core, research utilizing the Onion Theory involves progressively delving deeper into layers of understanding to uncover comprehensive insights.

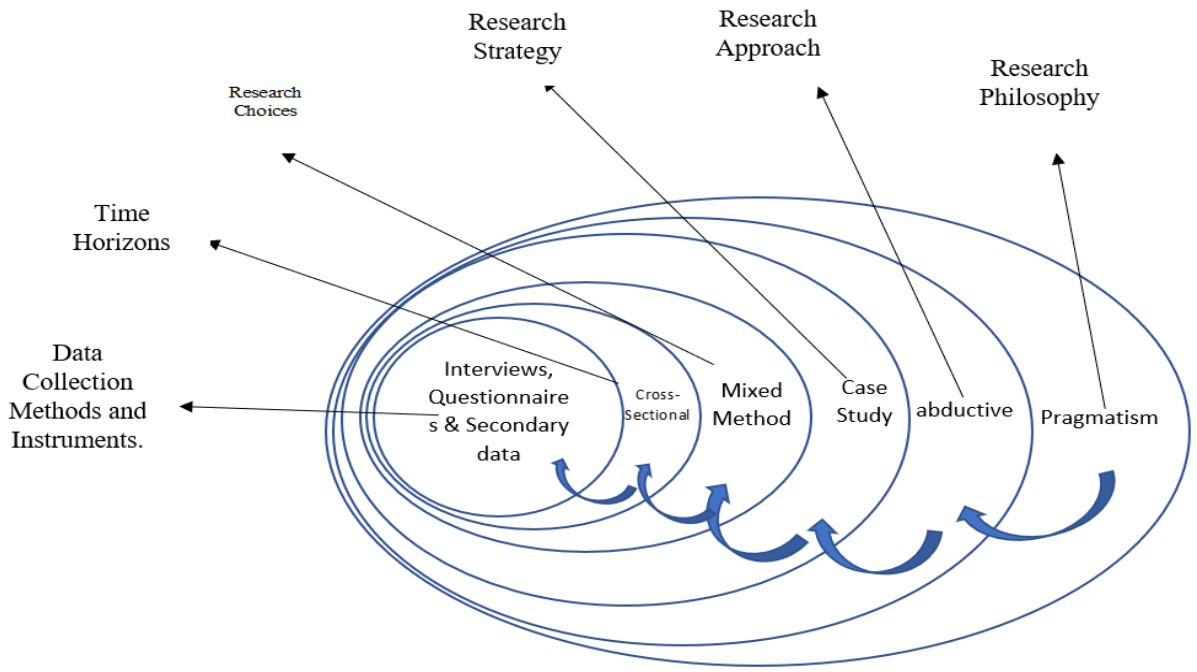

Figure 2: Research Onion Theory

3.2 Research Philosophy.

This is basically the lens that is used to understand the world when conducting investigations on an area of study and a belief of how data about a phenomenon is gathered, analyzed, and used (UKEssays. 2018). It serves as the foundation upon which the entire research process was built, shaping the perspective of the researcher, the methods used and reasoning. Our research study was stemmed from the epistemological point of view through the adoption of the pragmatism research

philosophy, as the knowledge obtained was based on the reality, we had to figure out from the communities to establish its limitations.

3.2.1 Pragmatism Research Philosophy.

The Pragmatism research philosophy was used to highlight the importance of using the best tools possible to investigate a phenomenon. The philosophy approaches research from a practical point of view where knowledge is not fixed but instead is constantly questioned and interpreted. In pragmatism, the truth of a theory or belief is measured by its success in practical application (Jacqueline Pei, 2013). The approach focuses on the outcomes and effects of ideas and posits that concept must be tested through practical experiments and real-world outcomes to be understood and validated (Jacqueline Pei, 2013).

The researcher embraced pragmatism as the guiding research philosophy for designing a framework for enhancing adoption of healthcare services in rural areas using mobile health technology aiming at improving accessibility to healthcare services and reducing healthcare disparities in communities. Pragmatism was chosen to ensure that the study's outcomes directly respond to the limited accessibility and adoption to healthcare services, system failures, transactional and transfer failures, price hikes, skimming of payments, systems being interoperable and un-integrated, unavailability of standards and procedures, poor or no recourse mechanism, weak complaints, queries, and dispute resolution mechanisms and lack of licensing criteria for those who intend to enter the mobile health ecosystem challenges, as experienced by the communities in remote areas.

3.3 Research Approach.

Research approach is the broader method used for research and selected for guiding data collection, analysis, and interpretation. A structured plan that helps in determining how to investigate a research problem effectively using the common approaches such as quantitative, qualitative, mixed research Methods and inductive research approach was used for the research study.

3.3.1 Inductive Approach.

In this approach, the research study begun with observation and data collection relevant to the topic of establishing a framework for the adoption and acceptance of Mobile Healthcare services which enabled the development a theory that explains the identified patterns. It’s used in reasoning to draw a conclusion based on observed evidences, data collected, patterns analyzed and theory developed on the patterns.

3.4 Research Strategy.

This details how the study is conducted. In Science direct journals and books, research strategy is defined as specific plans and methodologies outlined in a research project to address the objectives and research questions, advance the field, and overcome barriers to progress. The strategy will support in laying down the strategic plans and methods that will guide the acquisition of the information required. A case study research strategy to be used in understanding of the challenges, environment operations and requirements of Mobile Health Technology with particular focus on the people with chronic illnesses in Moyo District. It offered a fine approach of allowing in-depth exploration of real-world phenomena within their natural contexts. By focusing on Mobile Health Technology and examining its implementation across healthcare centers, hospitals, clinics, pharmacies, laboratories and patients with chronic illnesses, we aimed to capture diverse perspectives and experiences related to use of the services.

3.5 Case Study.

In an article by (Kendra Cherry, MSED, 2024), A case study is an in-depth study of one person, group, or event where every aspect of the subject's life and history is analyzed to seek patterns and causes of behavior. The strategy was used to gain an in-depth study of the Mobile Health Technology with the objective to gain an in-depth understanding of the study.

3.6 Research Choices.

(Saunders, 2019) Describes research choices as the selection between quantitative, qualitative, and mixed methods research. They highlight the importance of choosing the appropriate approach based on the research question, objectives, and the nature of the data. They categorize research choices into mono-method which is a single data collection technique and corresponding analysis procedures, multi-method which are more than one data collection technique and corresponding analysis procedures, and mixed methods combining both quantitative and qualitative data collection techniques and analysis procedures.

This study employed a mixed-method approach, combining both qualitative and quantitative methods, to comprehensively explore the challenges for low adoption of Mobile Health Technology, security challenges and requirements specific to Mobile Health Technology in Uganda, focused on patients with chronic illnesses within the Ugandan healthcare landscape, Moyo district.

In designing an enhanced framework for adoption of Mobile Health Technology, employing a mixed research method combines surveys and interviews offering a multifaceted approach to data collection.

3.6 Time Horizon.

The researcher used a cross-section time horizon, considering the time limit factor of conducting research. A cross-sectional study looks at data at a single point in time (Saunders, 2019). Given the practical limitations of time and resources, a cross-sectional time horizon allowed the researcher to efficiently capture a snapshot of the state of art Mobile Health Technology security practices, challenges, and stakeholder perceptions within the Ugandan healthcare landscape, Moyo District. This approach acknowledged the need for timely insights informing the development of the Mobile Health Technology framework while balancing the constraints of conducting comprehensive longitudinal research.

By leveraging a cross-sectional time horizon, the researcher effectively collected data from diverse sources across different healthcare facilities within Uganda, providing valuable insights into adoption and use of Mobile Health services, prevailing security measures and identifying areas for improvement. This approach doesn't capture longitudinal changes but it offers a practical and insightful means of understanding the operational landscape of Mobile Health services in Uganda within the confines of the research scope and timeframe

3.7 Data Collection Methods and Instruments.

Data collection employed mixed methods often referred to as triangulation. Triangulation involves studying a specific scenario from multiple perspectives (Neuman, 2011). This approach enabled the collection of extensive and detailed data, facilitating comparison. The methods utilized included interviews, surveys, and document review.

Data collection is an important aspect of any type of research. As mentioned, (Lopes, 2010). Qualitative studies normally rely on permitting researchers into the personal lives of participants. To facilitate this process, flexible and varied methods are required. This study therefore used Surveys and interviews. The rationale for the use of more data collection methods is to minimize the shortcomings of using a single data collection method. More data collection methods enabled the researchers to benefit from the advantages associated with triangulation. Primary data was collected using both interviews and surveys.

3.7.1 Surveys Method.

Surveys were employed to gather quantitative data from different patients with chronic illnesses, IT Professionals, M&E Staff, Medical officers, supervisors and health professionals working with Moyo District health service commission, and patients with chronic diseases. These surveys were designed to capture various aspects of their experiences and perceptions regarding the operation and adoption of Mobile Health services. By using structured questionnaires, the research aimed to systematically assess the operational landscape of Mobile Health Services from their perspective based on their daily interactions.

The surveys included both closed and open-ended questions to balance between quantifiable data and more nuanced insights. Closed-ended questions provided measurable data on specific security issues, while open-ended questions allowed respondents to elaborate on their experiences and suggestions for improvement. This mixed-method approach ensured comprehensive coverage of the topic.

3.7.2 Data Sources.

The surveys were distributed to both Mobile Health and Non-Mobile Health users in all the region of Moyo District in Uganda interacting ensuring a diverse sample. The survey forms were made available both online and issue in hard copy for those who had challenges with internet access. This included urban and rural health centers to capture a wide range of contexts and challenges.

3.7.3 Purposive sampling.

Purposive sampling was employed to select participants who were to provide valuable insights into the development of an Enhanced Framework for mobile health Systems in Uganda. Purposive sampling was chosen due to its ability to target specific individuals with relevant expertise and experience in framework design and mobile technology.

Participants were selected based on criteria such as their roles within the healthcare system of Moyo district, their involvement with mobile Health technology systems, and their expertise in security practices. This approach allowed collection of detailed and context-specific data essential for addressing the unique challenges faced during the adoption and use of Mobile Health systems in Uganda.

The sample consisted of key stakeholders, including **IT Professionals:** Staff managing the technical aspects of the mobile systems and application development, whose expertise provided critical information on the robustness of mobile systems, current security measures and technical vulnerabilities. **Monitoring and Evaluation (M&E) Staff:** Personnel involved in the assessment

and improvement of health services, the feedback helped in determining the adoption of mobile health services and overall effectiveness of security protocols from a system performance perspective. **Health Professionals:** Doctors, nurses, pharmacists, clinicians, laboratory attendants, District Health Officers and other medical staff that regularly interact with Mobile Health systems to serve patients and whose experiences highlighted practical security concerns in daily clinical operations.

By analyzing the responses, the research aimed to identify common trends and issues, providing a foundation for recommending targeted improvements the use and adoption of mobile health services. The collected data was crucial in developing a framework for use and adoption of mobile health technology tailored to the challenges faced by patients with chronic illnesses in Moyo district and health facilities in Uganda at large.

The Respondents

The T*able 2* below shows the respondents designation and number of respondents

Table 2: Respondents

SN	Designation	Number of Respondents
1	Patients	17
2	Lab Officer	2
3	M & E Officer	4
4	Medical Officer	4
5	MEL Advisor	1
6	Nurse	5
7	Pharmacist	1
8	Quality Improvement Assistant	1
9	Systems Administrator	5
10	Data Officers	2
11	ICT/IT	3
12	Software Developer	2
13	Database Administrator	1
14	Senior IT Officer	1
15	HIS Lead	1

16	MIS Officer	1
17	Counsellor	1
18	HIS Analyst	1
	Total	**53**

The study comprised a total of 53 respondents who included patients with chronic illnesses, IT staff, data staff, medical staff, lab staff, monitoring and evaluation (M&E) staff, and store personnel.

3.7.4 Interview Method

Interview methods were conducted with five key individuals, including an IT Officer, a Software Developer, a Health Information System Analyst, and two Systems Administrators. These interviews aimed to gather in-depth qualitative data about their experiences and perceptions regarding the use and adoption of Mobile Health Services by communities in Moyo district. By using semi-structured interview guides, the research sought to systematically explore the operational landscape of mobile health systems from the perspective of those who interact with them daily for delivery of health services.

3.8 Data source:

The primary data source comprised semi-structured interviews with key participants, including IT Officer, a Software Developer, a Health Information System Analyst, and two Systems Administrators. Due to limited resources, only 5 participants were interviewed as summarized in **Table 3**. The selection criteria were based on roles and expertise in managing and interacting with the EHR systems, providing a detailed understanding of the security landscape. The first-hand experiences and insights were crucial in identifying the strengths and weaknesses of the current EHR security practices, allowing assessment of the system's vulnerabilities and the development of targeted recommendations for improvement.

Table 3: Interview Respondents

SN	**Title**	**Number**
1	IT Officer	1
2	Software Developer	1
3	Systems Administrator	2
4	Health Information System Analyst	1

Research Questions:

1. What are the healthcare needs and challenges identified by the rural communities that require the use and acceptance of mobile healthcare systems?
2. What are the challenges affecting the acceptance of mobile healthcare technology in rural areas?
3. How have these challenges negatively impacted on the accessibility to healthcare services in rural areas?
4. What are the major requirements for enhancement of mobile healthcare services in rural areas?
5. What are the benefits rural communities consider in improving healthcare accessibility?
6. What are the major limitations identified from the use of mobile healthcare systems?
7. What are the major challenges identified by the rural communities in accessing healthcare services and how can the use and acceptance of mobile healthcare systems help to bridge the gaps?
8. What are the characteristics of the rural community which may impact on the use of the proposed mobile technology?
9. What are the current established infrastructures in the rural community and how can the acceptance of mobile healthcare technology improve on the existing infrastructures?
10. What is the current system in use by the healthcare service providers and patients in the rural communities?
11. What are the technical requirements for implementing remote diagnosis and telemedicine in rural community?
12. How can the healthcare service providers be supported to effectively use mobile technology in enhancing healthcare services in rural community?
13. What are the merits and concerns of using remote diagnosis and telemedicine in rural areas?
14. How can the challenges identified be solved?
15. What are the most suitable ways of enhancing adoption and usage of mobile health technology in rural areas?
16. What components are considered in enhancing the usage of mobile healthcare technology in improving service delivery in rural communities?
17. What can be considered in designing a mobile health technology that will ensure seamless integration with the current health care system being used in rural areas?
18. How can the designed framework for improving healthcare services in rural areas be integrated to ensure the remote diagnosis and telemedicine in management of the diseases?

19. What are the security threats and privacy consideration for the mobile health technology?
20. What are the current healthcare frameworks in use in the rural communities?
21. How can the mobile system be improved to suit the requirements of the rural communities?
22. Can the proposed mobile healthcare system address the identified needs of the rural communities?
23. How do the stakeholders consider the acceptance and usage of the introduced technology?
24. What are the gaps/challenges that affect the implementation of mobile health technology?
25. What are the requirements for duplicating the same system in other rural areas?
26. Can the system enhance satisfaction to stakeholders in rural communities?

3.9 Sampling Technique

(Saunders, 2019) Defines sampling techniques as methods used to select a subset of a population to gain insights about the entire population. They emphasize that sampling techniques are critical in reducing research costs, time, and effort while ensuring that the sample accurately reflects the population's characteristics. A sample is a portion of the population chosen to represent the entire population (Tatherdoost, 2016). The main aim of sampling is to capture data from a minimal group that can increase efficiency by permitting generalizations to be concluded about the entire population without necessarily having to examine the entire population. The sampling technique will affect the validity of the research therefore it should be undertaken with maximum rigor.

The researcher employed a purposive sampling technique to gather data from users of the Mobile Health services in Moyo district. The selection was based on its effectiveness in identification of participants who are knowledgeable and experienced with the system, thereby providing rich and relevant insights. The sample comprised a diverse group of users, including healthcare professionals, administrative staff, and IT personnel, ensuring advanced understanding of the system's usage and the service, strengths, and weaknesses. By focusing on these key stakeholders, the research was able to obtain detailed and context-specific information critical for developing an enhanced framework for the Mobile Health Technology.

CHAPTER FOUR

FINDINGS

4.0 Introduction:

The main objective of the study was to design a framework for enhancing adoption of healthcare services in rural areas using mobile health technology aiming at improving accessibility to healthcare services and reducing healthcare disparities in communities of Moyo district. The focus was on understanding the factors that impacts on adoption of mobile health technologies in Moyo district rural communities, identifying patient information on adoption and use of mobile services in enhancing healthcare services, data management, system access controls, payment systems, data security and integrity, and user training. The factors that have negatively affected efficient and effective healthcare service delivery to the rural communities in Moyo district with extensive data on patients with chronic illnesses.

This chapter includes the findings of the research, observation, comparisons, comprehensive examination of the data, interpretation of results, and discussion of the implications for Mobile Health technology.

4.1 The Respondents.

The study targeted a total of 90 respondents, with 60 filled out the Survey and 30 to be interviewed. However, 53 survey forms were submitted representing 88.3%, and 5 interviews were completed representing 16.6%. "This rate is considered excellent, as internal surveys typically attract a response rate of 30-40% on average (Fryrear, 2015).

4.1.1 Background Characteristics of The Respondents.

The background characteristics of the respondents is clearly provided based on their designations and the respective departments.

Table 4: Categories of Respondents by their Designations

SN	Designation	Number of Respondents
1	Chronic Disease Patients	17
2	Lab Officer	2
3	M & E Officer	4
4	Medical Officer	4

5	MEL Advisor	1
6	Nurse	5
7	Pharmacist	1
8	Quality Improvement Assistant	1
9	Systems Administrator	5
10	Data Officer	2
11	ICT/IT	3
12	Software Developer	2
13	Database Administrator	1
14	Senior IT Officer	1
15	HIS Lead	1
16	MIS Officer	1
17	Counsellor	1
18	HIS Analyst	1

53 respondents from the selected case study participated as summarized in **Table 4** above, these consisted of patients with chronic diseases, IT staff and medical Staff. The respondents were grouped based on their primary job functions as follows

- **IT Group**: Systems Administrator (5), Data Officer (2), ICT/IT (3), Software Developer (2), Database Administrator (1), Senior IT Officer (1), HIS Lead (1), MIS Officer (1), HIS Analyst (1) totaling 17 respondents.
- **Medical Group**: Lab Officer (2), Medical Officer (4), Nurse (5), Pharmacist (1), Counsellor (1) totaling 13 respondents.
- **M&E Group**: M & E Officer (4), MEL Advisor (1), Quality Improvement Assistant (1) totaling 6 respondents.
- **Patients Group**: Patients with chronic diseases (17)

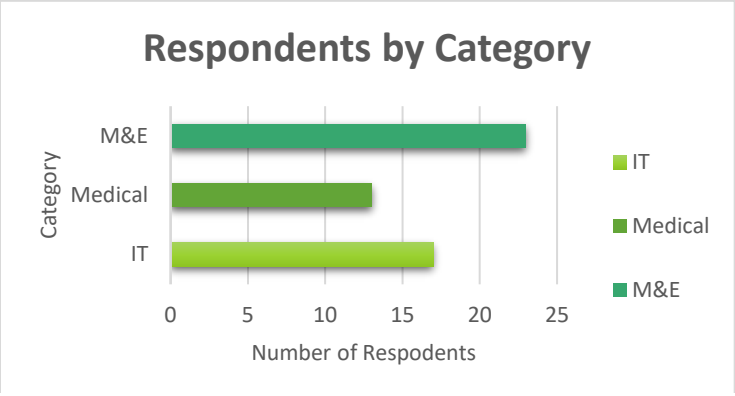

Figure 3: Respondents by Category

Table 5: Groups of Respondents

Category	Respondents	Percentage
IT	17	32%
Medical	13	25%
M&E	6	1%
Patient	17	32%

The selection criteria for the respondents were based on knowledge of the Mobile Health ecosystem and their interaction with it. To ensure a measurable sample, collection of data was decentralized to several community within Moyo district with aim of capturing a bigger contexts and challenges. The target population were patients of chronic illnesses and were responsible for using the Mobile Health systems to access medical services and these are key in understanding frontline adoption and usage of the Mobile Health services; IT professionals, who manage the technical aspects of Mobile Health Systems and whose expertise provides critical information on the robustness of current mobile technology and systems, security measures and technical vulnerabilities; monitoring and evaluation (M&E) staff where involved in the assessment and improvement of health services and whose feedback helped gauge the overall effectiveness and adoption of Mobile health system. Performance perspective of health team which included doctors, nurses, clinicians, Laboratory attendants and other medical staff, who use Mobile Health systems to provide health support, clinical and administrative tasks, provided essential insights into the usability and operational challenges of these systems, and their experiences highlighted practical usage and security concerns in daily clinical operations. The collected data is crucial in designing a framework for enhancing adoption of healthcare services in rural areas using mobile health technology aiming at improvement and accessibility to healthcare services hence reducing healthcare disparities in communities.

4.1.2 Respondents Distribution by Designation and Gender.

Demographic data is crucial in designing an enhanced Mobile Health systems framework as it ensures the framework addresses the diverse needs and vulnerabilities of various population groups, enhancing overall effectiveness and inclusivity.

In this section, the distribution of survey respondents is analyzed based on their professional designations and gender to understand the perspectives and insights from different roles and genders within the healthcare environment as illustrated in **Figure 4**

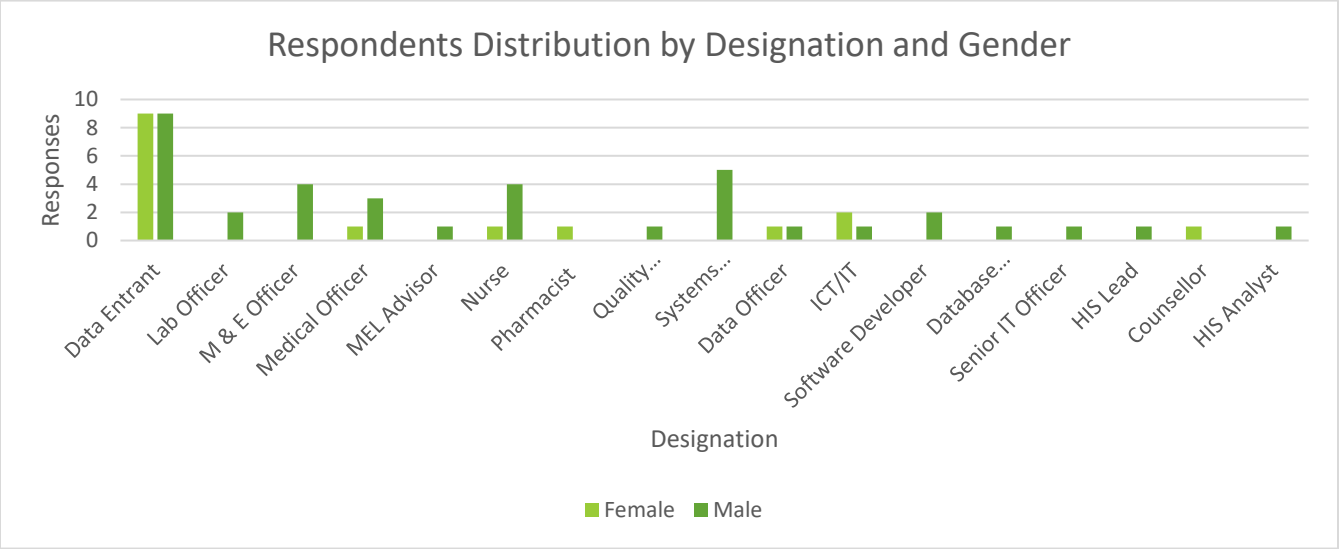

Figure 4: Respondents Distribution by Designation and Gender

The highest number of responses, totaling 18 (41.9%), were patients of chronic illnesses as illustrated in **Figure 4**. These categories were identified based on their integral role as daily users of the system and responsible for use of Mobile Health devices to access health services, they normally share key information with medical personnel to enhance services. Their involvement as informants was very crucial for the establishment of the framework as they carried out a vocal role in provision of data on usage and adoption of Mobile Health technology for access to medical services.

In this study, male respondents (37 out of 53, **69.8%**) outnumbered their female counterparts, reflecting a predominant demographic trend within the participant pool. The gender demographic provided valuable insights for the research findings, particularly in understanding the perspectives and experiences of male healthcare professionals and IT specialists involved in Mobile Health systems. Their overrepresentation suggests a potentially greater involvement in roles that interface closely with Mobile Health technologies, such as system administration, software development, and data management.

4.2 The Case Study

4.2.1 The Mobile Health Technology

Mobile health is basically the means of providing health services and information through mobile technologies, reducing travel time and transport costs and promoting remote healthcare services in the community. It is seen as a novel technology that supports self-management to improve healthcare outcomes, integrating technologies of electronics, sensors, mobile computing, communication, payment systems and medical services, and it's considered an excellent opportunity for health care, widely accepted in developing countries. Mobile Health systems enable continuous health monitoring at home, Health self-management, fewer hospital visits, and seamless payment for health services and lower health care cost for persons with chronic disease or experience inadequate health services, benefiting the most from a health care system. Mobile health (mHealth) technology has been widely embraced due to their significant contributions in the few years they have been deployed. Their benefits have impacted on all categories by lowering costs of healthcare services, efficient payment methods and increased patient awareness which has improved health of the community.

4.3 Data Processing

According to (Cint, 2021) Data processing in research involves transforming a dataset into valuable, actionable information. During this process, researchers, data engineers, or data scientists transform raw data into meaning and better interpretable formats, such as graphs, reports, or charts, either manually or using automated tools.

Google Forms was the efficient tool used in gathering responses from participants. Upon completion of the survey period, the responses were downloaded in CSV format for initial review and analysis. The following steps were undertaken to process and analyze the data:

4.3.1 Data Cleaning and Validation

Initially, the downloaded CSV files were processed to clean and validate the data. This involved identifying and correcting any formatting errors, missing values, or outliers that could affect the accuracy and reliability of the dataset. Several stages are involved in ensuring accuracy and reliability of the dataset. Firstly, formatting errors were identified and corrected. This included ensuring consistent data formats for dates, numerical values, and categorical variables. Missing values were addressed by removing the entire rows with missing data. Additionally, outliers that

could skew the results were detected and handled appropriately. These stages were significant for further analysis and ensuring datasets were accurate, complete and reliable.

4.3.2 Interrelated Question Analysis (IQA)

According to (Turner, 2010), Interrelated Question Analysis (IQA) can be instrumental in understanding the intricate web of factors influencing a particular phenomenon. By systematically analyzing how questions relate to each other, researchers can uncover hidden correlations and causative links, enhancing the depth and reliability of their findings.

Special attention was given to the analysis of questions where the response to one question (question A) influenced the answer to another (question B). For example, responses regarding the availability of a Mobile Health framework (question A) were cross-checked against perceptions of system user training on the framework (question B). This interrelated question analysis helped identify correlations and dependencies between different survey items. By understanding these relationships, the study could better interpret how different factors, such as the existence of a Mobile Health Systems framework and the level of user training, influenced each other and contributed to the overall usage and adoption of Mobile Health systems.

4.3.3 Quantitative data Analysis

Software such as python and excel were used in statistical data analysis to explore relationships between variables and derive quantitative insights. Descriptive statistics, including frequencies and percentages, were computed to summarize participant demographics and their responses to survey questions. These statistical methods helped to highlight key trends and patterns within the data. This quantitative analysis provided a robust foundation for understanding the adoption and usage of the Mobile Health Systems, their security challenges and opportunities.

4.3.4 Integration of Findings

The quantitative and qualitative findings were integrated to provide a better understanding of Mobile system usage and adoption; several challenges were identified including Infrastructure and Connectivity, Health Workforce Capacity, Data Management and Information Systems security of data, User-Centric Design and Accessibility, System Adaptability and Integration, inadequate governance and Collaboration and Privacy and Security challenges and opportunities were analyzed using both quantitative and qualitative data analysis to gain more insights in capturing an in-depth view of the issues. This integration helped to validate the findings, ensuring that the results were both contextually and statistically relevant. The various data sources enhanced interpretation of

results and provided a deeper understanding of the operational requirements of Mobile Health systems which enabled conclusive and actionable decisions.

4.4 Ethical Considerations

Throughout the data processing phase, ethical considerations were prioritized. Participant were informed of the data protection principles, regulations and guidelines. They were assured of confidentiality, integrity and anonymity during data handling. All practices relevant to data protection regulations and institutional guidelines were adhered. Anonymity was maintained by de-identifying personal information, ensuring that individual identities would not be traced back from the data.

4.5 Limitations

The limitations encountered during data processing, such as potential biases in participant responses, limitations inherent to self-reported data, and constraints from survey methodology employed.

4.4 Data Analysis Techniques

The data collected was analyzed using several methodologies to enable better understanding of the operational service landscape of Mobile Health systems. These techniques included statistical analysis and thematic analysis for qualitative data.

4.4.1 Statistical data Analysis

Software Used: The main software deployed for statistical analysis was Python based on its significant statistical computing capabilities. Python provided a versatile platform for handling and analyzing the data collected from surveys. According to the finding, the privacy and security highly impacted on data management of mobile health systems and this affected the adoption and acceptance rate of mobile healthcare systems due to exposure of patient information. Extensive analysis and data collection was done on privacy and security to ensure mobile healthcare data is safe and efficient to enhance adoption and acceptance of the healthcare system aimed at improving the healthcare services in these rural communities of Moyo district.

Key Metrics.

- **Infrastructure and Connectivity;** This involved assessing whether powers were installed to ensure to enable 24hours functionality of the system, the level of installation and

distribution of electricity to rural areas and integration of solar power systems as durable solution to support 24hrs charging and use of mobile technology.

- **Health Workforce Capacity;** Assessing the level of integration of simple design interfaces with user-friendly applications that give room for user interaction provision of provision of frequent training sessions for community health workers (CHWs) focusing on the digital literacy and mobile Health tools.
- **Data Management and Information Systems;** Assessing of the Mobile health integration to enhance interoperability performance with the existing system. The alignment of data collection to meet the requirements of the current system.
- **User-Centric Design and Accessibility;** This involved prioritized Apps that are developed with user-friendly features and simplicity since the users have limited technological literacy.
- **Governance and Collaboration;** Assessing the level of partnership and collaboration with private sector, local mobile developers and NGO in creating adaptable and locally sourced digital solutions.
- **System Adaptability and Integration;** Assessing the level of adoption and acceptance of mobile health integration of modular design for digital health applications with ease and quick modifications.
- **Privacy and security of data;** the mode of accessing healthcare system data
- **Frequency of Security Incidents:** This metric involved counting the number of reported security issues within a specific timeframe. It helped identify security loopholes in the Mobile Health systems.
- **User Compliance Rates:** This involved assessing how well the healthcare staff adhered to the prescribed security practices and protocols. Higher compliance rates indicated poor implementation of security measures.
- **Password Management:** This metric involved assessing the management of passwords which included password expiration, Account sharing, tools used in keeping passwords
- **Access control:** This metric is used to find out the authentications available, how user roles are defined, and which user have access to information.
- **System user training program:** This involved counting the number of reported trainings, and topics covered in the Mobile Health user training.

- **Sensitive data management:** This metric is used to find out how sensitive data for patients is managed, these include finding out which patient data is collected and stored in Mobile Health systems, patient consent, data backup, and storage of sensitive data.

Using Python, various statistical tests and descriptive statistics were performed to analyze these key metrics, providing insights into the current state of Mobile Health Systems security.

4.6 Emerging themes and findings from the study

These present the results of the data analysis, organized by the key components of the framework; there are number of concerns that have been identified that need to be addressed. The infrastructure and connectivity issues, data management and information systems, governance and collaborations, system accessibility where the concern is the data privacy and security of health patient health records, health workforce capacity which requires training of the health team, the integration of existing health databases with the mobile system to eliminate duplicates of health records. The privacy and security issues have been seen to be a major concern in adoption and accessibility of healthcare data. The access of the system requires robust data encryption measures, access rights management, user training, and patient consent management in accessing patient mobile healthcare data. The framework clearly shows the concerns and how they are being addressed by the mobile health systems.

4.6.1 Map of Moyo district showing the distance of public health facilities

The framework for mobile health systems in Moyo District.

Percentage Distribution of Households 5 Km and over, to the nearest Public Health Facility; Moyo District.

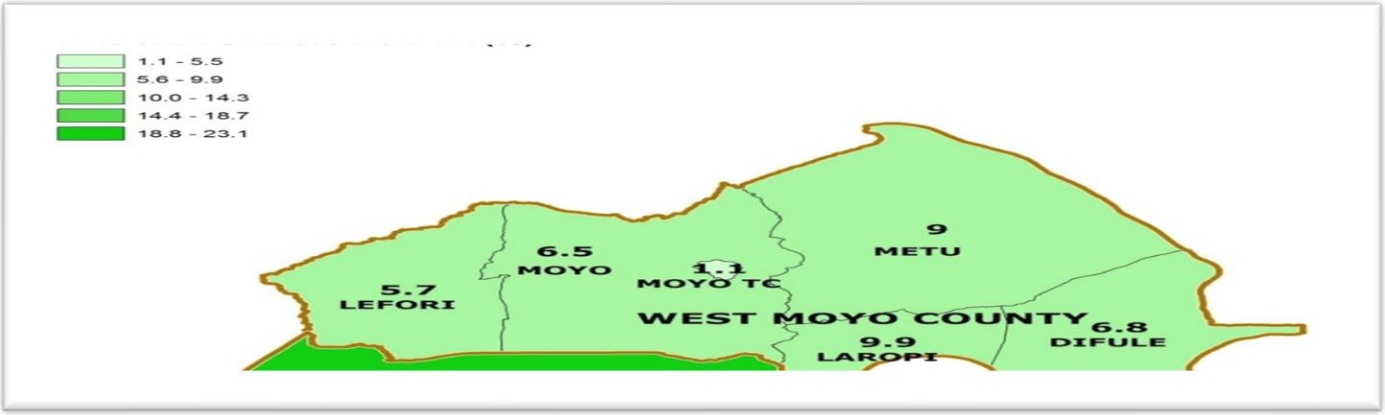

Figure 5: percentage distribution of households 5km and over to the nearest public health facility in Moyo district.

The healthcare facilities are unevenly distributed in Moyo district in the different villages as seen from the kilometers covered by the community in search of health services. The map of Moyo district shows the distance that are covered by communities in need of healthcare services, this shows the need for adoption and accessibility of mobile health to enhance remote diagnosis, treatment, remote consultation and telemedicine services by use of the mobile device.

To achieve these, the mobile system uses a framework to address the need of the rural communities through the implementation of a set of components that enhance adoption and accessibility of the healthcare services in the district.

The introduction of Socio-Political and economic environment which sets out a number of mHealth initiatives including government technical support and financial policies integrated to enhance the services delivered to the community, this can be done through the multi-sectoral engagement and ownership, which facilitates adoption through collaboration, shared ownership among government, non-profits, private sectors and local communities. The government involvement enhances political leadership, national strategy and policy in financial support which reduces costs to the communities, thus enabling efficient adoption and acceptance of the system.

The implementation of reliable technology is foundational for mobile health initiative in ensuring that the remote and low resource areas healthcare centers of Moyo are, accessible with available and efficient internet access, power both solar and electricity in addition to compatible and affordable device access for all the types.

The healthcare center environment is key for the adoption of the system, provision of training support to the community bridges the literacy gap, user involvement in all the stages of development and implementation giving them more access to system design and interactions increases their satisfaction and subsequent adoption of the system. The increased deployment of health professionals in addition to provision of motivation incentive for the users encourages their adoption and acceptance of the system.

The personal attributes of health workers and patients significantly impact on mHealth adoption and accessibility to the system, the ease of use of system, capacity building, privacy and security and confidentially attached to patient health records enhance need to adopt the services. Perception and ownership of the initiative, in addition to secure records enable the participant to fully contribute on the adoption and acceptance of the system.

Table 6: The framework for mobile health systems in for adoption of mobile healthcare services in Moyo District.

Generalized challenges	Description challenges	Framework component	Proposes solution
Foundational Infrastructure & connectivity	Unequal distribution, unreliable electricity & inadequate solarization of the rural areas. Inadequate mobile networks challenges.	Foundational Infrastructure &connectivity	Increase distribution & access of electricity in all community, integrate solar power systems as durable solution to support 24hrs charging & use of mobile technology.
Health workforce capacity	Design of the interfaces are not user-friendly in addition to Indequate training sessions for community health workers (CHWs)	Health workforce capacity	Building of user capacity on mobile health systems, technical support and capacity enhancement to government health professions on the usage & management of digital initiatives bridging the technological identified gaps,
Data management & Information Systems	Integration of the mobile system and the existing health management information system and the electronic record system have not been practical to ensure that health data is not duplicated.	Data management & Information Systems	Integrating Mobile health technology with the current system to enable interoperability performance with the existing system, ensuring that mobile Health data collection is aligned with the current Health Management Information Systems (HMIS) and the electronic health record systems (EHRs) to improve quality of data collected which eliminates duplication from different sources.
User-Centric Design & Accessibility	Limited technological literacy on the design interfaces of mobile health systems.	User-Centric Design & Accessibility	Prioritize Apps that are developed with user-friendly features, easy to access and use with simplicity to support technological illiteracy users. Incorporated the use of native languages into the system design to enhance accessibility and adoption of mobile health system.
System Adaptability & Integration	Limited integration of modular design system for digital health applications which allows modification and ease and quick.	System Adaptability & Integration	To enhance adoption and acceptance of mobile health, there is need to ensure integration of modular design for digital health applications which allows ease and quick modifications, addition of new functional features, protocol and e-learning modules where users can easily teach themselves into the system, Integrate the mobile system with the existing information systems to

			facilitate more connected and efficient healthcare ecosystem.
Governance & Collaboration	Inadequate partnership and collaboration with the private sector, local mobile developers and NGO to create adaptable and locally source digital solutions fostering public-private partnership Low participation of stakeholders.	Governance & Collaboration	To enhance partnership and collaboration, there is need to engage with the private sector, local mobile developers, NGO to create adaptable and locally sourced digital solutions which helps in fostering public-private partnership which leads to adoption and accessibility of the mobile health systems. The active involvement of stakeholders from the government in both health facilities and community levels during the implementation and evaluation of mHealth initiatives. Government support in financial support to in subsidization of costs attached to the devices and mobile services.
Privacy & Security	Limited use of security measure to enhance health data protection. Lack of strong access control leads to unauthorized persons whose motive may be destructive.	Privacy & Security	To ensure protection of sensitive patient information, the system will design and implement robust data security measures utilizing access control codes, so that sensitive data such as HIV status are well protected from unauthorized access, introduction of Multi-Factor Access (MFA), biometric systems to ensure that only authorized personnel can view private data. A well designed mHealth services prevents privacy violations such as potential exposure of medical information. The exposures normally happen during public charging and sharing of phones with unauthorized persons whose motive are destructive.

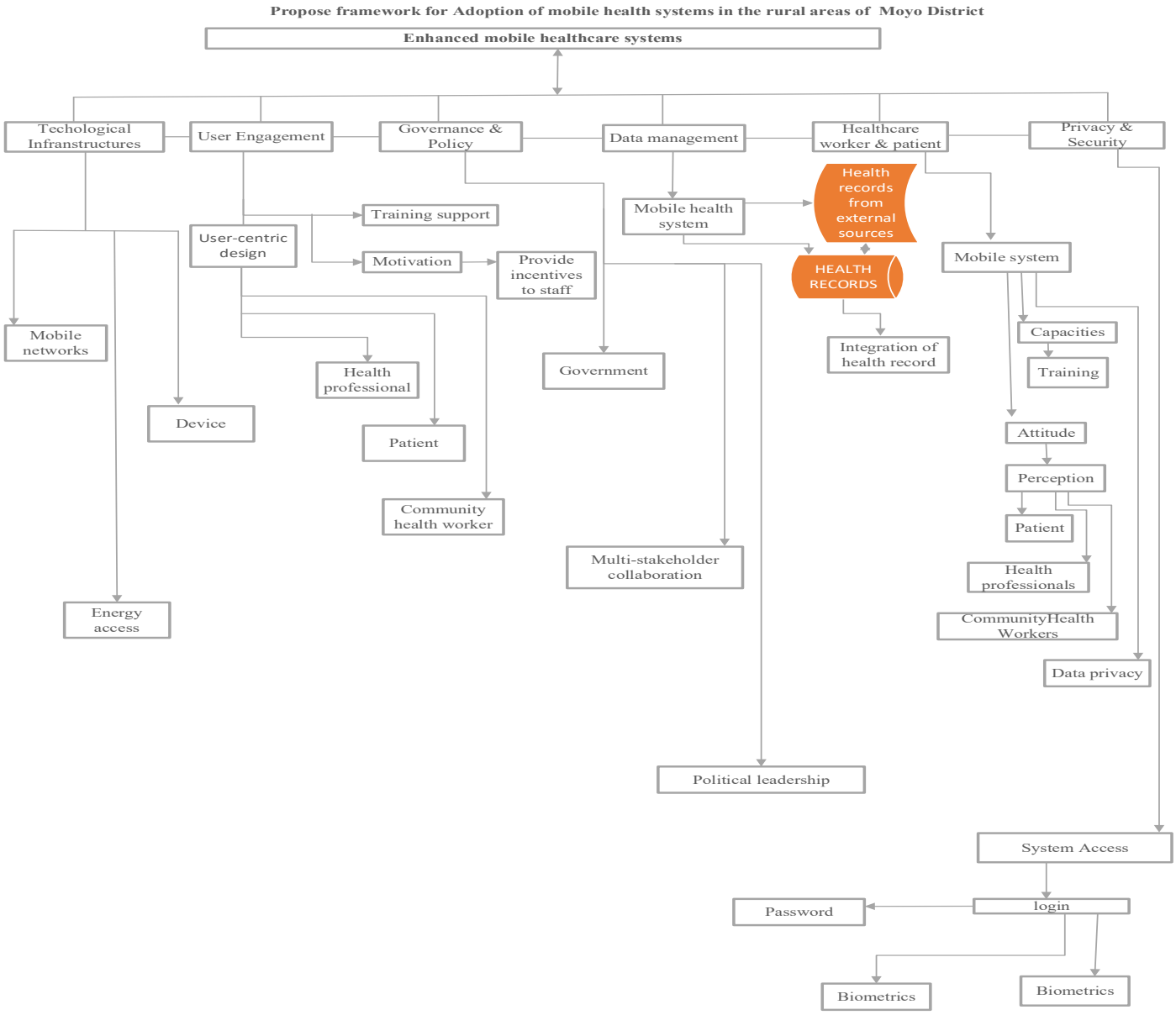

Figure 6: Proposed framework for adoption of mobile health systems in the rural areas of Moyo District

4.7 Factors affecting the adoption of mobile health Technology

The factors that have affected efficient adoption of mobile health systems in the community have been identified by the users, a number of concerns have been raised as causes to low adoption, the study in the community helped to rate the impact of each component in adoption of mobile health and the proposed solutions.

Table 7: Factors affecting the adoption of mobile health Technology

SN	Designation	Components that enhance adoption					
		System Adaptability & integration	**Infrastructures & connectivity**	**Capacity building**	**User-center**	**Privacy & Security**	**Governance & Collaboration**
1	Patient	10	9	18	18	18	8
2	Lab Officer	1	1	2	2	2	0
3	M & E Officer	4	4	4	4	4	4
4	Medical Officer	4	3	4	4	4	4
5	MEL Advisor	1	1	1	1	1	0
6	Nurse	5	5	5	5	5	5
7	Pharmacist	1	1	1	1	1	0
8	Quality Improvement Assistant	1	1	1	1	1	1
9	Systems Administrator	5	3	5	5	5	5
10	Data Officer	2	2	2	2	2	2
11	ICT/IT	3	3	3	3	3	2
12	Software Developer	2	2	2	2	2	2
13	Database Administrator	1	1	1	1	1	1
14	Senior IT Officer	1	1	1	1	1	1
15	HIS Lead	1	1	1	1	1	1
17	Counsellor	1	1	1	1	1	0
18	HIS Analyst	1	1	1	1	1	0
		44	**40**	**53**	**53**	**53**	**36**

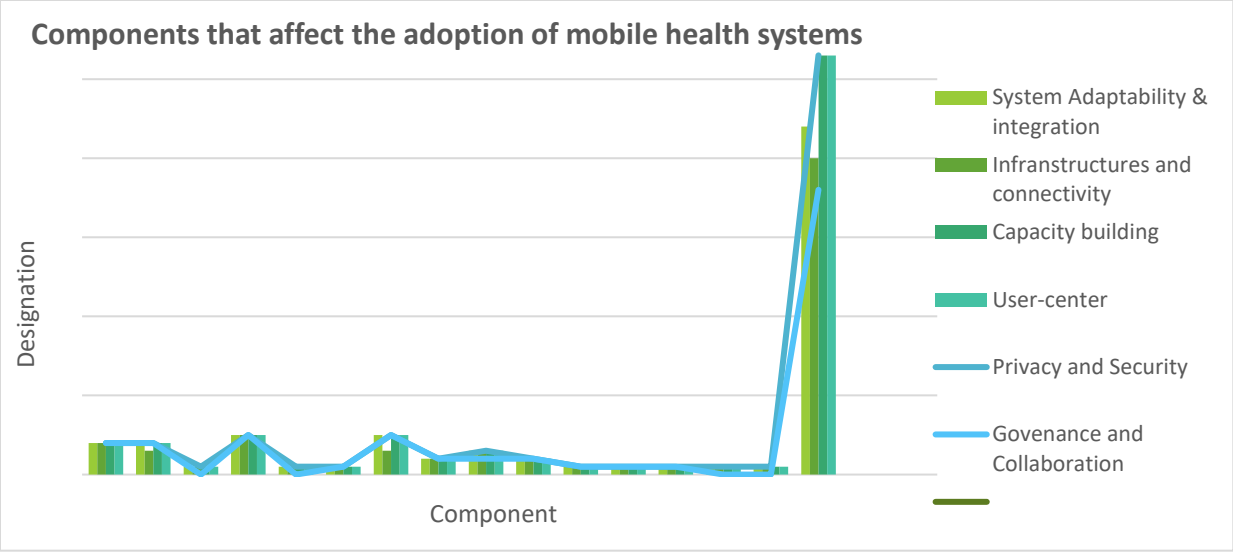

Figure 7: Components that affect the adoption of mobile health system

4.7.1 Access to the System;

The privacy and security concerns have been reported by all participant as a major factor to adoption and the mode of system access into mobile system on the current system requires investigations to understand the situation and propose best durable solutions. The security of the existing system will be studied in detail to identify gaps that can be bridged by suggested robust measures.

Table 8: Access Methods to the EHR Systems in Uganda

SN	Designation	Access to the system		
		Password	**MFA**	**Biometric**
1	Patient	18	0	0
2	Lab Officer	2	0	0
3	M & E Officer	4	0	0
4	Medical Officer	4	1	0
5	MEL Advisor	1	0	0
6	Nurse	5	0	0
7	Pharmacist	1	0	0
8	Quality Improvement Assistant	1	0	0
9	Systems Administrator	5	0	0
10	Data Officer	2	0	0
11	ICT/IT	3	1	0
12	Software Developer	2	0	0
13	Database Administrator	1	0	0
14	Senior IT Officer	1	0	0
15	HIS Lead	1	0	0
17	Counsellor	1	0	0

18	HIS Analyst	1	1	0
		53	**3**	**0**

Table 8 Summarizes the use of different access mechanisms (Password, MFA, Biometric) across various designations and user roles. The total counts are **53** for Password, **3** for MFA, and **0** for Biometric. This indicates a heavy reliance on passwords, with minimal implementation of multi-factor authentication (MFA) and no use of biometric verification. This approach, while straightforward, is highly susceptible to numerous security threats, including brute force attacks, password spraying, and phishing, which exploit the simplicity of such credentials (Henry, 2023).

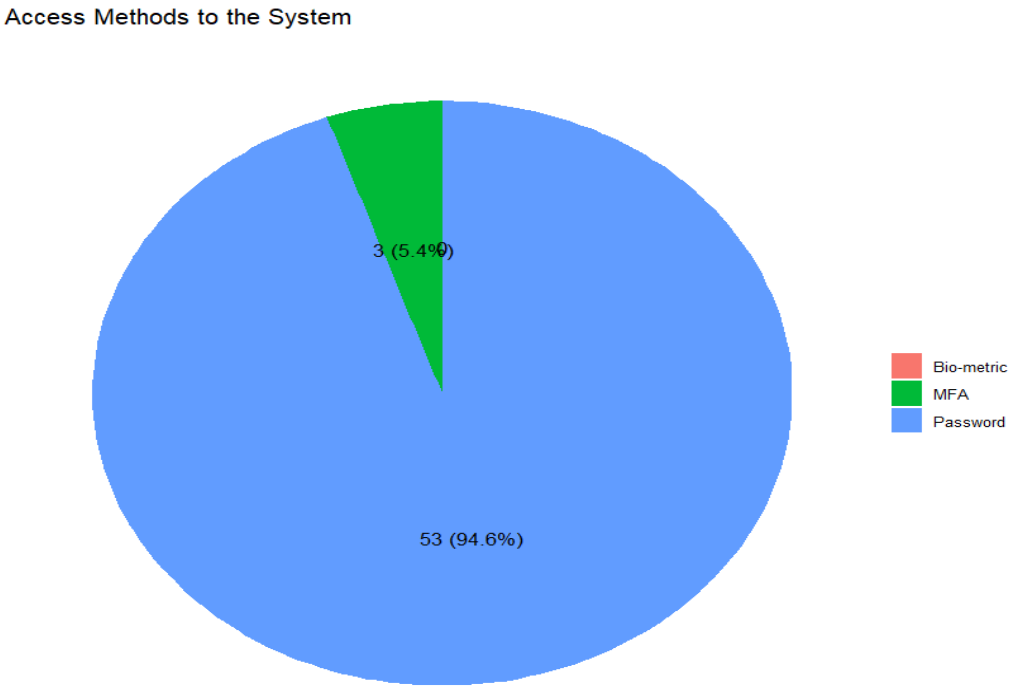

Figure 8: Pie Chart of Access Methods to Mobile Health Systems in Uganda

Despite the well-documented security advantages of Multifactor Authentication (MFA) which adds an extra layer of protection by requiring users to present two or more verification factors to gain access, the adoption rate remains low among respondents as illustrated in **Figure 8 above** with only 3 **(5.4%)** respondents confirmed using MFA. MFA significantly mitigates the risk of unauthorized access, yet its implementation is not widespread. Additionally, the absence of biometric authentication methods among respondents is noteworthy. Biometric systems, which leverage

unique biological characteristics such as fingerprints or iris patterns, provide enhanced security and user convenience, making their lack of use a concerning gap in current security practices.

This reliance on basic authentication methods highlights a potential vulnerability in the security framework of Mobile Health systems. According to (HIPAA, 2022) guidelines, it is strongly recommended that organizations deploy Multifactor Authentication (MFA) across their Mobile Health systems to address the security vulnerabilities inherent in traditional username and password authentication. MFA enhances security by requiring users to provide two or more independent credentials such as something they know (a password), something they have (a security token or mobile device), or something they are (biometric data) before granting access. This multifaceted approach significantly reduces the likelihood of unauthorized access by adding layers of verification, which counteracts common threats such as password guessing, phishing, and credential theft.

Table 9: Password management

SN	Designation	Saved in Browser/ Device	Written Down on a paper or notebook	Memorize	Use Password Manager
1	Patient	8	9	7	3
2	Lab Officer	2	1	0	0
3	M & E Officer	3	2	4	0
4	Medical Officer	1	0	3	1
5	MEL Advisor	0	0	1	1
6	Nurse	0	1	2	1
7	Pharmacist	0	0	1	0
8	Quality Improvement Assistant	1	0	0	0
9	Systems Administrator	3	0	2	2
10	Data Officer	2	0	0	1
11	ICT/IT	1	0	1	1
12	Software Developer	1	0	0	0
13	Database Administrator	0	0	0	0
14	Senior IT Officer	0	0	0	0
15	HIS Lead	0	0	0	0
17	Counsellor	1	0	1	0
18	HIS Analyst	0	0	0	1
			23	**13**	**22**

4.7.2 Password management.

The study uncovered concerning practices regarding password management summarized in **Table 9** and illustrated in **Figure 10**. A significant number of respondents, 23 out of 40, admitted to saving their passwords in web browsers and mobile applications for easy access. According to (Verizon, 2022) over 61% of data breaches involve compromised credentials. This practice, while convenient, poses a substantial security risk as it makes passwords more susceptible to being compromised. Furthermore, 13 respondents disclosed that their passwords are written down in notebooks or on keyboards, further increasing the risk of unauthorized access if these written records are discovered. The (Bachman Fulmer, 2019)U.S. National Institute of Standards and Technology (NIST) provide a comprehensive set of guidelines for password management in its Special Publication (SP) "Digital Identity Guidelines". The use of long passphrases was one of the key recommendations and encourages users to easily remember but harder for attackers to guess. This approach aims to improve IT security while working with, rather than against, the capabilities and limitations of users.

Table 10 Password Management Practices by Users.

The bar chart in **Figure 9** below, illustrates the distribution of password management methods, with "Saved in the Browser" being the most common (**33.3%),** followed by "Memorize" (**31.9%),** "Write down" (**18.8%),** and "Password Manager" (**15.9%).** This data highlights a prevalent reliance on less secure methods, such as browser storage and written-down passwords, which can lead to high risks like malware attacks and weak passwords due to cognitive overload. In contrast, only a small fraction use password manager, which offer better security. To enhance Mobile Health systems, it's very important to adopt strong, unique passwords for each account and promoting reputable password managers with encryption, enable multi-factor authentication, regularly update and change passwords, securely store written passwords, and provide ongoing user education to prevent phishing and other security threats. Implementing these practices will greatly enhance the security of the Mobile Health system.

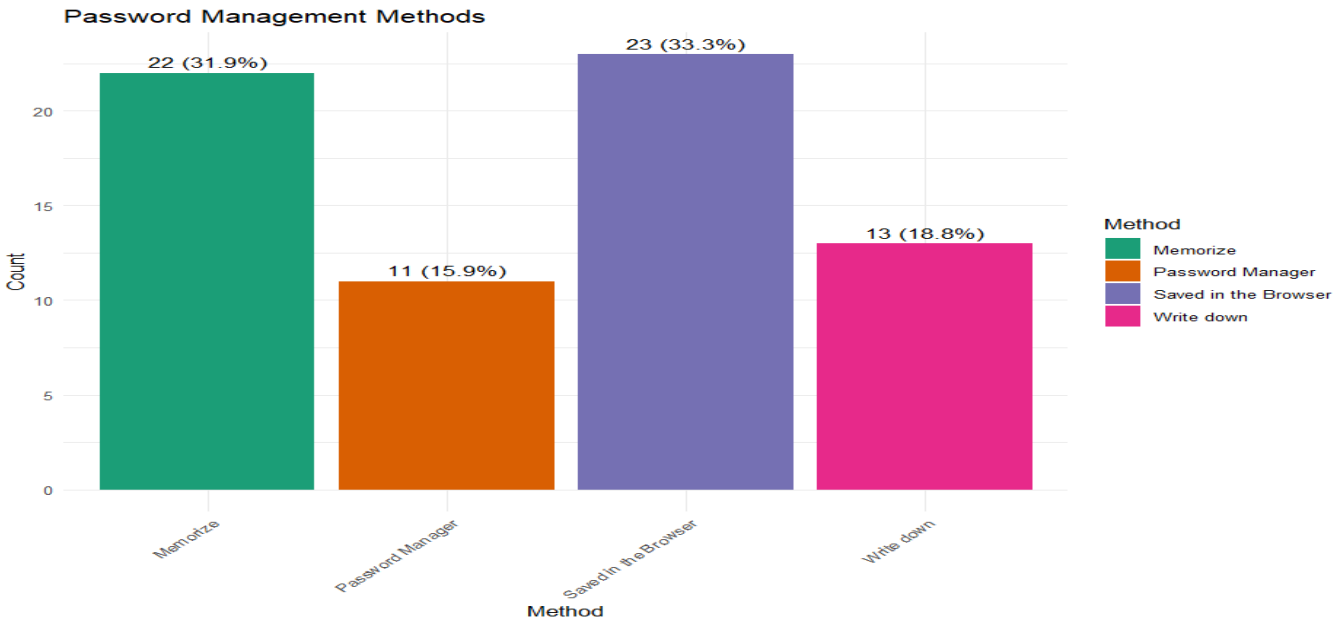

Figure 9: Histogram for Password Management Methods

4.7.3 Password Expire Policy

The data on password expiration policies across different designations as summarized in **Table 9** below, shows that only a minority of roles have passwords that expire regularly. Among the 53 respondents, 13 indicated their passwords expire after a certain period, while 40 do not. The breakdown reveals variability: Patients with chronic illnesses (4) and Medical Officers (2) are the most among those with expiring passwords, whereas several roles, including Systems Administrators (0), Software Developers (0), and Senior IT Officers (0), do not have password expiration policies in place. This distribution suggests a lack of uniformity in password management practices across the organization.

Table 11: Password Expire Distribution

	Password Expire?	
Designation	Yes	No
Patient	4	14
Lab Officer	0	2
M & E Officer	1	3
Medical Officer	2	2
MEL Advisor	0	1
Nurse	2	3
Pharmacist	0	1
Quality Improvement Assistant	0	1
Systems Administrator	0	5
Data Officer	1	1

ICT/IT	1	2
Software Developer	0	2
Database Administrator	0	1
Senior IT Officer	0	1
HIS Lead	1	0
Counsellor	0	1
HIS Analyst	1	0
	13	**40**

The absence of password expiration policies poses several risks to Mobile Health systems. Without regular password changes, the risk of compromised credentials increases, as outdated passwords may become vulnerable to breaches or unauthorized access over time. This vulnerability is particularly concerning for roles with access to sensitive patient data and critical system functions. Moreover, roles such as Systems Administrators and Database Administrators, who have high-level access, should ideally have stringent password policies to mitigate potential security risks.

(SANs, 2018) Recommend addressing this variability in password expiration policies by implementing standardized password management practices across all roles within an organization. They suggest adopting a uniform policy where passwords expire regularly, regardless of the role, to enhance overall security. Setting clear guidelines for password expiration intervals and ensuring all employees, including high-level roles such as Systems Administrators and Senior IT Officers, adhere to these policies.

To address these issues, it is recommended that all designations implement a password expiration policy to enhance overall security. Enforcing regular password changes will reduce unauthorized access and mitigate risks associated with compromised credentials. Additionally, providing training on password security and encouraging the use of strong, unique passwords, combined with multi-factor authentication where possible, will further protect the Mobile Health system. Ensuring that all roles, especially those with critical access, adhere to robust security practices that are essential for maintaining integrity and confidentiality of the Mobile Health system.

4.8 Reported Mobile Health System Issues.

The survey among **53** respondents revealed various issues associated with the Mobile Health system. The data indicates that problems span across multiple categories, with significant counts reported for each. The detailed distribution of these issues is illustrated in the histogram below.

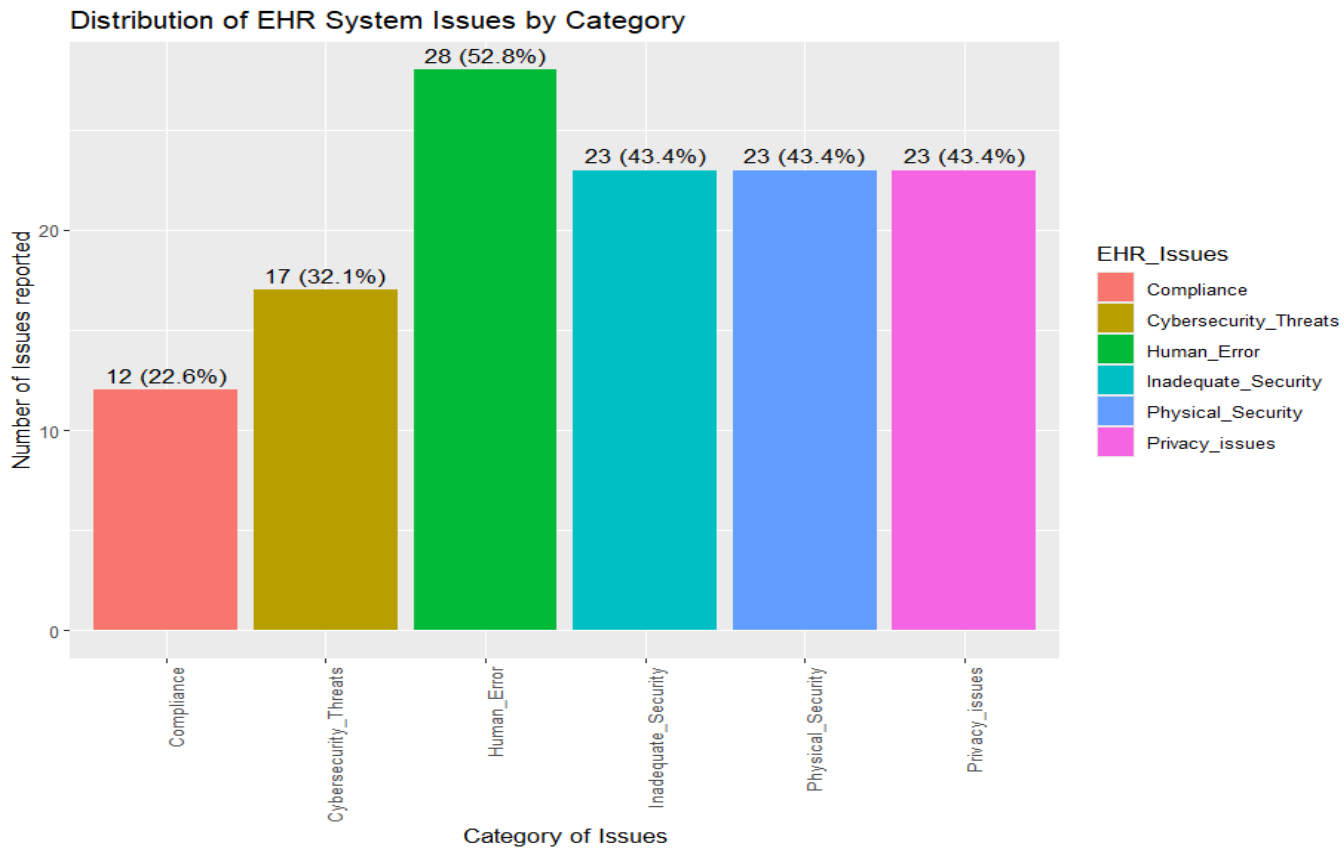

Figure 10: Bar Chart of Distribution of Current EHR issues

The findings reported 6 security issues above with the Mobile Health system, as depicted in **Figure 10** above, identifying human error as the most prevalent concern, accounting for 28 issues (52.8%). This indicates that a significant portion of problems arises from user mistakes, underscoring critical need for enhanced training and the designing of more robust operational protocols. Privacy concerns, reported 23 times (43.4%), highlight the necessity for stringent privacy policies to safeguard patient data effectively. Similarly, both inadequate security and physical security issues, also reported 23 times (43.4%), these suggest that their gaps in both digital and physical security measures. (Lee, 2021) Recommends focusing on enhancing system reliability through targeted user training and updated security measures. They emphasize the importance of developing detailed operational protocols and implementing robust security features to address both human errors and privacy concerns.

The identified risks underscore the urgency of addressing several key areas to protect the Mobile Health system. Human errors could lead to accidental data breaches or mishandling of sensitive information, emphasizing the need for comprehensive user training and clearer protocols. Privacy issues indicate potential weaknesses in data protection practices, while the issues with inadequate

security point to vulnerabilities that could be exploited by malicious actors. Additionally, the cybersecurity threats, reported 17 times (32.1%), reflect the ongoing challenges in defending against evolving cyber threats, and compliance issues, with 12 reports (22.6%), stressing the importance of staying current with regulatory requirements to avoid legal repercussions.

Addressing the findings, it is recommended to implement targeted training programs aimed at reducing human error and enhancing user awareness of security practices. Strengthening privacy policies and ensuring rigorous digital and physical security measures are important for safeguarding patient data. Additionally, it's very crucial to enhance continuous update of cybersecurity defenses to counteract emerging threats and maintain adherence to compliance regulations. Further analysis comparing reported issues between technical teams and system end users, through histograms or similar visual tools, provide deeper insights for groups to encounter more security problems, allowing for more focused interventions.

The bar chart for the technical team illustrated in **Figure 10** below, revealed that their primary concerns centered around physical security 9 (69.2%), human error **9 (69.2%),** privacy issues **7 (53.8%),** cybersecurity threats **7 (53.8%),** compliance issues **6 (46.2%)**, and inadequate security measures **5 (38.5%)**. Professional's intricate details of system vulnerabilities and the need for stringent compliance with security protocols. As such, they reported higher counts in these categories, underscoring their focus on the technical robustness and regulatory adherence of the Mobile Health systems.

4.8.1 Technical Team EHR issues report

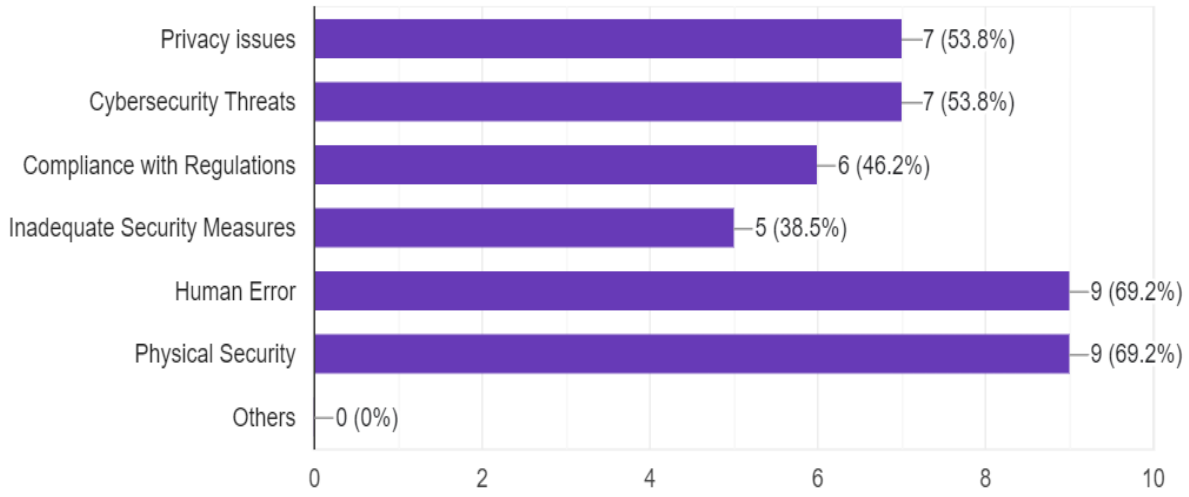

Figure 11: Distribution of Issues Reported by Technical Team

In contrast, the bar chart as illustrated in **Figure 11 below** for the system end users comprising healthcare professionals and administrative staff highlighted a different set of priorities. Their reports predominantly focused on human error **23 (57.5%)**, Inadequate security measures **18 (45%)**, privacy issues **16 (40%)**, physical security **14 (35%)**, Cybersecurity threats **10 (25%),** and compliance with regulations **6 (15%)** concerns. This group's interaction with the Mobile Health systems is more user-centric, which explains the heightened awareness and reporting of issues related to usability, data privacy, and the physical security of the devices and environments in which they operate.

4.8.2 EHR issues reported by system end users

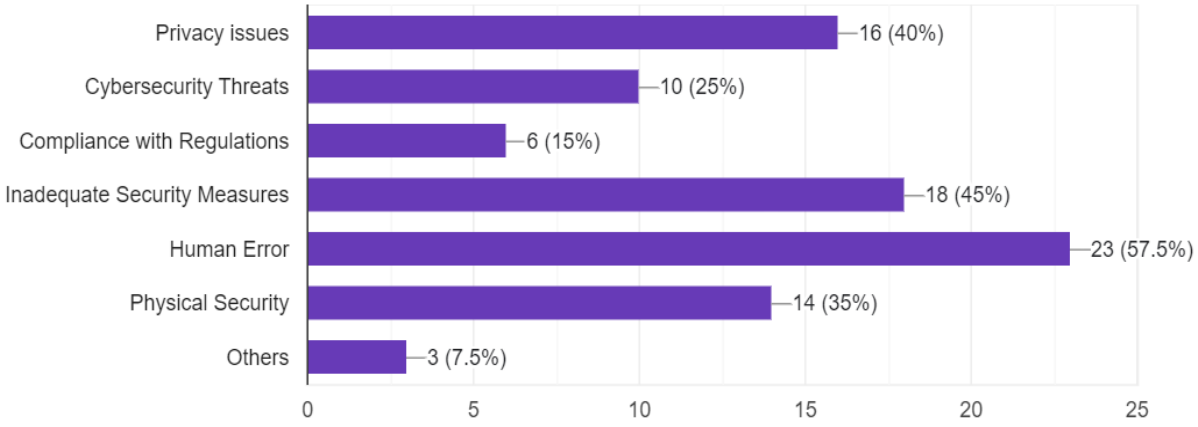

Figure 12: Distribution of Issues reported by Health workers

4.9. Patient Briefing, Information, and Consent

In a study on the Mobile Health system, the researcher assessed patient briefing, information dissemination, and consent acquisition across various healthcare roles as summarized in **Table 12** below. The research aimed to determine how effectively patients are briefed about data collection, informed about data retention duration and asked for consent. Our findings show significant variations in these practices among different designations, highlighting areas for improvement.

Table 12: Patient Consent Management

Designation	Briefed	Informed	Consent
Data Entrant	15	8	11
Lab Officer	2	0	1
M & E Officer	4	1	1
Medical Officer	4	1	1
MEL Advisor	1	0	1
Nurse	4	4	4
Pharmacist	1	0	1
Quality Improvement Assistant	1	0	1
Systems Administrator	4	2	5
Data Officer	2	0	1
ICT/IT	2	0	2
Software Developer	1	0	0
Database Administrator	1	0	1
Senior IT Officer	1	0	1
HIS Lead	0	0	0
Counsellor	1	0	1
HIS Analyst	1	0	1

The study shows that patient briefing is most commonly conducted by Data Entrants as summarized in **Table 10**, with **15** recorded instances, followed by roles such as Medical Officers, M&E Officers, Nurses, and Systems Administrators, each with four **(4)** instances. This indicates a general effort to inform patients at the start of data collection, though the extent varies across roles. However, informing patients about data retention duration is less consistently practiced, with Data Entrants leading again with eight instances, while many roles show minimal or no engagement in this area. This inconsistency suggests a need for standardized protocols to ensure patients are adequately informed.

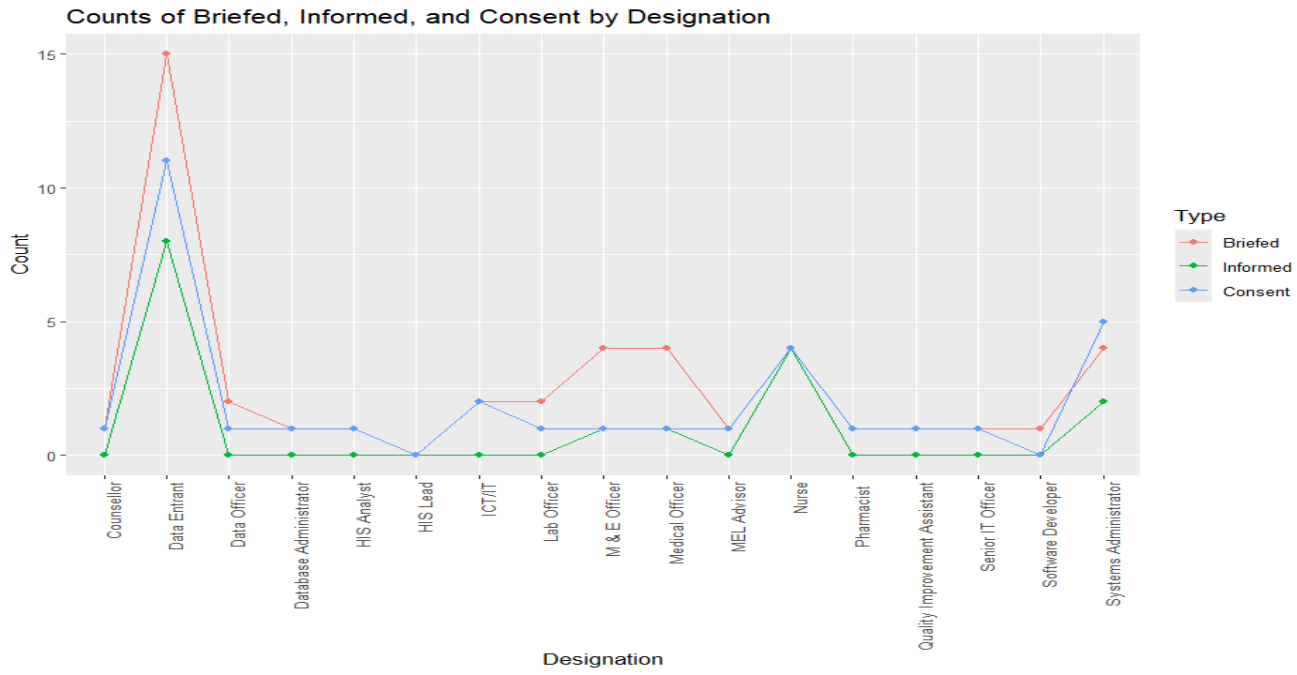

Figure 13: Patient Consent by Designation

Patient consent acquisition also varies as illustrated in **Figure 13**, with Data Entrants and patients with chronic diseases recording 11 instances and Systems Administrators showing a relatively high engagement with five instances. Despite efforts to obtain consent across various roles, the frequency is lower compared to the briefing. The findings emphasize the need for improved training and protocols across all healthcare designations ensuring that patients are fully informed and their consent is consistently obtained and documented. Strengthening these practices is important for maintaining trust and compliance with data protection regulations, ultimately enhancing the security and transparency of the EHR system.

4.6.1 Patients Information stored in Mobile Health Systems

The researcher identified three main types of patient data stored within the Mobile Health system: Patient Biodata, Sensitive Information, and Video Adherence Recordings (METs, 2024). Patient Biodata includes basic identifying information such as names, phone numbers, and addresses. While this data is essential for patient identification and communication, it is highly vulnerable to unauthorized access if not properly secured. Currently, this information is not encrypted, posing a significant risk to patient privacy and security.

Sensitive Information includes highly confidential data such as HIV, TB and Diabetes test results, medication records, and other lab results. This type of information is critical for accurate diagnosis and treatment but carries a heightened risk of misuse and discrimination if exposed. The result from the findings indicate that sensitive data is also not encrypted, leaving it susceptible to breaches that have severe repercussions for patients. The limited encryption of using only SSL certificates without encrypting data at rest fails to comply with standard data protection regulations and best practices, highlighting immediate need for improved security measures.

Lastly, Video Adherence Recordings are used for monitoring patient compliance with treatment regimens which are stored without encryption. These recordings can provide in-depth understanding of patient behavior and treatment effectiveness but are extremely sensitive as they can reveal personal health information and patient interactions. The absence of encryption for these recordings further exacerbates the potential for privacy violations and unauthorized access. Overall, the unencrypted storage of these critical data types underscores the necessity for immediate action to implement robust encryption protocols, ensuring the protection and confidentiality of patient information within the EHR system.

The Uganda Data Protection Act 2019 (ICT, 2019) puts emphasis on the importance of obtaining explicit consent from individuals before collecting, processing, or sharing their data, including patient information. It stipulates that consent must be freely given, specific, informed, and unambiguous. Prior to patient data collection, healthcare providers must clearly explain the purpose of data collection and obtain consent from patients before handling their information. Patients also have the right to withdraw their consent at any time, and any processing of data without proper consent constitutes a violation of the Act.

4.6 Statistical Evidence

Comparison of the kind of data collected from patients and security measures at presences. This showed username and password as the most used method to protect data, however, password management is poor since most of the system users save their password in the browser or Mobile Application.

4.7 Security Breaches in Mobile Health Systems

The researcher discovered significant instances of security breaches experienced by Mobile Health systems in Uganda. Of the data collected from 8 respondents (**15.1%)** revealed a concerning pattern of vulnerabilities and attacks that compromised patient data and the overall integrity of the Mobile Health systems. The most prevalent issues reported included ransomware attacks on Mobile Health servers, cyber-attacks, theft of computers and mobile health devices, and malware attacks, such as phishing emails. These breaches highlight critical security gaps and the urgent need for enhanced protective measures.

Table 13: Some of the Security Breaches Faced

SN	Security Breach	No. Of Respondents
1	Ransom attack	3
2	Cyber Attack	2
3	Theft of computers	1
4	Malware attacks	1
5	Others	1

Table 14 above, summarizes the ransomware-reported, attacks were particularly damaging, as they not only encrypted sensitive patient data but also demanded hefty ransoms for data decryption. This type of attack severely disrupted healthcare services, leading to potential delays in patient care and a loss of trust in the system's ability to safeguard information. Respondents also reported direct cyber-attacks aimed at exploiting system vulnerabilities that allowed unauthorized access to sensitive data. The theft of computers containing unencrypted patient information further exacerbated the risk, as stolen devices provided attackers with easy access to valuable data

Malware attacks, especially through phishing emails, were another common issue reported by respondents. These attacks typically involved deceptive emails that tricked staff into downloading malicious software, which then compromised the Mobile Health system. The frequent occurrence

of such breaches underscores the desire for comprehensive security strategies, including regular staff training on phishing attempts, robust encryption of all patient data, and the implementation of advanced cybersecurity measures. Addressing these vulnerabilities is critical for ensuring the security and reliability of Mobile Health systems in Uganda, ultimately protecting patient data hence maintaining the integrity of healthcare services.

The ((ENISA), 2022) report on ransomware provides in-depth knowledge of the increasing threat of ransomware attacks and offers several key recommendations. The report points out the importance of implementing robust encryption for all sensitive data to protect against unauthorized access, as well as deploying advanced cybersecurity measures such as firewalls, intrusion detection systems (IDS), and regular vulnerability assessments to strengthen defenses. It also underscores the need for comprehensive incident response plans to swiftly address and mitigate the impact of ransomware attacks, alongside ongoing staff training to recognize and handle phishing attempts and other social engineering tactics. ENISA's findings highlight the necessity of securing both digital and physical assets, maintaining rigorous access controls, and conducting regular backups to ensure data recovery in case of a cyber-attack, thereby enhancing overall resilience against ransomware threats.

Technical safeguards, a key component of HIPAA's Security Rule, are crucial for addressing reported breaches. They include access controls to ensure only authorized personnel can access Mobile Health system data, audit controls to monitor access and modifications, and integrity controls to prevent data alteration or destruction. Advanced encryption for data at rest and in transit is essential to protect sensitive patient information from cyber-attacks. Additionally, implementing multi-factor authentication (MFA) enhances security by requiring multiple forms of verification before granting access.

4.6.1 Causes of Breaches in Mobile Health Systems:

The research identified several causes of security issues in Mobile Health (mHealth) systems. These included security loopholes within the system, which left it vulnerable to attacks, and phishing emails that deceived users into divulging sensitive information. Additionally, there was a lack of adequate access control measures from several mHealth application developers, allowing unauthorized individuals to gain entry to the system. Human error played a significant role, as mistakes made by users and administrators of different mHealth applications compromised security. Lastly, there were instances where malicious actors successfully hacked into the servers of service

providers and developers of Mobile Health (mHealth) application systems, exploiting these vulnerabilities to access confidential data.

The recommendations (Green, 2021) emphasize the need for comprehensive strategies to address security issues in Mobile Health (mHealth) systems. Brotman and Klein advocate for targeted training programs that focus on mHealth-specific vulnerabilities, including data encryption, access controls, and compliance with data protection regulations. (Green, 2021) Highlight the importance of specialized training to mitigate the impacts of human error and system loopholes. Chen and Lin recommend enhancing security measures through regular updates and integrating security best practices into routine training. Collectively, these recommendations underscore the necessity for improved training, robust access controls, and ongoing security enhancements to effectively protect mHealth systems from various security threats.

4.7.1 Security Training Among Respondents

In the survey conducted, a total of 53 respondents provided information about their training in IT security for Mobile Health (mHealth) systems. Out of these, 38 reported having received some form of security training, while 15 indicated that they had not received any training. This significant number of trained individuals suggests that there is a considerable emphasis on security training within the institutions surveyed. However, the nature and content of the training varied among the respondents.

Some respondents who reported being trained mentioned topics that were not strictly related to IT security for mHealth systems. These included sensitization topics on how to be safe online, health education about personal hygiene and sanitation, and general online safety training. The inclusion of such topics indicates a broader approach to training that encompasses overall safety and hygiene practices, reflecting a holistic view of personal and professional security.

(Brotman, 2020) and (Klein, 2019) both emphasize the need for targeted training programs that address the specific security challenges of Mobile Health (mHealth) systems. Brotman highlights that training should include modules on data encryption, access controls, and compliance with data protection regulations to bridge the gap between general IT security and mHealth-specific needs. Similarly, Klein recommends developing specialized training programs that focus on mHealth-specific vulnerabilities and integrating security best practices into routine training. Both researchers stress the importance of ensuring that staff are well-versed in mHealth security protocols to enhance the overall effectiveness of the training.

This finding reveals a discrepancy between the expected content of IT security training for mHealth systems and the actual topics covered. While the broader training topics are valuable, they may not sufficiently address the specific needs of securing mHealth systems. It highlights a potential gap in the training programs, suggesting that while institutions are providing training, there may be a need to refocus and align the content more closely with the critical aspects of mHealth security. This misalignment could impact the effectiveness of the training in safeguarding sensitive patient information and ensuring robust security practices are followed.

4.8 Conclusion

The findings from Chapter Four underscore critical security vulnerabilities within the Mobile Health (mHealth) service system, emphasizing the urgent need for an enhanced security framework. Through extensive surveys and interviews, several key issues were identified, including inadequate password management, insufficient access controls, and a lack of comprehensive security protocols. The predominant use of traditional username and password combinations without multi-factor authentication (MFA) or biometric methods presents significant security risks. Alarming password management practices, such as saving passwords in web browsers, mobile applications and writing them down, compromise system security. The absence of an expiring password policy for the mobile services and lack of encryption for sensitive data further exacerbate these vulnerabilities. Additionally, the findings reveal inconsistent practices in briefing patients and obtaining consent, compromising patient trust and data integrity.

To address these security challenges, it is recommended to incorporate MFA and biometric authentication to strengthen access controls and enforce regular password expiration. Promoting the use of password managers and ensuring unique accounts for each user to mitigate risks associated with weak passwords and enhance accountability. The Implementation of a robust encryption protocols for sensitive data and developing targeted training programs focusing on secure practices are crucial steps in safeguarding patient information. Performance of Regular security audits and compliance checks are necessary for needs identification and addressing vulnerabilities promptly. The implementation of these measures enables Mobile Health (mHealth) systems to significantly enhance security posture, safeguarding patient data and ensuring the system's integrity and reliability, ultimately contributing to improved health outcomes and patient trust.

CHAPTER FIVE

FRAMEWORK DESIGN

5.0 Introduction

In response to the several concerns identified in Chapter Four of the Mobile Health (mHealth) system, Chapter Five proposes an enhanced operational framework to address these issues. The previous chapter highlighted significant weaknesses such as inadequate password management, insufficient access controls, inadequate sensitive data management, user training, and a lack of robust security protocols, all of which posed severe risks to patient data integrity and system reliability.

This chapter focused on developing and recommending solutions to fortify the operations of the Mobile Health system against these vulnerabilities. Key strategies included the integration of multi-factor authentication (MFA) and biometrics to enhance access controls, the implementation of a regular password expiration policy, and the promotion of password managers for secure password handling. Additionally, robust encryption protocols for sensitive data and training programs for staff emphasized to ensure secure practices were maintained. The ultimate goal of this chapter is to provide a strategic roadmap for improving the operational environment of the Mobile Health (mHealth) system, thereby safeguarding patient data, ensuring system integrity, and fostering patient trust. The MPI contributes to improved patient safety, the healthcare providers have access to the correct patient information

By ensuring that all healthcare providers have access to the correct patient information, the MPI contributes to improved patient safety.

5.1 Proposed Enhanced Operational Framework of the Mobile Health System.

Table 14: Proposed Enhanced Operational Framework of the Mobile Health System

Area of the system	Description
Institution	Moyo General hospital has several health facilities in the different sub-counties; it's an organized facility that provides medical services and supports all the other healthcare delivery and referral pathways to regional hospitals and referral centres in Uganda. The institution has infrastructures that consists of the physical facilities, equipment with well-designed systems which efficiently support healthcare service delivery to all persons. The hospital provides both the private and the general services, with equipped clinics, pharmacy, medical equipment, adequate utilities and had digital technologies which enables quality healthcare services in the areas.

Patient registry	Master Patient Index (MPI), is a central database in Moyo hospital with unique identifier for every patient who visits the health centres and clinics, it ensures accurate and consistent patient information across the different systems in the operating healthcare centres, all patients within the areas are easily identified through their linked records regardless of where the information was recorded. The patient registry assigns identification numbers to all patients and eliminates any duplications. All patients used their assigned Identification numbers to access their records and get services in the health centres.
Healthcare profession registry	Database of all registered healthcare providers, any medical profession is assigned an identification number to access the system. All healthcare providers have access to the correct patient information. Through the MPI which improves patient safety and ensures that all healthcare providers have access to the same, accurate data of patient thus promoting efficiency.
Healthcare facilities	Healthcare facilities registry contains database for all health facilities.
Electronic health records (EHRs)	A centralized digital database that contains all patient's medical histories, information such as diagnoses, medications, lab results, treatment, appointment and schedules. The information is shared with different healthcare providers.
Quality assurance	Identifies and provides standard code for use.
Health information officer (Health information exchange)	Information exchange we have the USSD services, where the mobile telecom networks operate, the SMS gateway, as central platform for receiving and sending clinical databases.
Point of service applications	Client systems in the exchange services, data collection and transmission services to the HER system for storage.

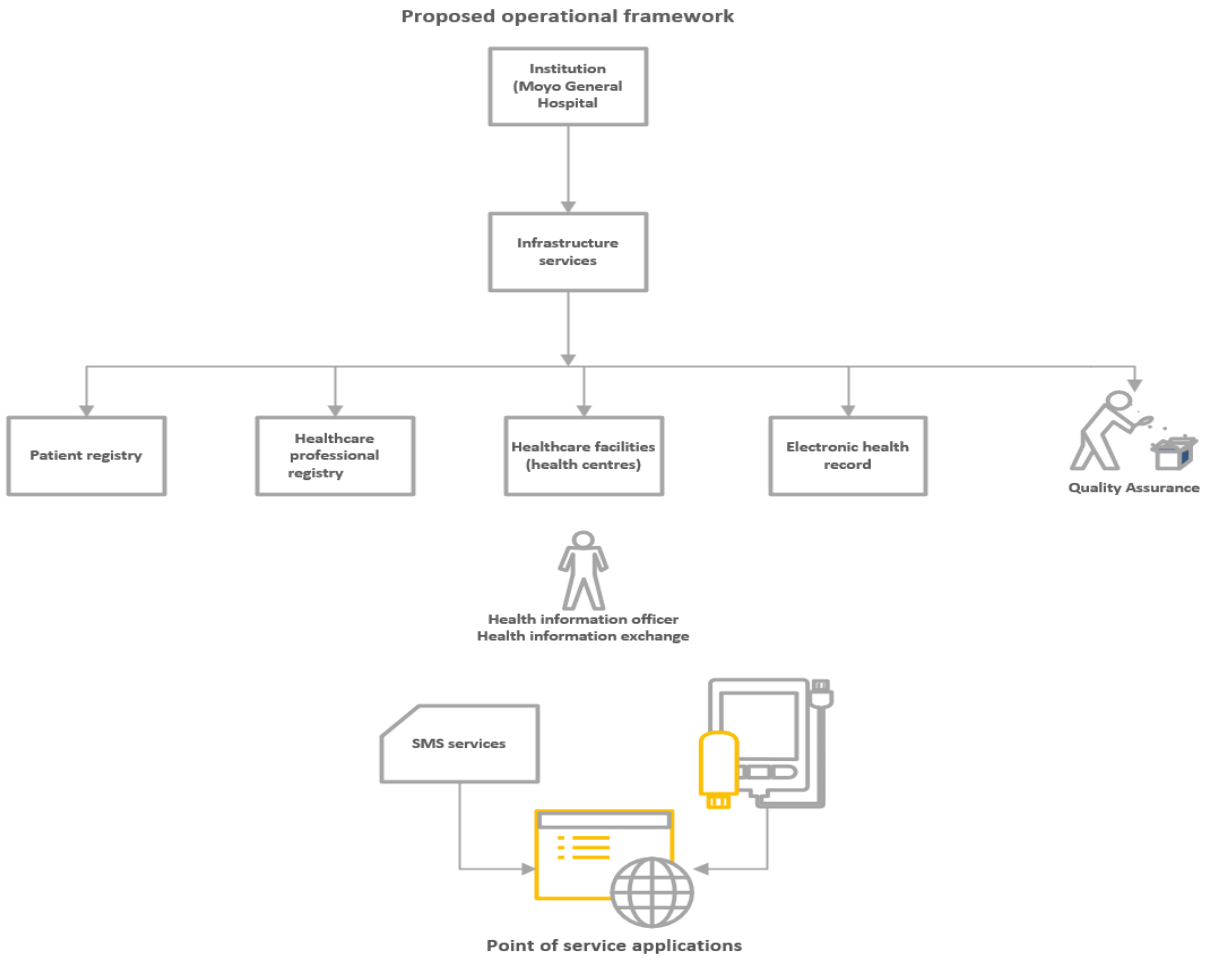

Figure 14: Proposed operational framework

5.1.1 Purpose:

Mobile Health Technology (mHealth) was developed with the aim of promoting safety, efficiency, adoption and use of Mobile Health systems, with a view of fostering stability and economic growth in the health sector, through digitized data collection and management of health information, real-time information sharing facilitating prompt decision-making, extending reach of healthcare by equipping community health workers with tools to manage and deliver health services to remote areas through telemedicine that connect health expertise, overcoming infrastructure challenges and expanding access to services. This improves accuracy, timeliness, accessibility, overall efficiency, effectiveness and quality of healthcare services. It's been designed consisting of the institutions, instruments, procedures and technology used to facilitate the safe and efficient acceptance of Mobile Health services within the health sector of the country.

The use of Mobile Health services and systems in Moyo district and Uganda has increased dramatically over the years compelling the need to ensure that these systems and services are operated in a secure and efficient manner to ensure a timely flow of health services.

A safe and efficient mobile health system will help establish and maintain health stability in the sector by preventing or containing health crises and help reduce the cost and uncertainty of quality service delivery and settlement, which could otherwise act as an impediment to the growth of the sector. The Mobile Health system was placed in the Ministry of Health's core functions due to the fact that they;

a) Contribute to Stability of the Health Sector.
b) Support open market operations.
c) Play a crucial role in creating confidence in the national health unit as one of the key functions of the Ministry of Health to maintain trust in the operations of the sector.

The policy seeks to put in place a framework that will facilitate

1. Enactment of a Mobile Health System law.
2. Clear understanding of the roles and responsibilities of the all the mobile health systems stakeholders.
3. Accountability for ensuring the safety of all health systems in the country.
4. Broadening the access and use of electronic systems to reduce cash-based payments and promote electronic payments.
5. An environment that encourages innovation and collaboration in the development of the Mobile Health System to meet the need of the Ugandan population.

The overarching goal of the Mobile Health System policy framework is to provide safe and efficient mobile health systems to the Ugandan population to foster stability in the health sector and economic growth. Based on the policy objectives the guiding principles are:

1. Safety: Safety aims at minimization of risk in Mobile Health (mHealth) systems. The process of minimizing risk requires the identification and understanding of how risks of various types may arise or be transmitted within the system and determine where they are borne. Once these risks are properly analyzed and assessed, appropriate and effective mechanisms must be devised to monitor, manage and control them.
2. Efficiency: Efficiency is characterized by several factors which include competition in price and quality of health services, wider access to usage and variation of payment produces and

services and level of expediency in clearing and settlement of payments. Quality of service relates to such characteristics as speed and predictability of settlement and convenience of access to payment instruments and related service. An efficient Mobile Health system reduces the cost of exchanging goods and services and is vital to the smooth functionality of the sector.

3. Consumer interests: Consumer interests relate to consumer protection, ensuring broad access to payment systems and privacy and security of both health and payment information.

5.2 The Mobile Health System framework sets forth the following objectives

The mobile health system in Moyo district comprise set of implementation guides and objectives to efficiently and effectively assess and address the adoption of mobile healthcare systems. The system requires a clear needs assessment identifying the barriers and factors such as infrastructure, workforce capacity, and existing workflows in the community, Designing of mHealth solutions and implementation plans given the results and findings from the needs assessment, ensuring support from governmental and community leaders to establish a workable plan for sustainable funding while investing in robust training support to both healthcare professionals, community health workers and the patients in addition to enhanced user-friendly design interfaces for frequent interaction providing confidence and motivation for the use, adoption and access of the system.

The system framework set objectives;

a) To strengthen the legal, regulatory and oversight framework in order to protect the users of the mobile health system.
b) To ensure effective management of the risks in the Mobile Health system.
c) To broaden the access to Mobile Health Systems.
d) To promote consumer interest and protection.
e) To foster competition and collaboration between stakeholders to promote efficiency in Mobile Health (mHealth) systems.
f) Promote the development of suitable infrastructure for the Mobile Health (mHealth) system

This policy framework presents the results of the studies on Mobile Health system landscape in Moyo District with the objective of developing new Mobile Health (mHealth) system legislation that will enhance the regulation of Mobile Health Services.

The Mobile Health (mHealth) policy framework is based on the extensive research and interviews with representatives of the health sector in Uganda. These included the Ministry of Health representatives, medical officers and personnel, nurses, clinicians, laboratory technicians, nutritionists, community health workers, district health members and supervisors, and patients with chronic illnesses in Uganda. These meetings took place in Moyo district.

5.2.1 Mobile Health Systems in Uganda

The diagram shows the Mobile Health service systems operating in Uganda at present. These systems can be classified into three broad areas;

Mobile Health Systems operated by the Ministry of Health (Blue): In Uganda, the Ministry of health operates mobile health through several platforms such as electronic community health information system (eCHIS) which uses the community health workers to empower village heath teams (VHT) in data collection, this improves access to information and boost productivity by the staff. The use of electronic medical records (EMR) facilitates and digitizes patient records streamlining healthcare services. The district health information software 2 (DHIS2) used for data collection and management, and is comprised of quality control checks when synchronized with the Ministry server, they support data driven decision making across health centre.

Mobile Health Systems operated by Medical Health facilities (Green): Medical facilities and health organizations operate mobile health systems in provision of services using mobile units, digital tools which includes mobile clinics, portable devices, and apps, in delivering healthcare services to remote, underserved and crisis-affected communities. The use of mobile health system support in enhancement of preventive care, diagnostic tests, treatment, and health education which improves access, manages chronic diseases, reduces healthcare costs for vulnerable populations. This makes the system more reliable to the rural areas and when integrated by the government enhances health services to the community in outreach medical services. They use vans as mobile health clinics, these are equipped to provide primary and preventive care, screening, immunisations and provide basic medical treatment to communities with limited access to traditional health facilities, mhealth technologies manages and delivers digital health services through the use of mobile apps for remote monitoring and managing health data, SMS and Communication Tools for health education, delivery of test results, and remote consultations between health workers and patients and between healthcare professionals in enhancing service delivery to the community.

Mobile Health Systems operated by Private Sector Companies (Red): Private sector companies normally use mobile health (mHealth) systems to bridge gaps in healthcare access which leverages

mobile phones for services of telehealth consultations, remote patient monitoring, health information delivery. They organise free health advice at call centers, health camps using mobile platforms and other initiatives that bring medical care to remote communities, The private sector normally develop mHealth tools and applications to partner with public entities in improving health outcomes. Integrating these based on the use of mixed systems requires careful regulation and integration with government systems.

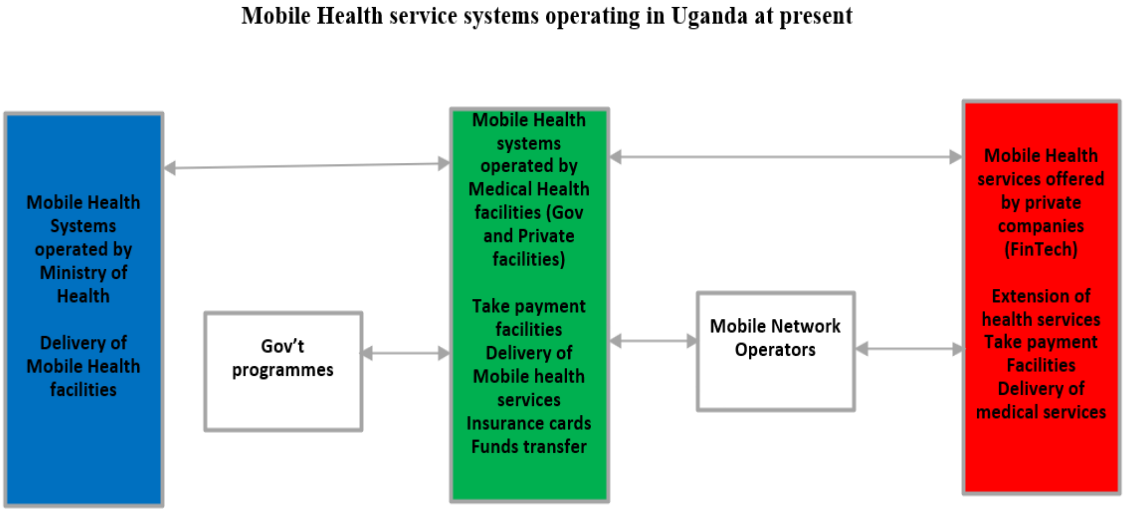

Figure 15: Mobile health service systems operating in Uganda

5..2.2 Mobile Health (mHealth) System Policy Framework

An mHealth policy framework basically looks at the strategic roadmap for integrating mobile health technologies into a healthcare system which addresses aspects of technology, finance, stewardship, and organizational factors ensuring user-cantered, high-quality, and sustainable care. This policy framework guide decision-making scaling up mHealth interventions, evaluating app quality, ensuring data privacy and security, defining stakeholders' roles and enables training support for healthcare professionals and users.

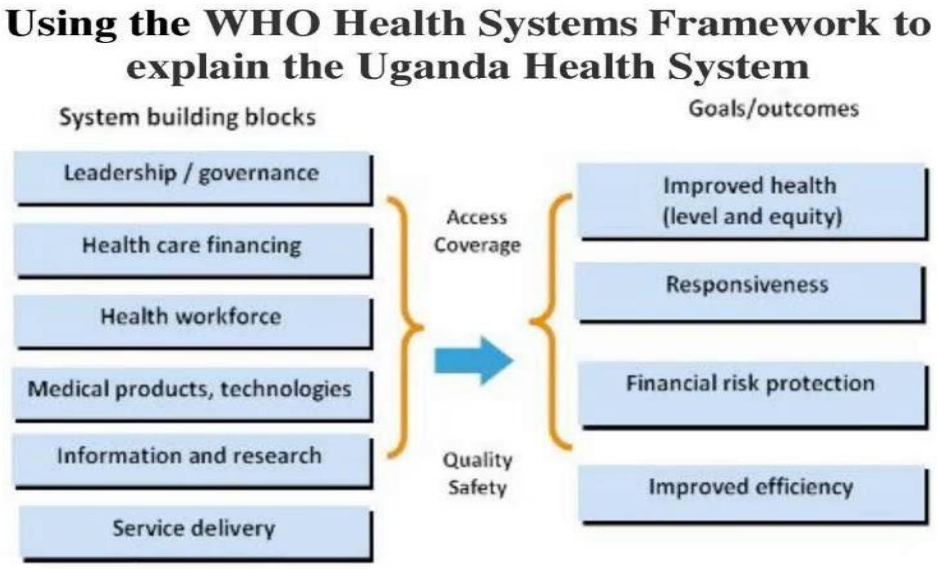

Figure 16: WHO health systems Framework to explain the Uganda Health System

5.4 Guiding Principles

Given the public policy objectives, the guiding principles are:

5.4.1 Safety

The primary guiding principle in the Mobile Health System policy framework was all mobile health transactions and services must be safe. Safety in Mobile Health service systems related to the requirement of mobile health systems to be secure and reliable as they are an important aspect of stability of the health sector. The aspect of safety focused on assurance that appropriate measures be taken to reduce risk, in particular systemic risk, in the use of mobile health systems. Systemic risk refers to the failure of a single system participant to meet their obligations. This failure could cause other participants who are otherwise sound to fail in meeting their obligations. This failure too would also result into a significant failure of the health market and sector. It is for this reason that safety is considered as a primary guiding principle. This is of particular concern in systemically import mobile health systems given that such systems handle high value and time critical transactions.

Operational failure of a mobile health system also has the potential of threatening stability of the health sector even in the case of retail payment systems such as the mobile money services in Uganda. Operational risk refers to the risk associated with the failure of clearing or settlement system. The failure of a system that is responsible, for example, for payment for medical supplies

could cause widespread disruption. In Uganda, this is of particular importance as it is the only system that performs such transactions.

In addition to systemic and operational risk there are reputational, security and legal/ regulatory risks that must be addressed in the pursuit of safety in management of medical records and payments. Safety is a shared responsibility between the regulator, participants/ service provider, operators, settlement institutions and users.

All stakeholders must identify and understand how risks of various types may arise or be transmitted within the system and determine how they will be borne. Once these risks are properly understood, appropriate and effective mechanisms may be devised to monitor, manage and control them.

5.4.2 Efficiency

Efficiency is characterized by several factors which include: convenient and wider access to health service instruments and related service; variation of health products and services; speed/timeliness in processing and finalization of payments and accessing the service; ease of use and affordability. Efficient systems should also be interoperable to allow for integration of various systems and adaptable to the changing needs of the users. An efficient mobile health system reduces the cost of exchanging services which is vital for the smooth functioning of the health sector. Efficiency is also the basis for building of consumer confidence which is a prerequisite for growth in the use of mobile health systems. Innovation is vital to the growth of mobile health services and an important aspect of efficiency. With cash payments still occurring at a very high rate, it is vital to offer creative payment mechanisms that broaden access and reduce cost of service delivery of health services in Uganda. This is often affected through technical innovation in mobile and payment services. Use of new technologies will provide the system with a level of flexibility that allows for the adoption of new mobile health services and instruments that provide significant benefits to providers and users. Competitive and innovative mobile health systems attract a broad range of users and, through their cost-effective use of resources, contribute positively to the efficient operation of the national and international economy.

Collaboration and cooperation focus on getting stakeholders to work together to provide users the most cost-effective systems through the use of common infrastructure and standards. Transaction costs can be reduced through cooperation amongst mobile app and payment system service providers and through the establishment of financial infrastructure that takes advantage of economies of scale, scope and the use of infrastructure to support multiple services. Though

payment system service providers often compete directly in the provision of retail payment instruments and services to end-users, they also cooperate in shared payment networks. The goal is to ensure a forum for collaboration and cooperation in the context of strategic planning, development and implementation of infrastructure, regulations and systems.

An important consideration in fostering innovation is to have sufficient regulation in place to assure safety without adversely impacting creativity. This requires balance and the use of risk analysis to assess potential threats associated with the introduction of new products or instruments. Stakeholders are responsible to foster growth and innovation to ensure participants and users have access to the most appropriate mobile health systems and instruments to meet the requirements of the Ugandan population and financial system.

Lastly, transparency and accountability are important aspects of efficiency as it affects consumer confidence and usage. Transparency in mobile health systems focuses on both access to and disclosure of health-related information. This information enables stakeholders to understand how laws, policies and regulations will affect their interests. It also helps them to understand their roles and responsibilities as participants in payment systems. Accountability ensures that stakeholders are held responsible for their actions and that there is redress when duties and commitments are not met. The regulations in the Mobile Health Administration should be clearly articulated and enforced to ensure all parties are treated in an equal and fair manner.

5.4.3 Consumer interest

Serving consumer interests through protection, access and inclusion is a guiding principle consistent with public policy objectives. It is a result of public policy initiatives that the rights and interests of consumers are addressed. These considerations are appropriate and necessary in the area of mobile health systems as usage is based on the confidence consumers place in the mobile health service or instrument.

Consumer protection refers to the effort (s) to ensure fairness and clarity with respect to the rights of privacy and the responsibilities of the consumer. Consumers need confidence that the mobile health systems in use are secure, transparent, accessible, and affordable. Consumer protection is important in Uganda due to significant growth with respect to access to mobile health systems, most notably in the area of mobile payments. Consumer protection in payments seeks to provide consumers:

1. More control over their health records and payments,
2. Information regarding the use of their health and payment data and the level of privacy related to that data as consumers may not have the same voice as business to redress grievances,
3. Understanding of the resolution process for disputes or consumer complaints
4. Transparency in terms of disclosure of costs, risks, availability of medical supplies, services and funds and security of payments,
5. Protection from commercial interests based on illegal use of consumer information and data,
6. Disclosure of fees associated with the use of a mobile health and payment system for the purpose of comparison,
7. Knowledge of the built-in protections used to detect and limit errors and,
8. Understanding of the accountability of operators, participants and users to ensure against misuse of the system.

This is accomplished through education, consultation with consumers and facilitation of dispute resolution. The basic principles of consumer protection include the following:

1. Fairness and reliability
2. Transparency
3. Consumers' data and/or information protection
4. Effective complaint handling and resolution

Broad access to mobile health and payment systems refers to the need for users to have a variety of access points and options for the use of mobile health service capabilities. These are important public policy considerations as the private sector is less inclined to place this as a high priority.

5.5 Mobile Health System Objectives, Strategies and Actions

The overarching policy goal for the Mobile Health System Policy Framework is to provide safe and efficient mobile health (mHealth) systems to the Ugandan population to foster proper health and stability of the medical sector. Safety of mobile health and payment systems is achieved through the reduction of risk both from the perspective of the operator and participants. Efficiency is achieved by ensuring that mobile health system service providers offer the most appropriate mobile health service instruments through the most cost-effective mobile and payment systems to meet the practical needs of Ugandan payment system participants and consumers.

5.5.1 Objective 1: Strengthen the Legal, Regulatory and Oversight Framework for the Mobile Health System.

The Ministry of Health must have a recognized legal mandate to perform it's regulatory, supervisory and oversight responsibilities to support it's role in the Mobile Health System.

Policy Statements:

1. The Ministry of Health shall regulate, supervise and oversee the operation of mobile health systems in order to provide prudent management of risk in the mobile health systems.
2. The Ministry of Health shall oversee mobile health system operators as deemed necessary or appropriate to achieve the goals of safety and efficiency
3. All mobile health system operators shall be required to obtain a license from Ministry of Health
4. Mobile Health systems operated by Ministry of Health shall not be
   Subject to a licensing regulatory requirement; however, shall be subject to the same oversight norms and standards applied to the industry.
5. Mechanisms to protect mobile health systems and participants will have a legal basis.

Strategies:

1. Develop and implement a Mobile Health (mHealth) System Act that will provide the appropriate legal foundation for the regulator to perform the following functions:
   (a) Licensing of mobile health (mHealth) systems

   (b) Monitoring of mobile health (mHealth) systems,

   (c) Development and enforcement of regulations to provide norms and standards,

   (d) Oversight of mobile health (mHealth) systems

   (e) Induction of change

Actions:

1. The government should enact the Mobile Health Systems Law.
2. The Ministry of Health implements the oversight policy framework.
3. The Ministry of Health to develop and implement a policy framework for the supervision of Mobile Health System Service Providers

5.5.3 Objective 2: Effective Management of Mobile System Risk to assure Safe and Efficient Operation of the Mobile Health Systems

The Mobile Health System must have a comprehensive and consistent risk management approach across all mobile health (mHealth) systems in Uganda. The goal is the development of a comprehensive framework for the management of mobile health (mHealth) system risks. The framework will include the management of systemic, legal, general business and operational risks.

Policy Statements:

1. All mobile health (mHealth) and settlement system providers and participants shall develop and implement a comprehensive framework for risk management in compliance with the standards adopted by the Ministry of Health to ensure that mobile health (mHealth) systems in Uganda are operated in a safe, responsible and efficient manner.
2. The Ministry of Health shall monitor and enforce compliance to the risk management framework.

Strategies:

1. The Ministry of Health working with the Stakeholders and Participants will formulate a working group within the Mobile Health Systems Council to develop a comprehensive risk management framework.
2. The working group composed of the Ministry of Health, operators and participants will collaborate to develop and implement a comprehensive framework for risk management for all mobile health (mHealth) systems operated in Uganda. This will include systemic, legal, general business and operational risks.

Actions:

1. Formulate a Risk Management Committee as part of the Mobile Health Systems Council chartered with developing the framework for a comprehensive risk management strategy.
2. Oversee stakeholder compliance with the comprehensive risk management framework adopted by the Ministry of Health.

5.5.4 Objective 3: Broaden Access to Payment Systems

The Ministry of Health will encourage the growth of financial inclusion on the broadest possible level by supporting expanded access to payment systems. The Ministry of Health will broaden access in a responsible manner balancing access and risk. This includes fostering innovation in the

payments marketplace to ensure creative products are brought to market that meet specific consumer needs.

Policy Statements:

1. The Ministry of Health shall ensure that access requirements do not unnecessarily or disproportionately restrict direct participation and usage of mobile health (mHealth) systems and do not act as a barrier to entry and expansion for new and emerging mobile health (mHealth) System Providers.
2. The Ministry of Health shall encourage the private sector to play a key role in expanding the range of retail instruments and increasing access to mobile health (mHealth) service centers;

Strategies:

1. Actively support the adoption of Digital Financial Services (DFS) to assure access by the unbanked and underbanked to safe and secure payment services.
2. Develop and implement public awareness and educational programs to increase understanding and confidence in modern mobile health (mHealth) service instruments.
3. Encourage innovation in the mobile health (mHealth) systems marketplace to foster the creation of new products that meet specific consumer needs.
4. Encourage and educate current non-participants on the benefits of becoming direct or indirect mobile health (mHealth) system participants.
5. Define ways to broaden access to mobile health (mHealth) systems in a responsible manner that balances access and risk.

Actions:

1. Develop and implement criteria that extend mobile health (mHealth) system access to potential new participants that do not currently have either direct or indirect access of mobile health (mHealth) systems.
2. Encourage eligible institutions to participate and provide a path for participation for supervised institutions that are not currently eligible.
3. Implement a Health Services Committee that ensures all of the Government of Uganda goals for health inclusion are aligned.

5.5.5 Objective 4: Promote Consumer Interests and Protection

Take an active role in promoting consumer interests to ensure they are being met in the health marketplace in a responsible manner that protects the consumer by providing: more control over

payments; information on health and payment data usage by the operator and data privacy rights; full disclosure of fees, costs, risks, funds availability and security and dispute resolution mechanism. This includes fostering innovation in the payments marketplace to ensure creative products are brought to market that meet specific consumer needs in a cost competitive manner.

Policy Statements

1. Mobile health (mHealth) service providers shall ensure fairness, transparency and reliability in the provision of mobile health services to consumers.
2. There shall be a reliable means of resolution for complaints and conflicts.

Strategies

1. Working with stakeholders, develop a plan for the deployment of rules and regulations aimed at protecting consumers of mobile health systems.
2. Introduce regulations that protect consumer interests with specific enforcement actions.

Actions

1. Develop and implement a plan to define consumer protection regulations.
2. Develop and implement a framework for complaints and conflict resolution.

5.5.6 Objective 5: Forster Competition, Cooperation and Collaboration between Stakeholders and with Other Domestic and Other International Regulatory Bodies.

Proactively engage the mobile health (mHealth) system stakeholders to ensure transparency, collaboration and cooperation in the planning and execution of mobile service initiatives. In addition, be responsible for fostering competition that benefits both participants and consumers while ensuring that competing organizations are part of a collaborative planning process composed of operators, participants and consumers. Collaboration is not limited to the direct stakeholders, but includes other domestic and international regulatory bodies for coordination and cooperation.

Policy Statements

1. The Ministry of Health shall foster collaboration and cooperation between mobile health stakeholders for the purpose of defining and providing input to regulations, policies, strategies and initiatives.
2. The development of the Mobile Health Systems infrastructure shall be a collaborative responsibility.

3. The Ministry of Health shall foster collaborative partnerships with other regulators, government agencies, central banks and international agencies for sustainable development of Mobile Health Systems.
4. There shall be established a Mobile Health Systems Council.

Strategies

1. Establish a forum to promote the Mobile Health (mHealth) System agenda where participants will actively engage in policy setting and the development of regulations for the benefit of the health sector as a whole.
2. Establish cooperative arrangement with relevant stakeholders to promote development of the Mobile Health System.
3. Foster competition that benefits both participants and consumers while ensuring that competing organizations are part of a collaborative planning process composed of operators, participants and consumers.
4. Ensure a competitive payments landscape by encouraging competition through provision of licenses to mobile health service providers in health sectors that may be too tightly held.
5. Foster collaborative payments industry by ensuring stakeholders have a voice in the development of policies and regulations.
6. Proactively engage the mobile health (mHealth) system stakeholders to ensure transparency, collaboration and cooperation in the planning and execution of mobile health initiatives through a Mobile Health Systems Council.
7. Facilitate collaboration between health centers and the other main mobile health service participants, promote joint initiatives to implement mobile health system infrastructure, develop mobile health strategies including mobile health system architecture, discuss policy initiatives such as system reforms, facilitate exchange of information on health needs of the parties affected by the mobile health system and promote standardization of procedures, policies and systems.
8. Proactively engage other regulatory bodies such as the Uganda Communications Commission, and Ministry of Finance, Planning and Economic Development as well as other domestic regulatory bodies to ensure that its regulatory initiatives are consistent and supportive of other regulatory agencies.
9. Work with regional and international bodies to ensure consistency and compliance with regional and international initiatives.

Actions

1. Establish the Mobile Health Systems Council consistent with the roles and responsibilities defined.
2. The Ministry of Health will work cooperatively with all appropriate regional and international entities and organizations to ensure smooth functioning of mobile health systems.

5.5.7 Objective 6: Foster Infrastructure Development and Interoperability between Mobile Health Systems

The Stakeholders must work together to determine potential infrastructure investments that will result in greater processing efficiency and lower transaction costs. The Ministry of Health will actively promote interoperability between mobile service systems to ensure efficient processing of health services throughout the country. The goal of interoperability between mobile health systems is to make delivery of medical services and payments easier to perform, produce cost efficiencies and enable superior risk management.

Policy Statements

1. The Ministry of Health will promote achievement of interoperability between mobile health systems. This shall include medical institutions and health centers, financial institutions, mobile network operators and others as appropriate for the smooth flow of mobile health services across multiple systems.
2. The Stakeholders shall endeavor to implement infrastructure as necessary to offer services to virtually all subscribed and unsubscribed health patients to substantially increase the medical services outreach to the unsubscribed rural communities.
3. The Ministry of Health shall regulate or issue directives to support the goal of interoperability

Strategies

1. The Ministry of Health shall prioritize mobile health payment streams and engage providers for purposes of interoperability.
2. The Ministry of Health shall encourage mobile health service providers to utilize systems capable of becoming interoperable with mobile and other payment systems in the country and internationally, in order to facilitate full interoperability.
3. The Ministry of Health shall encourage interoperability between the card-based systems offered by financial institutions and payment service providers.

4. The Ministry of Health will encourage the development of standards and deployment of infrastructure to facilitate delivery of medical services and payments across multiple systems in Uganda.
5. The Ministry of Health will encourage stakeholders to define opportunities to gain efficiencies in the processing of mobile health services through investment in infrastructure.

Actions

1. Perform an assessment of the current mobile health infrastructure and define opportunities for investments in infrastructure that will broaden access and produce cost efficiencies.
2. The Ministry of Health shall monitor mobile health service payment streams using defined indicators for both infrastructure and interoperability.
3. Upon establishment of the Mobile Health Systems Council, define committees responsible for the development of plans for infrastructure and interoperability.
4. Engage mobile network operators and financial institutions to address issues of interoperability.

5.6 Mobile Health System Stakeholder Roles and Responsibilities

Stakeholders in Mobile Health System of Uganda

The Mobile Health System in Uganda is comprised of many independent but interrelated entities; the Ministry of Health, Other Internal and External Regulatory Authorities, Participants and Payment System Service Providers. These entities are owned and managed by different organizations. In an effort to provide clarity regarding the accountability and coordination of mobile health (mHealth) development efforts in Uganda, it is necessary to define the roles and responsibilities of the stakeholders in the payment system.

5.6.1 Mobile Health System Stakeholders

1. Ministry of Health (MoH)
2. Bank of Uganda
3. Other Regulatory Authorities
4. Participants
5. Payment System Service Providers
6. National Payments Council

5.6.2 Roles and Responsibilities of MoH

The MoH will provide leadership in coordinating and implementing this policy. Implementation of the policy will involve active engagement of various stakeholders including Bank of Uganda, other Regulatory Authorities, Payment Service Providers and Participants. Upon approval of the policy, MoH will organize workshops and dissemination meetings to ensure each stakeholder appreciates the roles within their mandate. The Ministry will dispatch copies of the Policy explaining modalities for implementation.

5.6.3 Roles and Responsibilities of the Bank of Uganda

The Bank of Uganda is responsible for ensuring that the country's monetary and banking system as a whole is sound, meets the requirements of the community and keeps abreast of developments in international finance. The National Payment System is of great importance in supporting these responsibilities because it provides information on the demand for money, the influence of monetary policy and the efficiency and stability of the financial markets. As such, the Bank of Uganda must be at the center due to its overall responsibility for a sound currency and ensuring effective means of payment.

The Bank of Uganda shall adopt the responsibilities of a central bank as set forth by the Bank for International Settlement's Committee on Payment and Settlement Systems who are considered to be representative of international best practice for central banks and regulators. The BIS considers regulation and oversight to be the primary responsibilities of the central bank in payment systems.

To ensure clarity, the terms regulation and oversight are explained below.

- Oversight is a central bank task, principally intended to promote the smooth functioning of payment systems and to protect the financial system from possible "domino effects" which may occur when one or more participants in the payment system incur credit or liquidity problems. Payment systems oversight aims at a given system (e.g. a funds transfer system) rather than individual participants.
- Regulation refers to the imposition of norms and standards of conduct and operation for payment systems and payment service providers.

The Bank of Uganda will perform the following roles as the regulator responsible for payment systems.

1. Oversight

(a) Licensing of payment system and payment service providers.

(b) Monitoring of payment systems and payment system service providers through:

(i) On-site inspections of payment system and payment service providers;

(ii) Off-site gathering of information and statistics from payment system and payment service providers and perform analysis of said data;

(iii) Assessment of payment systems operators and payment service providers;

(iv) Reviewing and assessment of customer complaints and claims on service providers and operators; and

(v) Monitoring the level of risk associated with the delivery of payment system and services.

(c) Impose enforcement actions or sanctions for non-compliance with regulations.

(d) Define the scope and publish its oversight principles, policies and guidelines.

(e) Monitor existing and planned systems and assess them against safety and efficiency objectives.

(f) Induce change to payment system organization and operations, where necessary.

2. Regulation

Impose norms and standards of business conduct and operation for payment systems and payment service providers by:

(a) publishing laws, regulations, guidelines, procedures, directives and policies related to delivery of payment services and the use of payment instruments; and

(b) Developing transparent regulatory policies and procedures with participation from payments stakeholders.

3. Operator

Bank of Uganda will provide and develop payment and credit services by:

(a) Maintaining accounts for interbank payment settlement;

(b) Operating systemically important payment systems or participating directly in private sector arrangements that operate clearing and settlement systems;

(c) Managing settlement accounts and providing settlement credit to participants; and

(d) Operating non-systemically important payment clearing and settlement arrangements, or participating directly in retail payment systems, as deemed necessary.

4. Participant

(a) Participate in systems owned and operated by external parties on behalf of its own customers (such as the government and its agencies);

(b) Participate in securities settlement and depository systems for its own operations; and

(c) Use correspondent banking services for other central banks and financial institutions.

5.6.4 Responsibilities of Other Regulatory Authorities

Other Regulatory Authorities within Uganda such as the Uganda Communications Commission involved in payment systems shall be expected to undertake the following:

1. Cooperation and collaboration with MoH in the regulation and oversight of components of Mobile Health (mHealth) systems Framework.
2. Sharing of information with MoH on issues relating to Mobile Health Systems Framework.
3. Allow for MoH involvement in regulatory and legal initiatives that may impact on the Mobile Health Systems Framework.
4. Setting standards and ensuring adherence to international best practice for components of the Mobile Health Systems Framework that they regulate.
5. Take part in forums set up to discuss issues relating to Mobile Health Systems Framework as and when called upon.

5.6.5 Responsibilities of a Participant

In the context of the Mobile Health System Framework, a participant is any medical institution, health center, health facility or entity that either directly or indirectly participates in a provision of medical services and facilities. In Uganda, this could be any entity allowed to participate in the system.

Within the context of the Mobile Health System Framework, mobile health system participants in Uganda are responsible for:

1. Managing the risks that they introduce or accept, while participating in the mobile health service and payment systems;

2. Ensuring that they have sufficient medical supplies, personnel, facilities and liquidity for their own interbank settlement;
3. Providing mobile health and payment-related services to its customers;
4. Ensuring that the mobile health services processing cycle is completed in accordance with established rules and regulations;
5. Making their customers aware of the features of, and the risks involved in, accepting and using mobile health instruments and services, and educating them in the alternatives available;
6. Issuing payment instructions on its own behalf, or as the beneficiary of a payment issued by someone else; and
7. Maintaining a settlement account where appropriate.

5.6.6 Responsibilities of a Mobile Health System Service Provider (MHSSP)

A Mobile Health System Service Provider means a person/entity licensed or authorized by the MoH to provide mobile health services. Mobile Health Services Include:

1. Services enabling medical aid, supplies and services to be placed and made available for remote access;
2. Any similar services if so, classified by the MoH

A MHSSP provides mobile health services to its participants by acting as an intermediary for processing of mobile health services and transactions.

A Mobile Health System Service Provider (MHSSP) is required to:

1. Obtain a license for operation from the Ministry of Health as appropriate;
2. Adhere to all rules and regulations set by the Ministry of Health;
3. Adhere to the applicable risk reduction/prevention measures;
4. Qualify in terms of equitable risk-based entry criteria as agreed by the Ministry of Health;
5. Collect payment transactions and provide receipt of confirmation of payments processed on behalf of the participant;
6. Acceptance of accountability for the processing of participant payment transactions;
7. Maintain agreements and service levels with the system participants; and
8. Obtain appointment as an agent of one or medical health facility entities subject to oversight.

5.6.7 Responsibilities of the Mobile Health Systems Council (MHSC)

The Mobile Health Systems Council is a council composed of Mobile Health Systems stakeholders with the major goal of supporting balanced and sustainable development of the Health Sector to ensure safe and efficient mobile health services in Uganda. Its primary functions are as follows:

1. Defining priorities and promoting actions in the area of mobile health services;
2. Setting out a general Ugandan mobile health services sector development strategy including the identification and setting of priorities;
3. Providing a forum for the exchange of information and experience in order to gain insight into the mobile health services market in Uganda and the requirements and expectations of the sector participants as well as identification of critical issues;
4. Defining the common interests of the stakeholders through consensus in order to establish common positions in the area of mobile health services in Uganda; and
5. Providing mandates to working groups working within the aegis of the Council.

The Mobile Health Systems Council is an important organization as it fosters cooperation between stakeholders, gives stakeholders a voice in the development of mobile health strategies and helps ensure transparency in the policy formulation process. Membership in the MHSC shall comprise of the following:

1. The Permanent Secretary of Ministry of Health, as the chairperson;
2. Representative from Bank of Uganda
3. A representative from National Information Technology Authority
4. A representative from Uganda Communication Commission
5. A representative of Banks operating in Uganda;
6. A representative of Telecommunication Companies
7. Any other member as deemed necessary

5.6.8 Monitoring and Evaluation of the Mobile Health System Policy Framework

A policy framework requires continual monitoring and evaluation to ensure that the defined objectives and actions are, in fact, performed and have the intended outcomes. As the regulator, it is incumbent upon Ministry of Health in conjunction with the Ministry of Finance Planning and Economic Development to define a plan with milestones and performance indicators that can be presented to and periodically updated for the Mobile Health System stakeholders.

CHAPTER SIX.

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

The previous chapter looked at the process of designing a framework to enhance adoption and usage of Mobile Health systems in the rural communities of Moyo district. This chapter gives an overview of the study, summarizes the findings, draws conclusions, and presents resulting recommendations. Generalizations and inferences will be included in the conclusion along with the researcher's recommendations to the beneficiaries of this study. Discusses the opportunities for future research.

6.1 Summary of Findings

The study clearly elaborated on a number of factors that greatly contributed to the low adoption of mobile health and upon improvement the entire community is willing to take on mobile healthcare systems. The study revealed the following areas;

User-centric designs and capacity building. A number of respondents reported that the Apps that were developed were not user centered, the users' contributions were not incorporated. The users looked at need to make the design features more user friendly and incorporate native languages in the system design to bridge the language gap and enhance adoption, most of the users were technologically illiterate and therefore required specialized training programs focusing the use of Mobile Health (mHealth) systems. Enhance training sessions focusing on all the areas of mobile health systems, data management, privacy and security of data and access right management to change the behavior, attitude and perception of the users to willingly adopt and use the mobile health system in the community.

Data management & Information Systems. The study identified challenges with Integration of health systems, its suggested that for the Mobile health technology to work well and motivate the users into adoption, there is need to have a unified data management system where the current system is made to work interoperable with the existing system, ensuring that mobile Health data collection is aligned with the current Health Management Information Systems (HMIS) and the electronic health record systems (EHRs) to improve quality of data collected which eliminates duplication from different sources. In this way the users especially the health professionals and the community workers would be motivated to adopt the mobile system in the community.

Infrastructure & connectivity. The findings the study also revealed that there are several gaps in regards to infrastructures, adequate health staff accommodation, the distance covered from some health centres to the main hospital is quite big and this hinders movements of staff and patients, in addition the poor road networks in the community affects their smooth operations. The electricity is poor distributed in the community thus the community have limited power sources to keep their mobile devices charged at all times. The respondents admit that the increased poor distribution of solar installation in the health and community centres with free charging points created for users could highly contribute to ease of use and adoption of the mobile system in the community since users would no longer incur cost on mobile charging. The installation of free internet access in the community centres would support the use of mobile health system. The reduction of user cost is a motivation to adoption and use of the mobile systems.

Privacy and security of healthcare data. This was a serious concern in a way that the users expressed the fears in the confidence attached to healthcare data. They raised concern of lack of d**ata Encryption tools to protect the healthcare records.** the current mobile Health system in use lacked encryption for sensitive data types, including Patient Biodata, Sensitive information such as test results for chronic illnesses. This oversight posed substantial risks to patient privacy and the confidentiality of health information, indicating an urgent need for the implementation of robust encryption protocols to protect these critical data types. **Access Rights Management was clearly brought out, the** findings highlighted the predominant use of traditional username and password combinations for system access, with only a small fraction of respondents (3 out of 53) employing multi-factor authentication (MFA) and none using biometric methods. Additionally, concerning password management practices were identified, including saving passwords in browsers, mobile applications and writing them down, which undermine system security. The study also revealed the use of shared accounts and a lack of unique user accounts, leading to reduced accountability and increased risk of security breaches. Furthermore, the majority of respondents reported that passwords do not expire, increasing the likelihood of compromised passwords over time.

Ethical considerations in regards to Patient Consent Management, the finding indicated variability in practices related to information, briefing patients, about data retention and obtaining consent from them to enable data collection and the use of data. These left patients unaware of the actions and purpose of the data collectors, the inconsistency created a situation of trust issues. Improvement and

standardized protocols for patient briefing and consent acquisition are essential for maintaining patient trust to comply with data protection regulations.

The research identified several causes for low adoption which looked at security loopholes within the system, inadequate access control measures, Malicious actors which exploit the vulnerabilities to access confidential data. While addressing the identified issues would enhance adoption. Bridging technological, performance, user experience, economic and social factors would enhance adoption and use of the system.

6.2 Conclusion

In today's environment, the adoption and use of mobile health systems in health centres would greatly contribute to improved healthcare services in rural areas. The efficient adoption of mobile health system may be quite difficult given the several issues that ranges from personality, social requirement, technical concerns, economic factors, perception of its usefulness, the user-friendliness, privacy and security concerns that are a key determinant area and greatly influence mobile health system use. To fully embrace mobile health systems, there is need to consider the user cantered approach, which ensure that users' interests are met right from the design, training support to enhance digital literacy and education of community in mobile health systems. Empowering of health staff through mobilisation and involvement of healthcare teams is essential for the successful adoption, integration and utilization of mobile Healthcare systems.

The findings underscore critical security vulnerabilities within the Mobile Health (mHealth) system in Moyo district, emphasizing the urgent need for an enhanced security framework. Key issues include inadequate password management, insufficient access controls, and a lack of comprehensive security protocols. The predominant use of traditional username and password combinations without multifactor authentication (MFA) or biometric methods presents significant security risks, compounded by poor password management practices, such as saving passwords in web browsers and writing them down. Additionally, inconsistent practices in briefing patients and obtaining consent compromise patient trust and data integrity. To address these challenges, incorporating MFA and biometric authentication, enforcing regular password expiration, promoting the use of password managers, in ensuring unique accounts for users to implement robust encryption protocols. Targeted training programs, regular security audits, and compliance checks are also necessary to safeguard patient information and enhance the system's integrity and reliability.

The overall objective of this dissertation was to design a framework to enhance the adoption and usage of Mobile Health Service systems in Uganda, using Moyo district as a case study. This research followed a structured inquiry by initially understanding the challenges and risks associated with Mobile Health (mHealth) systems, determining the requirements needed to enhance their adoption prioritizing all factors that hinders full adoption and usage, utilizing existing frameworks and best practices to design a user friendly and ease to use framework, and finally evaluating the designed framework.

6.3 Recommendations

To enhance adoption and effective use of mobile healthcare system in Uganda, its essential for the government to develop and implement strong national health polices and frameworks on governance and sustainability of health systems, prioritising investment of digital infrastructures and information systems that are launched on a national wide platform. Addressing unreliable power, limited connectivity and reduced cost of digital access in the community. There is need to make digital literacy programs mandatory to all health professionals and community health workers scaling up initiatives for greater reach.

There is need for enhanced capacity building and management of both private and public health. Empowering health team with knowledge and skills in the mobile health field and encouraging collaboration, and health data sharing amongst health sectors in addition to total integration of existing health systems to encourage adoption and practical use of mobile health systems.

The privacy and security of patient data is a key contribution to increased adoption, the availability of robust security measures such as the use of biometric features, Multi-Factor Authentications is key in ensuring safety of patient data which build trust and integrity in adoption of mobile health systems. There is need for individual two step authenticated access measure to eliminate unauthorize access.

6.4 Proposed areas for Further Research

Given the several factors that affect the efficient adoption of the mobile health systems and privacy and security greatly influence implementation, future research should focus on implementing the designed security framework for Mobile Health (mHealth) systems in Uganda to evaluate its practical effectiveness and identify areas for refinement. The implementation will provide valuable insights into real-world challenges and benefits, guiding further enhancements. Additionally, given the significant gaps identified in current security practices, further investigation is needed into

specific areas such as robust encryption protocols for sensitive data, effective access rights management including the adoption of multi-factor authentication and biometric methods, and comprehensive user training tailored to Mobile Health (mHealth) security needs. Exploring the unique security challenges within the context of developing countries and integrating advanced security measures, such as continuous monitoring and anomaly detection, will also be crucial. Lastly, standardizing protocols for patient consent management and improving governance through well-defined roles and responsibilities contributing to a more secure and resilient Mobile Health (mHealth) system.

REFERENCES

Addotey-Delove, M., Scott, R.E. and Mars, M., 2023. Healthcare workers' perspectives of mHealth adoption factors in the developing world: scoping review. *International journal of environmental research and public health*, 20(2), p.1244.

Alemede, V., Nwankwo, E.I., Igwama, G.T., Olaboye, J.A. and Anyanwu, E.C., 2024. Designing state-level policies to support independent pharmacies in providing specialty care services in rural regions. *Magna Scientia Advanced Biology and Pharmacy*, 13(1), pp.19–29.

Aljedaani, B. and Babar, M.A., 2021. Challenges With Developing Secure Mobile Health Applications: Systematic Review. *JMIR mHealth and uHealth*, 9(6), p.e15654. https://doi.org/10.2196/15654.

Alsahli, S. and Hor, S., 2024. The adoption of mobile health applications by physicians during the COVID-19 pandemic in developing countries: The case of Saudi Arabia. *International Journal of Information Management Data Insights*, 4(2), p.100289. https://doi.org/10.1016/j.jjimei.2024.100289.

Anon. 2025a. *Boosting digital health can help prevent millions of deaths from noncommunicable diseases*. [online] Available at: <https://www.who.int/news/item/23-09-2024-boosting-digital-health-can-help-prevent-millions-of-deaths-from-noncommunicable-diseases> [Accessed 15 September 2025].

Anon. 2025b. *Sustainability metrics for real case applications of the supply chain network design problem: A systematic literature review - ScienceDirect*. [online] Available at: <https://www.sciencedirect.com/science/article/pii/S0959652619318141> [Accessed 15 September 2025].

Anon. 2025c. *What Is a Case Study in Psychology?* [online] Verywell Mind. Available at: <https://www.verywellmind.com/how-to-write-a-psychology-case-study-2795722> [Accessed 16 September 2025].

Anon. n.d. mHealth. *AIDH*. Available at: <https://digitalhealth.org.au/advocacy/mhealth/> [Accessed 16 September 2025a].

Anon. n.d. Mobile Health Smiles Wallets. *Global Health Progress*. Available at: <https://globalhealthprogress.org/collaboration/mobile-health-smiles-wallets/> [Accessed 15 September 2025].

Anon. n.d. Mobile Health Smiles Wallets. *Global Health Progress*. Available at: <https://globalhealthprogress.org/collaboration/mobile-health-smiles-wallets/> [Accessed 15 September 2025b].

Borges do Nascimento, I.J., Abdulazeem, H., Vasanthan, L.T., Martinez, E.Z., Zucoloto, M.L., Østengaard, L., Azzopardi-Muscat, N., Zapata, T. and Novillo-Ortiz, D., 2023. Barriers and facilitators to utilizing digital health technologies by healthcare professionals. *NPJ digital medicine*, *6*(1), p.161.

Chioma Anthonia Okolo, Oloruntoba Babawarun, and Tolulope Oyinlola Olorunsogo, 2024. MOBILE HEALTH (MHEALTH) INNOVATIONS FOR PUBLIC HEALTH FEEDBACK: A GLOBAL PERSPECTIVE. *International Medical Science Research Journal*, 4(3), pp.235–246. https://doi.org/10.51594/imsrj.v4i3.915.

Demonte, M.L.B. and Souto, V.T., 2022. A framework for designing persuasive mobile healthcare applications. *Human Factors in Design*, *11*(21), pp.003-024.

Gill, S., 2025. How many people own smartphones in the world?(2024–2029). Prioridata. Noudettu, 14, p.2025.

Gonsalves, H., Santos, A.F.D., Azevedo, L.H. and Corrêa, L., 2025. https://www. sciencedirect. com/science/article/pii/S2212440325006418. Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 139(5), p.e131.

Ibeneme, S., Karamagi, H., Muneene, D., Goswami, K., Chisaka, N. and Okeibunor, J., 2022. Strengthening health systems using innovative digital health technologies in Africa. *Frontiers in Digital Health*, *4*, p.854339.

Jia, Guifeng & Yang, Pan & Zhou, Jie & Zhang, Hengyi & Lin, Chengyu & Chen, Jin & Cai, Guolong & Yan, Jing & Ning, Gangmin. (2015). A framework design for the mHealth system for self-management promotion. Bio-medical materials and engineering. 26. S1731-S1740. 10.3233/BME-151473.

Kachimanga, C., Zaniku, H.R., Divala, T.H., Ket, J.C., Mukherjee, J.S., Palazuelos, D., Kulinkina, A.V., Abejirinde, I.O.O. and Akker, T.V.D., 2024. Evaluating the adoption of mHealth technologies by community health workers to improve the use of maternal health services in Sub-Saharan Africa: systematic review. *JMIR mHealth and uHealth*, *12*, p.e55819.

Kamulegeya, L.H., Ssebwana, J., Abigaba, W., Bwanika, J.M. and Musinguzi, D., 2019. Mobile Health in Uganda: A Case Study of the Medical Concierge Group. *East Africa Science*, 1(1), pp.9–14. https://doi.org/10.24248/easci.v1i1.12.

Knop, M.R., Nagashima-Hayashi, M., Lin, R., Saing, C.H., Ung, M., Oy, S., Yam, E.L.Y., Zahari, M. and Yi, S., 2024. Impact of mHealth interventions on maternal, newborn, and child health from conception to 24 months postpartum in low-and middle-income countries: a systematic review. *BMC medicine*, *22*(1), p.196.

Maha, C.C., Kolawole, T.O. and Abdul, S., 2024. Revolutionizing community health literacy: The power of digital health tools in rural areas of the US and Africa. *GSC Advanced Research and Reviews*, 19(02), pp.286–296.

Mbunge, E. and Batani, J., 2023. Application of deep learning and machine learning models to improve healthcare in sub-Saharan Africa: Emerging opportunities, trends and implications. *Telematics and Informatics Reports*, 11, p.100097.

Moreno-Ligero, M., Moral-Munoz, J.A., Salazar, A. and Failde, I., 2023. mHealth intervention for improving pain, quality of life, and functional disability in patients with chronic pain: systematic review. *JMIR mHealth and uHealth*, *11*(1), p.e40844.

Mugisha, I., n.d. 43 Percent of Ugandans Own Mobile Phones. *Nilepost News*. [online] Available at: <https://nilepost.co.ug/news/220052/43-percent-of-ugandans-own-mobile-phones> [Accessed 20 July 2025].

Musiimenta, A., Tumuhimbise, W., Atukunda, E.C., Mugaba, A.T., Asasira, J., Katusiime, J., Zender, R., Pinkwart, N., Mugyenyi, G.R. and Haberer, J.E., 2022. A mobile health app may improve maternal and child health knowledge and practices among rural women with limited education in Uganda: a pilot randomized controlled trial. *JAMIA open*, 5(4).

Muzurura, J. and Chigora, F., 2025. *Figure-1. Technology acceptance model (TAM 3).* [online] ResearchGate. Available at: <https://www.researchgate.net/figure/Figure-1-Technology-acceptance-model-TAM-3_fig1_337831455> [Accessed 20 July 2025].

Nanyombi, A. and Ejiri, D.A.H., 2016. Factors Influencing the Adoption of Mobile Health in Uganda Health Facilities: A Case Study of Mobile Tracking System in Kayunga. *American Scientific Research Journal for Engineering, Technology, and Sciences*, 23(1), pp.131–145.

Nielsen, P. and Kimaro, H.C. eds, 2019. *Information and Communication Technologies for Development. Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D: 15th IFIP WG 9.4 International Conference on Social Implications of Computers in Developing Countries, ICT4D 2019, Dar es Salaam, Tanzania, May 1–3, 2019, Proceedings, Part II*. IFIP Advances in Information and Communication Technology. [online] Cham: Springer International Publishing. https://doi.org/10.1007/978-3-030-19115-3.

Okolo, C.A., Babawarun, O. and Olorunsogo, T.O., 2024. Mobile health (mhealth) innovations for public health feedback: a global perspective. International Medical Science Research Journal, 4(3), pp.235-246.

Oladipo, E.K., Adeyemo, S.F., Oluwasanya, G.J., Oyinloye, O.R., Oyeyiola, O.H., Akinrinmade, I.D., Elutade, O.A., Areo, D.O., Hamzat, I.O. and Olakanmi, O.D., 2024. Impact and challenges of artificial intelligence integration in the African health sector: a review. *Trends Med Res*, 19(1), pp.220–235.

Osei, E., Kuupiel, D., Vezi, P.N. and Mashamba-Thompson, T.P., 2021. Mapping evidence of mobile health technologies for disease diagnosis and treatment support by health workers in sub-Saharan Africa: a scoping review. *BMC Medical Informatics and Decision Making*, 21(1), p.11. https://doi.org/10.1186/s12911-020-01381-x.

Rotondi, V., Kashyap, R., Pesando, L.M., Spinelli, S. and Billari, F.C., 2020a. Leveraging mobile phones to attain sustainable development. *Proceedings of the National Academy of Sciences*, 117(24), pp.13413–13420. https://doi.org/10.1073/pnas.1909326117.

Singh, B., Ahmed, M., Staiano, A.E., Gough, C., Petersen, J., Vandelanotte, C., Kracht, C., Huong, C., Yin, Z., Vasiloglou, M.F. and Pan, C.C., 2024. A systematic umbrella review and meta-meta-analysis of eHealth and mHealth interventions for improving lifestyle behaviours. *npj Digital Medicine*, *7*(1), p.179.

Taddewo William Senyonyi October 20, 2024, 56.7% Of Uganda's Population Doesn't Have a Mobile Phone-Report,https://businessfocus.co.ug/56-7-of-ugandas-population-doesnt-have-a-mobile-phone-report/

Takuwa, M., Mbabazi, S.E., Tusabe, M., Mulindwa, B., Makobore, P.N., Mulerwa, M., Kansiime, E.C., Birungi, D.M., Reboud, J., Cooper, J.M. and Ssekitoleko, R.T., 2023. Mobile Health Access and Utilisation in Uganda: Knowledge, Attitudes and Perceptions of Health and Veterinary Workers. *Telemedicine and e-Health*, 29(6), pp.912–920. https://doi.org/10.1089/tmj.2022.0375.

Team, J.E., 2025. *Data Collection Methods*. [online] Jotform. Available at: <https://www.jotform.com/data-collection-methods/> [Accessed 16 September 2025].

Tumuhimbise, W., Atwine, D., Kaggwa, F. and Musiimenta, A., 2022. Enhancing tuberculosis care in southwestern Uganda: Facilitators and barriers to utilizing mobile health technologies. *Global Implementation Research and Applications*, *2*(4), pp.404-414.

Williams, S.Y., Adeyemi, S.O., Eyitayo, J.O., Odeyemi, O.E., Dada, O.E., Adesina, M.A. and Akintayo, A.D., 2020. Mobile health technology (Mhealth) in combating COVID-19 pandemic: Use, challenges and recommendations. Electronic Journal of Medical and Educational Technologies, 13(4), p.em2018.

Williams, S.Y., Adeyemi, S.O., Eyitayo, J.O., Odeyemi, O.E., Dada, O.E., Adesina, M.A. and Akintayo, A.D., 2020. Mobile health technology (Mhealth) in combating COVID-19 pandemic: Use, challenges and recommendations. Electronic Journal of Medical and Educational Technologies, 13(4), p.em2018.

Woldemariam, M.T. and Jimma, W., 2023. Adoption of electronic health record systems to enhance the quality of healthcare in low-income countries: a systematic review. *BMJ Health & Care Informatics*, 30(1), p.e100704.

Zakerabasali, S., Ayyoubzadeh, S.M., Baniasadi, T., Yazdani, A. and Abhari, S., 2021. Mobile health technology and healthcare providers: systemic barriers to adoption. *Healthcare Informatics Research*, *27*(4), pp.267-278.

Zhang, K. and Aslan, A.B., 2022. Design Frameworks for Mobile Health Technology: A State-of-the-Art Review of Research From 2015-2021. *International Journal of Health Systems and Translational Medicine*, 2(1), pp.1–13. https://doi.org/10.4018/IJHSTM.302653.Zhang, K. and Aslan, A.B., 2022. Design Frameworks for Mobile Health Technology: A State-of-the-Art Review of Research From 2015-2021. International Journal of Health Systems and Translational Medicine (IJHSTM), 2(1), pp.1-13.