



**Strathmore**  
UNIVERSITY

Strathmore University  
**SU+ @ Strathmore**  
University Library

---

**Electronic Theses and Dissertations**

---

2017

# A Collaborative model for supporting shared healthcare in Kenya

Mariam Salim Heroe  
*Faculty of Information Technology (FIT)*  
*Strathmore University*

Follow this and additional works at <https://su-plus.strathmore.edu/handle/11071/5655>

## Recommended Citation

Heroe, M. S. (2017). *A Collaborative model for supporting shared healthcare in Kenya* (Thesis).

Strathmore University. Retrieved from <http://su-plus.strathmore.edu/handle/11071/5655>

**A Collaborative Model for Supporting Shared Healthcare in Kenya**

**MARIAM SALIM HEROE**

**Master of Science in Information Technology**

**2017**

**A Collaborative Model for Supporting Shared Healthcare in Kenya**

**MARIAM SALIM HEROE**

**083653**

**Submitted in Partial Fulfillment of the Requirements for the Degree in Master of Science in  
Information Technology at Strathmore University**

**Faculty of Information Technology**

**Strathmore University**

**Nairobi, Kenya**

**June, 2017**

This thesis is available for Library use on the understanding that it is copyright material and that no quotation from the thesis may be published without proper acknowledgement.

### Declaration

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

© No part of this thesis may be reproduced without the permission of the author and Strathmore University

Heroe, Mariam Salim [Name of Candidate]

..... [Signature]

..... [Date]

### Approval

The thesis of Heroe Mariam Salim was reviewed and approved by the following:

Dr. Vincent Omwenga,

Faculty of Information Technology,

Strathmore University

Dr. Joseph Orero,

Dean, Faculty of Information Technology,

Strathmore University

Professor Ruth Kiraka,

Dean, School of Graduate Studies,

Strathmore University

## **Abstract**

Shared care is the joint participation of primary and secondary healthcare professionals in a planned care delivery informed by an enhanced information exchange. To effectively practice shared care both the primary and secondary healthcare professionals must be able to collaborate effectively in order to coordinate their activities and assume complementary roles in formulating and carrying out patients' care plans. Currently, the collaborative shared care schemes implemented in Kenya use inefficient collaboration tools which have made healthcare professionals face various challenges that can result in medical errors, misuse of resources, poor patient outcomes and unnecessary or even harmful services that ultimately raise the healthcare costs and degrade the quality and continuity of healthcare services. This study aimed to come up with a web based collaborative model for supporting shared healthcare. The model was integrated with an analytical back-end system for generating reports on patients, healthcare professionals, diagnosis and referrals as requested by the users. The model was developed using V-process methodology since the user requirements were clear and well defined and the technical expertise needed was available. The research results showed that the proposed model enabled effective collaboration between health professionals. Therefore, if implemented, the model can contribute significantly to the improvement of the quality and continuity of healthcare as well as the patients' safety.

## **Dedication**

I dedicate this thesis to my loving family, mentors and friends for the support they gave me during the research period.

### **Acknowledgement**

I would like to express my gratitude to my supervisor Dr. Vincent Omwenga for his guidance and persistent help. I would also like to thank Strathmore University for the great opportunity to partake my master's degree at their prestigious institution. I would also like to express my deepest gratitude and special thanks to my parents (Salim Heroe, and Maua Juma Mutunga), my brothers (Aziz, Juma and Suleiman) and my friends for their continuous encouragement and support.

### **Abbreviations/ Acronyms**

EMRs	-	Electronic Medical Records
IT	-	Information Technology
MOH	-	Ministry of Health
PHCP	-	Primary Healthcare Professional
SHCP	-	Secondary Healthcare Professional
SMS	-	Short Messaging Service
WHO	-	World Health Organization

### **Definition of Terms**

**Shared care** - The joint participation of primary healthcare professionals and secondary or specialty care professionals in a planned care delivery, informed by an enhanced information exchange over and above the normal discharge and referral letters (Townsend et al., 2015).

**Healthcare professionals** - Primary healthcare providers and secondary care providers (Canadian Health Services Research Foundation, 2006).

## Table of Contents

Declaration .....	iii
Abstract .....	iii
Dedication .....	iv
Acknowledgement .....	v
Abbreviations/ Acronyms .....	vi
Definition of Terms.....	vii
Table of Contents .....	vii
List of Figures .....	xii
List of Tables .....	xiii
List of Equations .....	xiv
1.1    Background of study.....	1
1.2    Problem Statement.....	2
1.3    Objectives .....	3
1.3.1    General objective .....	3
1.3.2    Specific objectives .....	3
1.5    Research Questions.....	3
1.6    Justification of the Research.....	3
1.7    Scope and Limitations of the Research .....	4
Chapter 2: Literature Review .....	5
2.1    Introduction .....	5
2.2    Collaboration in Healthcare.....	5
2.3    Shared Care.....	5
2.3.1    Collaborative Methods Used in Shared Care Settings .....	6
2.4    Factors Affecting Collaboration in Shared Care Settings .....	8
2.4.1    Patriarchal Relationships between Healthcare Professionals .....	8
2.4.2    Lack of Interdisciplinary Education .....	9
2.4.3    Lack of Role Classification .....	9
2.4.4    Healthcare Professional and Organizational Culture.....	9
2.4.5    Proximity .....	9
2.4.6    Information Technology .....	10

2.5	Technologies Used to Support Collaboration between Healthcare Professionals .....	10
2.5.1	Doximity .....	11
2.5.2	Medscape Consult.....	12
2.5.3	Epic Haiku .....	12
2.6	Summary of the Approaches .....	12
2.7	The Collaborative Shared Care Model .....	13
2.7.1	Design.....	14
2.7.2	Conceptual Framework.....	15
Chapter 3: Research Methodology.....		17
3.1	Introduction .....	17
3.2	System Analysis and Research Design.....	17
3.2.1	System Analysis.....	17
3.2.2	Research Design.....	17
3.3	Target Population and Sampling .....	18
3.4	Data Collection Methods and Techniques.....	19
3.5	Data analysis and System Design.....	19
3.5.1	System Design .....	20
3.6	Research Quality Aspect .....	21
3.6.1	Validity .....	21
3.6.2	Reliability.....	22
3.7	Ethical Consideration .....	22
Chapter 4: System Analysis and Design .....		23
4.1	Introduction .....	23
4.2	Results from Questionnaire .....	23
4.3	Requirement Analysis.....	28
4.3.1	Functional Requirements .....	29
4.3.2	Non-Functional Requirements .....	29
4.3.3	System Requirements.....	30
4.4	System Design .....	30
4.5	Diagrammatic Representation of the Model.....	30
4.5.1	Use Case Diagram.....	30

Figure 4.9 Use Case Diagram .....	31
Table 4.2 Summary of Use Case Diagram.....	32
4.5.2 Sequence Diagram .....	36
4.5.3 Entity Relationship Diagram.....	37
4.5.4 Design Class Diagram.....	39
4.6 The Collaboration Model Architecture.....	40
Chapter 5: System Implementation and Testing.....	42
5.1 Introduction .....	42
5.2 System Implementation.....	42
5.2.1 Web Interface (Front-end) .....	42
5.3 Model flow .....	45
5.4 Model Testing .....	46
5.4.1 Validation Results.....	47
5.4.2 Usability Testing Results.....	48
Chapter 6: Discussion .....	50
6.1 Introduction .....	50
6.2 Factors Affecting Collaborative Shared Care in Kenya.....	50
6.3 Collaborative Methods in Shared Care Settings .....	50
6.4 Collaborative model for Supporting Shared Care .....	51
6.5 Testing of the Collaborative Model for Supporting Shared Care .....	51
6.6 Advantages of the Collaborative model for Supporting Shared Care.....	51
Chapter 7: Conclusion and Recommendation.....	53
7.1 Conclusion.....	53
7.2 Contribution of the Model to Research .....	54
7.3 Recommendations .....	54
7.4 Future Work .....	55
References.....	56
Appendices.....	63
Appendix A: Turnitin Originality Report .....	63
Appendix B: User Requirements Questionnaire.....	64
Appendix C: User Requirements Questionnaire.....	67

Appendix D: System Usability Questionnaire .....	70
Appendix E: Patient Diagnosis and Prescription Interface .....	72
Appendix F: Patient Referral Process Interface .....	73

## List of Figures

Figure 2.1 Conceptual Model .....	16
Figure 3.1 V-Process Model (Khan & Beg, 2013) .....	20
Figure 4.1 Research respondents .....	20
Figure 4.2 Healthcare Facilities .....	24
Figure 4.3 Presence of Collaboration between Healthcare Professionals.....	24
Figure 4.4 Collaborative Methods Used in Shared Care Settings .....	25
Figure 4.5 Collaboration Tools Used in Shared Care Settings .....	26
Figure 4.6 Challenges Respondents Face While Collaborating Using Tools in Figure 4.5 .....	26
Figure 4.7 Respondents Rating of the Existing Collaboration Methods .....	27
Figure 4.8 Respondents who think the Collaborative System for Supporting Shared Care is Necessary .....	28
Figure 4.9 Use Case Diagram .....	31
Figure 4.10 Sequence Diagram.....	37
Figure 4.12 Entity Relationship Diagram .....	39
Figure 4.13 Design Class Diagram .....	40
Figure 4.14 Collaborative Model System Architecture .....	41
Figure 5.1 User management interface .....	43
Figure 5.2 Patient Management Interface .....	44
Figure 5.8 Collaboration Interface .....	45
Figure 5.9 Reports Screen Shot .....	45
Figure 5.10: Model Flow Diagram .....	46
Figure 5.11 Login Interface .....	47
Figure 5.12 Respondents Who Successfully Accessed the System .....	48
Figure 5.13 Collaboration Model Attributes Rating .....	48

## **List of Tables**

Table 2.1 A taxonomy of shared care for chronic disease (Hickman et al., 1994).....	7
Table 2.2 Summary of Approaches .....	13
Table 4.1 Functional and Non-functional Requirements .....	29
Table 4.2 Summary of Use Case Diagram.....	32

## List of Equations

Equation 3.1 Random Sampling .....	18
------------------------------------	----

## **Chapter 1: Introduction**

### **1.1 Background of study**

Good health enables an individual perform daily living activities and lead a productive life (Basavanthappa, 2003). When an individual is unhealthy they may be prohibited from performing certain activities and this affects their productivity. Hence, there is nothing more valuable in life than good health (World Health Organization [UN], 1978). Good health being a prerequisite to human productivity and development is essential to a country's economic and technological development. According to the World Health organization, the right to health is a fundamental human right that every government should promote, provide and protect. Therefore, the right to health is a fundamental human right that every government including Kenya must promote, provide and protect.

Healthcare systems are set up to provide services and resources that ensure a healthy population exists (Beaulieu, 2000). The healthcare system is made up of facilities such as hospitals, clinics and health centers. This system has participants ranging from primary and secondary healthcare professionals, specialists or specialist teams to the patient's family and even the patient. Therefore, healthcare is a collaborative effort with each participant in the healthcare process having a special role and responsibility. Mickan (2005) describes healthcare as a multidisciplinary profession in which doctors, clinical officers, nurses and other health professionals from different specialties must work together, communicate frequently and share resources. Effective linkages between the facilities and health professionals in the care process can enhance the quality of healthcare services and patients' safety. These linkages bring together an array of resources and skills that strengthens an interdisciplinary healthcare approach that should be maintained to achieve health for all (Rod et al., 2015). Collaboration in healthcare employs the practices of enhanced communication to streamline the complementary roles of healthcare professionals and enable them to work as a unit towards a common goal.

In Kenya, as in other developing countries, structural deficiencies due to the present economic situation have led to substantial deficits in social policies, including those related to public healthcare (White, 2015). As illustrated by Salisbury, Johnson, Purdy, Valderas and Montgomery (2011), changes in demographics, epidemiological profiles and the increase of chronic diseases like cancer and diabetes have created a need for new healthcare models. Models

such as shared care which attribute an increasing level of importance to enhanced information exchange over and above the normal discharge and referral letters. These models facilitate collaboration between healthcare professionals which is considered central to the improvement of healthcare quality and continuity (Galarneau, 2015).

Currently, shared care is implemented using different schemes such as the community clinics shared care scheme, the basic model shared care scheme, the liaison model shared care scheme, the shared care record card scheme, the computer assisted shared care scheme and the electronic email scheme (Singer et al., 2011). Although these shared care schemes have contributed significantly to the improvement of patient's care delivery and care management. They have not been able to effectively support collaboration between healthcare professionals or the implementation and practice of shared care (Doessing & Burau, 2015).

This study using IT and IT related systems, aims to develop a collaborative model that supports collaboration among healthcare professionals and the implementation of collaborative shared care.

## **1.2 Problem Statement**

Kenya has a decentralized health system characterized by a fragmented healthcare delivery process (Ministry of Health [MOH], Kenya Health Investment Plan (2013-2017), 2013). Evidence of fragmentation in the delivery process includes poor communication and the lack of care coordination due to poor collaboration between healthcare professionals. Fragmentation in the healthcare delivery process results in medical errors, misuse of resources, poor patient outcomes and unnecessary or even harmful services that ultimately raise the healthcare costs and degrade its quality.

Governments, healthcare professionals and concerned citizens continually seek new ways to improve and transform healthcare systems to support the provision of quality and affordable healthcare. In Kenya, attempts have been made to integrate healthcare services, for example the implementation of the shared care schemes. Although these schemes have improved communication and the sharing of patient data among healthcare professionals, the resulting structure does not fundamentally improve the manner in which healthcare professionals collaborate within and across organizational boundaries to coordinate their services.

This study proposes a collaborative model for supporting shared care which connects health professionals working in public health facilities in Kenya. This model enables the healthcare professionals to collaborate and coordinate their services as well as give recommendations on patients' conditions and care plans. The model also enables users to interactively search the databases for patients', healthcare professionals' and healthcare facilities. The analytical back-end system will be used to track the number of patients seen, the number of referrals and the types of diagnosis. The collected data will be used to produce reports on patients' and healthcare professionals' data, diagnosis and the number of referrals.

### **1.3 Objectives**

#### **1.3.1 General objective**

The aim of the study is to develop a collaborative model for supporting shared care in public healthcare facilities in Kenya.

#### **1.3.2 Specific objectives**

The specific objectives include;

- i. To determine the factors affecting collaborative shared care in Kenya
- ii. To analyze the collaborative methods used in shared care settings
- iii. To develop a collaborative model for supporting shared care in Kenya
- iv. To test the model using the data collected from the study

### **1.5 Research Questions**

- i. What are the factors affecting collaborative shared care in Kenya?
- ii. Which collaborative methods are currently used in shared care settings?
- iii. How will the collaborative model for supporting shared care be developed?
- iv. How will the collaborative model be tested?

### **1.6 Justification of the Research**

There is a marked increase in the complications arising from the poor collaboration among health professionals. Adeley and Ofili (2010) report that, over 60% of patients cite the lack of collaboration and communication between their primary and secondary healthcare professionals as the main source of error in their care plans. The challenge with the current shared care

schemes is their inability to connect a larger percentage of healthcare professionals across organizational boundaries. This leads to inefficient collaboration which subsequently leads to poor care coordination among the healthcare professionals involved in a patient's treatment or care process. This results to a complex and fragmented pattern of healthcare delivery, that compromises the quality and continuity of the care process as well as the patient's safety (Adwok, Kearns, & Nyary, 2013).

The proposed collaborative model for supporting shared care will be web based to ensure easy access and to connect a larger percentage of healthcare professionals. Users will be able to interactively search the databases for patients', health professionals' and healthcare facilities' data as well as add additional notes and give recommendations on patients' conditions and care plans. This will enable them assume complementary roles and cooperatively work together in formulating and carrying out plans for patients' care. The analytical back-end system will be used to track the number of patients treated, the number of referrals and the diagnosis. The concept of tracking the number of patients and referrals and diagnosis will enable organizations and even the government to know the number of patients seen at specific healthcare facilities, the number of healthcare professionals operating at these facilities, the types of diagnosis made and the number of referrals as well the reasons for referral. This will help the health organizations as well as the government formulate better policies and make the correct investments with regards to healthcare in Kenya.

### **1.7 Scope and Limitations of the Research**

The research focused on creating a model not a fully functional system for supporting collaborative shared care. The model will connect and facilitate collaboration between primary and secondary healthcare professionals working in public healthcare facilities in Kenya, specifically Nairobi County. This model will help healthcare professionals from different disciplines and healthcare facilities across the county collaborate and cooperatively work together to formulate and carry out patient care.

## **Chapter 2: Literature Review**

### **2.1 Introduction**

This chapter focuses on discussing collaboration in healthcare and the current implementation and practice of shared care. The research also analyzes the factors affecting collaboration in shared care settings as well as the technologies used to support collaboration between healthcare professionals. Finally, based on the reviewed literature, the researcher conceptualizes the collaborative model for supporting shared care illustrating the major hardware components.

### **2.2 Collaboration in Healthcare**

Collaboration in healthcare is an intricate process that requires effective information sharing and joint patient care. The American Nurses Association describes collaboration in healthcare as a partnership between healthcare professionals with mutual valuing, recognized spheres of responsibility, mutual safeguarding of legitimate interests of each party and recognized shared goals. Collaboration is vital to both healthcare professionals and patients as the level of collaboration between healthcare professionals can directly influence patients' outcomes. Adeley and Ofili (2010), report that, over 60% of patients cite the lack of collaboration among healthcare professionals as the main cause of their adverse events. Therefore, an increase in collaboration between health professionals can improve both the patients' outcomes and the healthcare professionals' satisfaction.

### **2.3 Shared Care**

Shared care is described as the joint participation of primary healthcare professionals and secondary healthcare professionals in a planned care delivery, informed by an enhanced information exchange over and above the normal discharge and referral letters. According to Galameau (2015), shared care offers an opportunity to provide patients with the benefit of timely specialist intervention combined with continuity in the management of healthcare. Shared care as a model for improved service delivery and enhanced collaboration aims at increasing the positive outcomes and satisfaction of patients as that is the primary goal of healthcare systems (Traver, 2013).

Shared care has been identified as a healthcare model that can improve patient's outcomes and reduce the likelihood of adverse events (Reddy & Jansen, 2008). At present, shared care is

applied along the health continuum for a number of chronic health conditions like diabetes, cardiovascular diseases, respiratory diseases and mental illness among others. In this setting, shared care facilitates collaboration among the health professionals involved in a patient's care process as well as the sharing of patient's data. Additionally within the shared care setting, healthcare professionals share joint responsibility in a patient's care process as they share specific knowledge and skills pertaining to the patient's care. Healthcare systems all over the world are trying to promote the notion of "the right patient in the right place at the right time". For a patient to be in the right place and at the right time, communication and collaboration has to be streamlined to ensure optimal inter-organizational and inter-professional cooperation (Pisipati , Chow , & Payne , 2009).

### **2.3.1 Collaborative Methods Used in Shared Care Settings**

Within the healthcare sector, there are various shared care arrangements that promote collaboration, referred to as shared care schemes (Townsend et al., 2015). In their assessment of shared care, Hickman et al. (1994) came up with six classifications of such initiatives. A tabular representation of the shared care schemes is shown in table 2.1.

**Table 2.1 A taxonomy of shared care for chronic disease (Hickman et al., 1994)**

Classification	Description
Community clinics	A clinic within a general practice attended by a specialist. This set up enables direct transfer of patient's data, knowledge and skills between the primary care provider and the specialist.
Basic model	In this model of shared care communication is one way. This is because communication and information exchange between primary care providers and hospital teams or specialist is by letters e.g. referral letters and/ or standardized record sheets.
Liaison model	This model facilitates a two way communication as the primary care providers and the hospital team or specialists have regular patient discussion meetings (can be through telephone calls).
Shared care record card	The shared care record card model requires a patient to carry a liaison card or booklet between visits to their primary care providers and hospital or specialist to allow the systematic recording of the patient's data.
Computer assisted shared care	Health professionals participating in a patient's care process enter jointly agreed upon data into a central hospital computer. Secondary care providers have access to the data stored in the central computer which helps them plan the patient's care process. Based on the data collected, advice and recommendation letters are written by the specialists and forwarded back to the primary care provider who will continue with the patient care process.
Electronic email	This model of shared care has a common database where jointly agreed upon data is entered by the health professionals involved in the shared care process. The database has multi-access ports, therefore can be accessed by hospital teams and primary healthcare providers.

These shared care schemes promote collaboration among healthcare professionals and have the following characteristics in common; joint provision of interdisciplinary healthcare services, clear differentiation of roles among the healthcare providers, commitment to consistent high

quality communication and information exchange, shared responsibility for patient care process, the inclusion of the patient and their family in the care process and procedures to ensure confidentiality of patients records and medical history (Valentijn, Schepman, Opheij, & Bruijnzeels, 2013).

## **2.4 Factors Affecting Collaboration in Shared Care Settings**

Barriers to healthcare professionals' collaboration are relevant to the study as they hinder the implementation and practice of collaborative shared care. The literature reviewed reveals the major barriers to be; patriarchal relationships between the healthcare professionals, lack of interdisciplinary education, lack of role clarification, healthcare professional and organizational culture, proximity and information technology.

### **2.4.1 Patriarchal Relationships between Healthcare Professionals**

The relationship between health professionals has been studied by many researchers and it has been described as being hierarchical in nature with some healthcare professionals being considered subservient to others. In the primary and secondary healthcare providers' relationship, the primary healthcare provider is considered subservient to the secondary healthcare provider fulfilling their orders. According to O' Leary et al. (2011), this type of a relationship has been found to be a barrier to collaboration. While studying this relationship decision making process with regards to patients' care plans, Maxson et al. (2010) states that primary healthcare providers reported lower levels of satisfaction while secondary healthcare providers reported higher levels of satisfaction. The primary healthcare providers reported lower level of satisfaction as they felt that their views were not considered in formulating the patients' care process. The secondary healthcare providers reported higher levels of satisfactions as they were satisfied with the levels of collaboration; that is the decision making process that the primary healthcare providers were not satisfied with. These studies show the primary healthcare providers' desire to collaborate and their expectation for the secondary healthcare providers to collaborate with them as well. The results from these studies suggest that the primary and the secondary healthcare providers do not perceive their relationship the same way and clearly demonstrates a deficient collaboration process. Until both of them are equally satisfied with the relationship the collaboration process will remain unbalanced.

### **2.4.2 Lack of Interdisciplinary Education**

O'Leary et al. (2011) identifies the lack of interdisciplinary education as one of the barriers to collaboration between healthcare professionals and effective collaborative shared care. Collaboration strategies and benefits need to be taught to healthcare professionals to encourage collaboration between them. Maxson et al. (2011) puts forth two major reasons for promoting interdisciplinary education, that is; increased ability to share knowledge and skills, and the opportunity to enhance respect between the healthcare professionals. For interdisciplinary education and training to have the most impact, it should be conducted throughout the schooling period. In healthcare organizations, related seminars and trainings can be held frequently to help the healthcare professionals understand and respect each others' role within the healthcare system.

### **2.4.3 Lack of Role Classification**

The lack of role clarification has also been identified as a barrier to collaborative shared care due to the overlap in the roles of the healthcare professionals involved in a patient's care process. Due to this overlap it may be difficult to determine who is responsible for what part of the patient's care process (Naylor & Keating, 2008). Unlike in other sectors where specific hierarchies of authority exist, the healthcare sector has a variety of healthcare professionals from different disciplines providing overlapping services from different organizations in various locations therefore adding to the confusion as to whom to collaborate with and about what issue.

### **2.4.4 Healthcare Professional and Organizational Culture**

The influences of personal, professional and organizational culture may impact the healthcare professional's desire and willingness to collaborate with others. These factors shape the healthcare professional's thoughts and actions. According to Traver (2013) history and education shape a profession's culture and autonomy has been promoted in each profession. However, in healthcare this autonomous culture needs to change to one of collaboration as all the different healthcare professionals involved in a patient's care process are vital to the care process as they have specific roles to play and specialized knowledge and skills to share.

### **2.4.5 Proximity**

Studies have shown that one of the most important factors in building collaborative healthcare teams is geographical proximity between healthcare professionals as it helps them to get to know

each other and build trust. The lack of physical proximity and the random dispersion of the healthcare professionals involved in a patient's care process can negatively impact the communication and coordination of activities between healthcare professionals and subsequently compromise the quality and continuity of healthcare as well as the patients' safety (Younger, 2010).

#### **2.4.6 Information Technology**

According to Singer et al. (2011) information technology is the most current barrier to collaboration in shared care settings. Although information technology related systems enable healthcare professionals to collaborate even from different geographical areas, these systems still have challenges such as interoperability limitations that inhibit the connection between disparate IT systems and the sharing of data across organizational boundaries.

Another challenge with these systems is their inability to connect a larger percentage of healthcare professionals across organizational boundaries because they are hospital based. This means that these systems can only be accessed by authorized personnel within that particular hospital. Also, these systems do not provide feedback or notification mechanisms through which the healthcare professionals can access the outcome of their orders e.g. with regards to medication prescribed to a patient or be notified of the initiation or discontinuation of important medications or treatments (Nov & Schechter, 2012).

Furthermore, most of these information technology systems use electronic medical records which use checklists in most of the documentation. To some extent, these electronic medical records (EMRs) have constrained the practice of collaborative shared care as they lack the narrative that can provide more descriptions pertaining to a patient's condition or treatment (Virani, 2012).

#### **2.5 Technologies Used to Support Collaboration between Healthcare Professionals**

In most developed countries, governments and healthcare organizations have put mechanisms in place to facilitate effective communication and collaboration among healthcare professionals. These are efforts aimed towards providing seamless patient care with reduced medical errors and of improved quality at reduced costs. IT can play a pivotal role in the connection of healthcare professionals regardless of their geographical location and facilitate collaboration among them and coordination of their activities. To achieve optimal collaboration among healthcare

professionals, collaboration technologies need to be used as they can meet both clinical and non clinical needs within the health sector (Kim-hwang, Chen , Bell , Guzman , & Yee , 2010).

These technologies can improve communication across the entire healthcare system by traversing organizational and disciplinary boundaries and connecting healthcare professionals, administrators and patient's in a more personal and cost effective manner (Leonard, Mliga, & Mariam , 2002). This is because these technologies defy distance as they can provide real time communication using text, voice and even video. Collaborative technologies can also support internal communication needs of healthcare facilities as healthcare professionals and administrators alike can use them to provide timely feedback and updates to their teams from afar.

The delivery of healthcare services is an information intensive endeavor which requires timely communication and exchange of crucial information. Information technology systems provide a flexible and a cost effective option to connect healthcare professionals and enable them collaborate even from remote locations. Also using these systems, healthcare professionals, health organizations and even governments can easily collect, store, analyze and disseminate healthcare related data and information (Ward, Stevens, Brentnall, & Briddon, 2008). This study evaluated several technologies used to support collaboration between health professionals and they are Doximity, Medscape Consult, and Epic Haiku.

### **2.5.1 Doximity**

Doximity is the largest medical professional network in the US connecting over 60% of health professionals. Healthcare professionals can access Doximity either using their phones by suing the Doximity App or through their web page. Although largely used for professional networking and career development, some health professionals use it to discuss patient's cases to better understand their condition or disease so as to better formulate their treatment process and care plan (Younger, 2010).

In as much as the communication is secured, the delimiting factor is that the communication is not regulated and is done without the consent of the patient and this may lead to misuse of the shared confidential patient data. Furthermore, the information shared cannot be stored therefore

cannot analyzed to benefit governments or healthcare community or organizations. (Doessing & Burau, 2015).

### **2.5.2 Medscape Consult**

This application was specifically designed for the healthcare community as it provides secure sharing of different types of patient's data, including texts, video, photographs and other forms of patient data. Medscape consult connects healthcare professionals and enables them to share and discuss challenging or de-identified conditions or diseases. At the core of Medscape consult is a drugs and diseases reference database where health professionals can seek answers (Canadian Health Services Research Foundation, 2006). Medscape consult also features expert reviewers who contribute to and moderate the health professionals' discussions to enhance the quality of advice discussed and integrate the feedback.

### **2.5.3 Epic Haiku**

Epic Haiku is an App that enables hospitals build electronic health records and subsequently allows authorized healthcare professionals access to them. This approach allows authorized users access to a hospital's patients' list and also allows them to add and search for patients in the database (Nov & Schecter, 2012). Epic haiku also stores patients' data and doctors, nurses and other authorized health professionals can review and/ or update the information. Based on a patient's medical history the application can produce reports of the patient's vitals, diagnosis and admissions.

## **2.6 Summary of the Approaches**

The previously discussed approaches have several advantages. However, each possesses some notable demerits. These are summarized in Table 2.2.

**Table 2.2 Summary of Approaches**

Approach	Merit	Demerit
Doximity	Easily accessible since it is web based.  It connects health professionals from different disciplines and healthcare facilities.	Communication is not regulated.  Lack of confidentiality of the shared information.
Medscape Consult	Easily accessible since it is web based.  Connects doctors from different hospitals.	Has no central database for the patients' information and medical history.
Epic Haiku	Easily accessible since it is web based.  It has a central database for the patients' information and medical history.	Does not connect doctors from different hospitals.

## **2.7 The Collaborative Shared Care Model**

Ineffective collaboration among healthcare professionals is one of the leading causes of inefficiency in the Kenyan healthcare system (Ministry of Planning and National Development, 2007). This study conceptualizes collaboration as a crucial process that takes place between healthcare professionals involved in a patient's care process. The goal of this study is to develop a collaborative model for supporting shared care in Kenya. The proposed collaborative model will connect healthcare professionals across public hospitals in Kenya and enable them to efficiently and securely share patients' data. This model will also provide a communication platform to facilitate crucial dialogue between these healthcare professionals when coordinating their activities and formulating patients' care plans. The model is designed to support a holistic and a cohesive patient care process as it supports the ability for healthcare professionals to record patient data and process referrals electronically and coordinate their activities; therefore eliminating the use of paper based medical records and referral letters and providing an appropriate collaboration platform.

### **2.7.1 Design**

The design process of the collaborative model for supporting shared care is three fold. The first phase of the design process is definition phase, then the discovery phase and finally the development phase.

#### **The Definition Phase**

This is the requirements analysis stage carried out when developing the collaborative model involved tasks analysis to determine the requirements; the input, the output, the setting where the software will be used and the participants. Also at this stage the problems, the objectives and the resources available were clearly identified and defined to ensure the resulting model solves the identified problems and meets the intended objectives.

#### **The Discovery Phase**

To effectively build the collaborative model, relevant variables that influence collaboration among healthcare professionals had to be identified. The process of identifying these variables is referred to as discovery. Kumar (2012), notes that factors such as relationships between health professionals, interdisciplinary education, role clarification, healthcare professional and organizational culture, proximity and information technology are widely considered when building collaborative healthcare models.

At this stage conceptualization and formalization of the model was carried out. Conceptualization involved designing the model to ensure that the specific interactions and relationships in the problem domain were clear and understood. Also at this stage, key concepts were determined as well as the relationship between artifacts and processes as well as the control mechanisms to be enforced (Tripathi, 2011). Formalization involved organizing the key concepts and the information flow between the artifacts into formal representations. The refinement of the specific relationships between artifacts and their hierarchy gave a more clear and accurate understanding of the anticipated user interaction with the model.

#### **The Development Phase**

The development phase involved applying the results of both the definition and discovery phases in building the collaborative model for supporting shared care. At this stage the conceptual

model was complemented with all the necessary details required for the actual development (Felici, 2011). The conceptual navigation structure is mapped onto actual artifacts and processes. The general look of the collaborative model as well as its interface elements are also designed at this phase.

### **2.7.2 Conceptual Framework**

The conceptual design of the collaborative model for supporting shared care in Kenya is based on groupware tools that connect and facilitate collaboration among healthcare professionals. The conceptual framework outlines the functional and technical design of the model. It illustrates the major hardware components and their functions. Based on the reviewed literature and the collaboration technologies analyzed, the researcher conceptualized the framework of the collaborative. From “Epic Haiku” the researcher borrows the idea of having separate databases for patients and health professionals and the use of electronic health records for easy access and sharing of patients’ data. The researcher also borrows from “Medscape Consult” and Doximity the idea of connecting healthcare professionals across different organizations. The conceptual model is summarized in Figure 2.1. The conceptual framework has two main modules that is the primary healthcare provider module and the secondary healthcare module. In the primary healthcare module; the patient is added into the system and his medical history, diagnosis and prescription is recorded. Within this module if necessary the patient is referred to a secondary healthcare provider. In the secondary healthcare provider module, the secondary healthcare provider can view the referred patients diagnosis, prescriptions and medical history. In this module the healthcare provider can initiate a collaboration session to seek clarification or more information regarding the patient’s medical history, prescription and diagnosis.

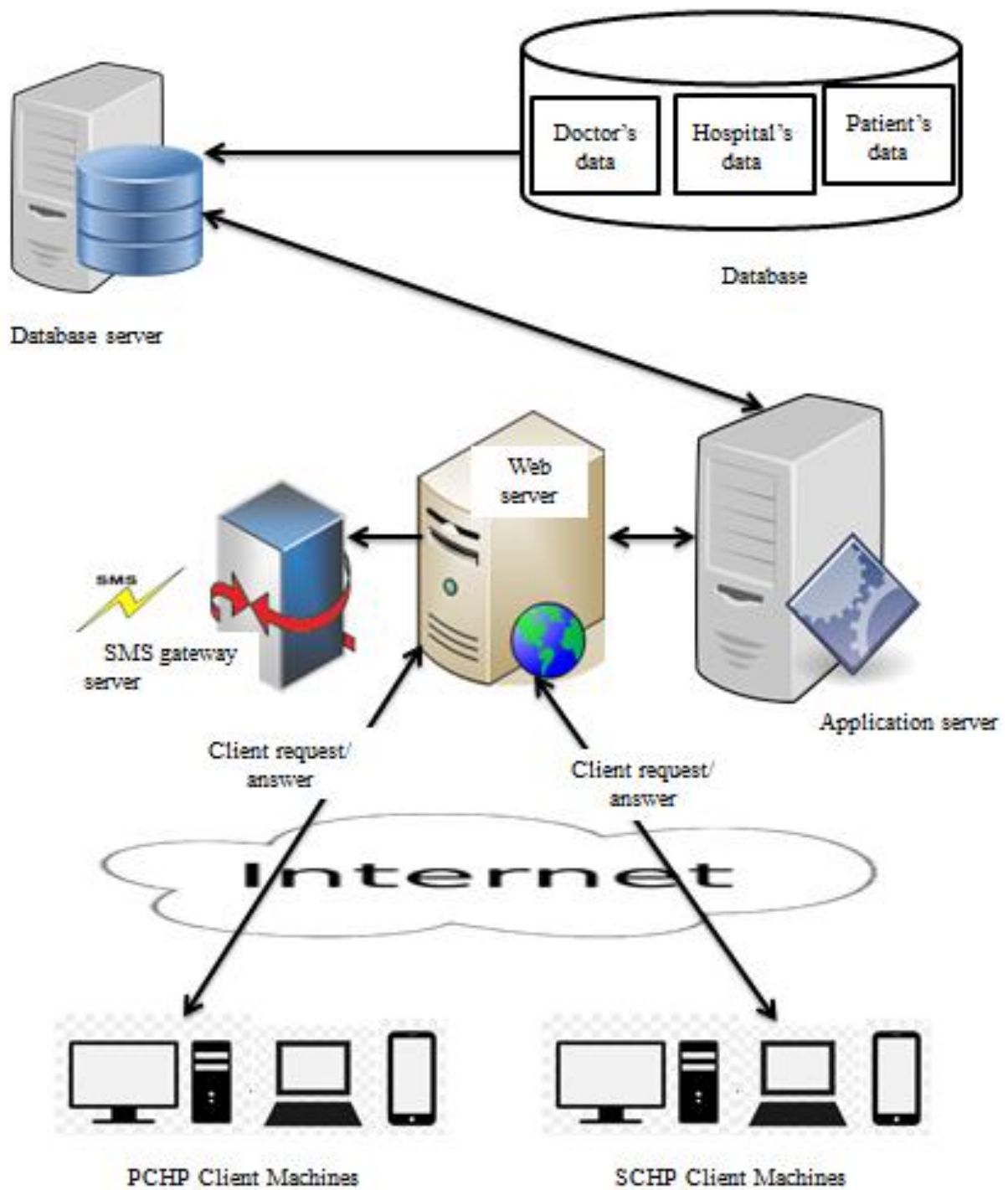


Figure 2.1 Conceptual Model

## **Chapter 3: Research Methodology**

### **3.1 Introduction**

The aim of this research is to find out the challenges healthcare professionals face within the collaboration methods currently being used and consequently come up with an effective and efficient way in which healthcare professionals can collaborate. Methods used for conducting this research are discussed in this chapter. Also discussed in this chapter is the target population, the sample size to be used for the research as well as the data collection and data analysis procedures. Additionally, this chapter describes the approaches applied in system analysis, system design, system development, system implementation and system testing.

### **3.2 System Analysis and Research Design**

#### **3.2.1 System Analysis**

In this study the object oriented analysis approach (OOA) was used as it combines both processes and data into single entities called objects (Russell & Norvig, 2013). The combination of processes and data into objects enables a better understanding of the problem domain and a smooth transition to the design phase (Hoffer, 2001). Use case and system sequence diagrams were also used to aid in the perfect understanding of the functional requirements of the collaborative model that will later be translated into more specific plans for implementation.

#### **3.2.2 Research Design**

In this study, an applied research design was employed, involving the use of both qualitative and quantitative approaches to examine, analyze and represent the relationship between variables. Qualitative approaches were used to enhance understanding of the current collaborative platforms and collaboration processes. Quantitative approaches were used to calculate the sample size of the target population needed for the research because previous researches allude that the combined use of qualitative and quantitative approaches, offers a better understanding of the research problems enabling them to be effectively addressed.

The research design provided a theoretical structure of the research as it assimilates the disparate components of the research study in a coherent manner. It also provided guidance on the

collection and analysis of data required and applied in the developing of the collaborative model. The research is prescriptive in nature as it seeks to offer potential solutions to the prevalent problem.

### 3.3 Target Population and Sampling

Since the research was carried out in Kenya, the target population was the healthcare professionals working in Kenyan public healthcare facilities and the patients seen or treated at these facilities. The research assumption is that all the respondents will be over 18 years and of sound mind.

Healthcare professionals practicing in public healthcare facilities in Nairobi are 3,038 as in 2012 while the number of patients seen or treated at these facilities was estimated to be 1,883,021 (MOH, 2016). Since the target population number was large, a probability sampling technique was used, to randomly select the participants. To obtain the required sample size, equation 3.1 was used.

$$n = \frac{NZ^2 \times 0.25}{[d^2 \times (N-1)] + (Z^2 \times 0.25)}$$

**n** = Sample size

**N** = Total Population size (known or estimated)

**d** = Precision level (usually 0.10)

**Z** = Z statistic for a level of confidence (e.g. 1.96 for 95% confidence level)

#### Equation 3.1 Random Sampling

$$n = \frac{1,886,059 \times 1.96^2 \times 0.25}{[0.1^2 \times (1,886,059 - 1)] + (1.96^2 \times 0.25)}$$

$$n = 96.035$$

The questionnaire was issued to 96 respondents.

The questionnaire was issued to both healthcare professionals and patients. Due to the disparity in the number of healthcare professionals compared to the number of patients, extreme case purposive sampling was used to select the number of respondents from each stratum.

### **3.4 Data Collection Methods and Techniques**

Both primary and secondary data was used for the study. The main method used to collect primary data were online questionnaires, interviews and observation. Online questionnaires were used to collect information about the system needs and user requirements from the respondents of the research (Appendix B). Questionnaires were used for this study because they allowed the collection of a lot of information from a larger number of people. Secondary data was obtained from national and hospital records as well as relevant literature reviewed. The secondary data gathered provided information on the average number of patients seen or served at the different healthcare facilities, the health problems treated at these facilities and the ratio of healthcare professionals to patients.

### **3.5 Data analysis and System Design**

Quantitative data was analyzed using Microsoft excel and the analysis results presented using the following tools; tables to summarize the significant variables of the collected data, bar graphs to present different categories of results that need to be shown together and pie charts to present different parts of a whole from the study. Both bar graphs and pie charts provided a visual representation of the quantitative data to facilitate comparison and correlation of the data that was collected.

Use case models were used to described the users interaction with the model, sequence diagrams to show the sequence of activities that are followed, entity relationship diagrams (ERDs) to define the business procedures and describe data in terms of entities and their attributes and class diagrams to illustrate the classes; their attributes, methods, objects and interactions. These diagrams were used to analyze the user requirements and generate system design models.

### 3.5.1 System Design

To refine the object requirements identified in the system analysis phase object oriented design (OOD) techniques were used to develop an appropriate model for the solution domain. From the system sequence diagram the class diagram was designed to describe the structure and the software systematics of the collaborative model. The class diagram also illustrated all the classes; their attributes, methods, objects and interactions of the collaborative model (Felici, 2011). Entity relationship diagram (ERD) were also be used to demonstrate the relationship between objects, people, places and events within the system. The ERD enabled the researcher define the business procedures and describe data in terms of entities and their attributes (Pagh, 2006).

The collaborative model for supporting shared care was developed using the V process methodology. This methodology is appropriate as it offers fast delivery of the system as it can be broken down into modules and allows the researcher deliver an optimal quality system due to its emphasis on the verification and validation of the model in the early stages of development.

#### 3.5.1.1 V process methodology

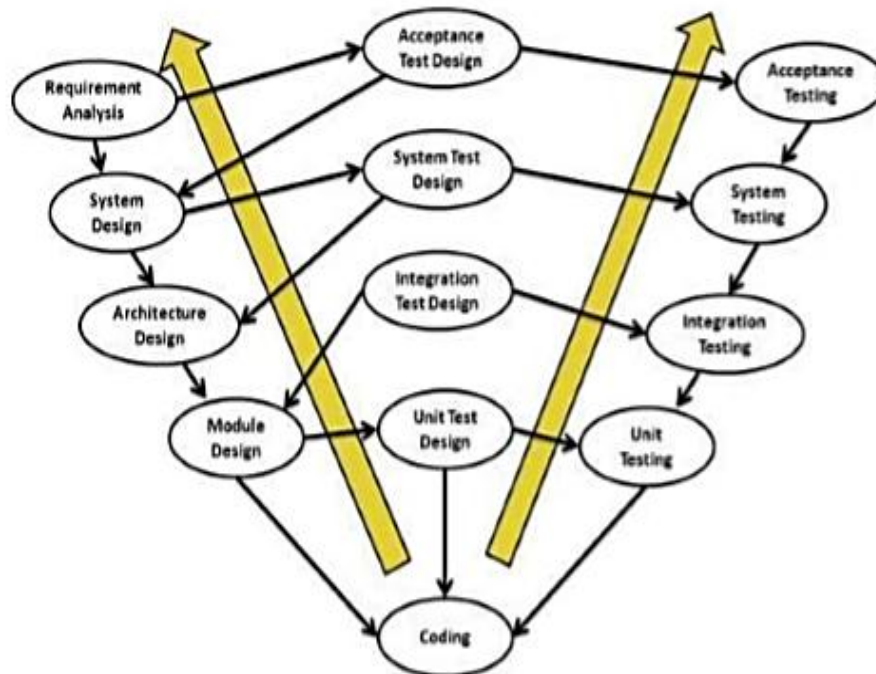


Figure 3.1 V-Process Model (Khan & Beg, 2013)

The V process methodology emphasizes the verification and validation of the model in the early stages of development as it allows for the parallel development and testing of the system's deliverables. Figure 3.1 illustrates the steps to be followed in the development of the collaborative model. The first step was the requirements analysis stage which involved the collection of the requirements of the model by analyzing the needs of the users so as to establish what the ideal model will perform. The second step was the system design phase which included defining of the user requirements and identifying the variables to be used in the development of the model. The third step was the architecture design phase which involved defining the architecture and design of the model. The fourth phase was the module design phase which involved the breaking down of the model design into modules for easy development. The coding phase was the final step which involved the actual coding of the modules designed in the module design phase. Since each verification phase in the V process methodology has a corresponding validation phase several tests were carried out throughout the model's development process and these are: unit testing to eliminate bugs and ensure the modules functioned as expected. Integration tests were carried out to verify that the modules built and tested independently can be integrated and can communicate. Lastly, the system test was carried out to ensure that the functional and nonfunctional requirements of the model were met. To ensure the functional requirements were met. The usability test was performed to test the functionality of the collaborative model by verifying and validating that the communication components function as expected, the navigation flow is smooth and that the resultant system is user friendly and meets the user requirements (Belatrix, 2015).

### **3.6 Research Quality Aspect**

To test the research quality aspect, validity and reliability measures were used.

#### **3.6.1 Validity**

This approach measured the degree to which the study was carried out correctly, that is measuring the degree to which the test items represent the domain to be measured (Hsieh, 2005). This approach also determined if the research frankly and accurately processed the research test items and how truthful the results were. Since there is no statistical test that can determine the degree to which the test items represent the domain to be measured, research survey questions were sent out to respondents to test the study's content validity. The responses from the

respondents were analyzed and it was established that the content validity chosen matched the test content.

### **3.6.2 Reliability**

The reliability approach was used in this study to measure the degree to which there will be consistency in the research results yielded. The research reliability was achieved by ensuring that the questions contained in the questionnaire were non ambiguous and easy to understand. The inter-rater reliability approach was be used to ensure that the information will be gathered in a trustworthy manner.

### **3.7 Ethical Consideration**

To uphold ethical standards, the researcher obtained consent from the respondents before the survey was conducted. Relevant information about the study was be relayed to the respondents for them to understand why and what they were doing so as to ensure their voluntary participation. The data collected was treated with a high degree of confidentiality and was exclusively used for this research.

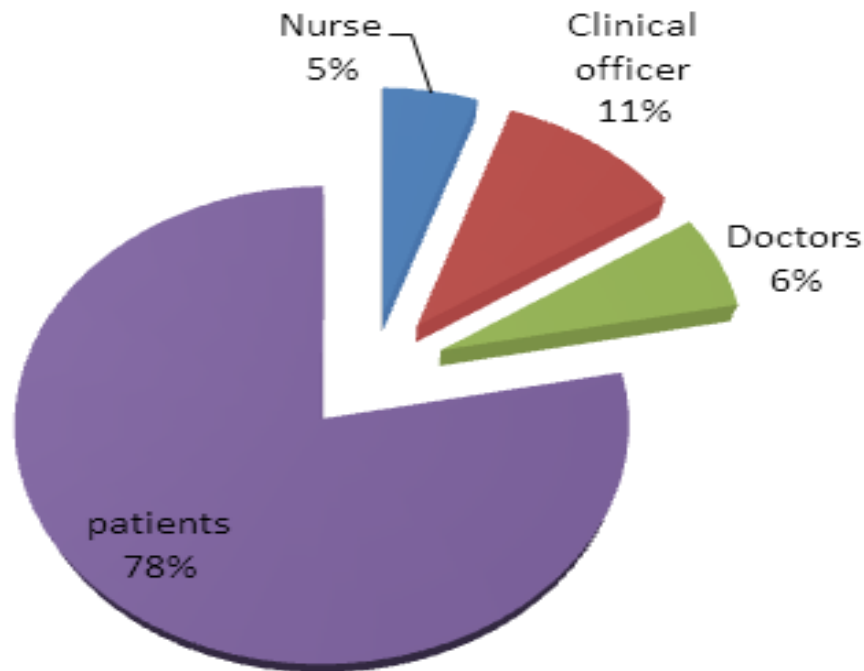
## Chapter 4: System Analysis and Design

### 4.1 Introduction

The main objective of this study is to develop a collaborative model for supporting shared care in Kenya. In this research, object oriented analysis approaches were used to define the problem domain and object oriented design techniques used to design the solution domain.

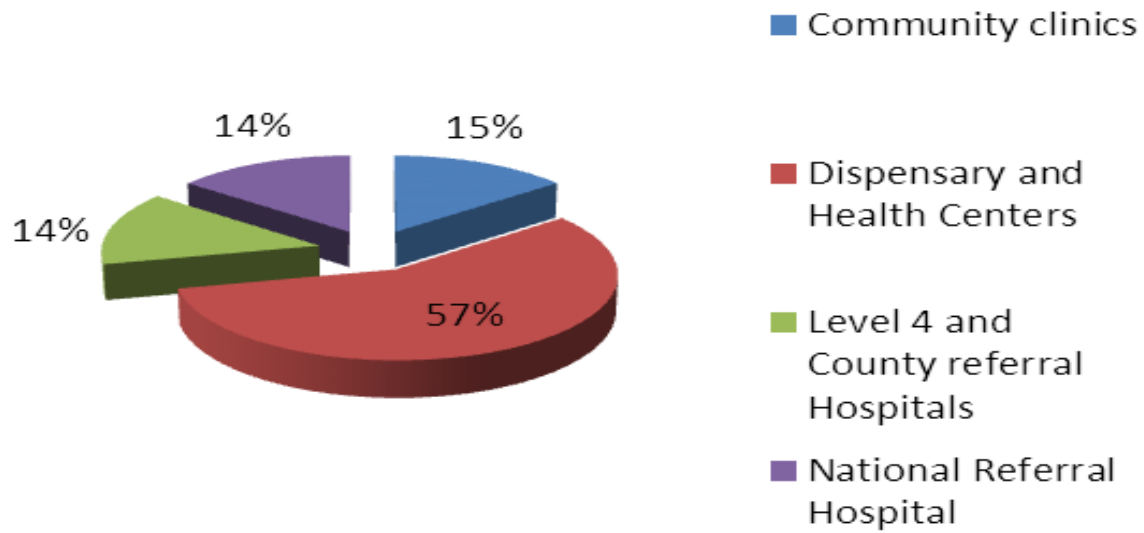
In this chapter, data analysis, system analysis and system design are discussed in detail. Data analysis focuses on the data collected from the research respondents, then system analysis focuses on the system requirements based on the data collected and finally system design focuses on the resulting system's design and architecture.

### 4.2 Results from Questionnaire



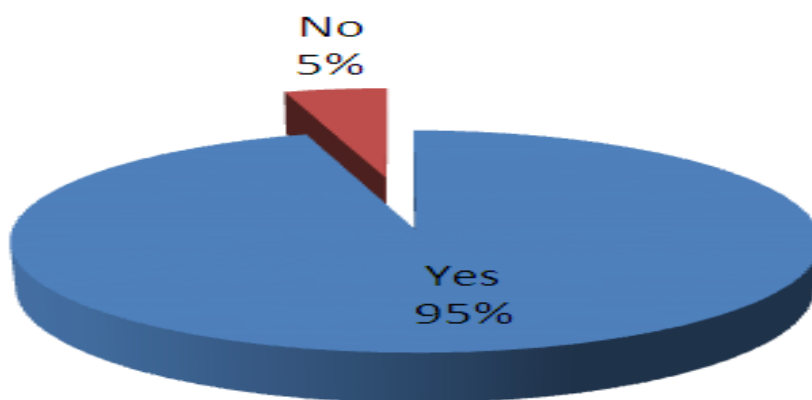
**Figure 4.1 Research respondents**

As illustrated in Figure 4.1, of the respondents who participated in the study. 5% of them were nurses, 11% clinical officers, 6% doctors and 78% patients.



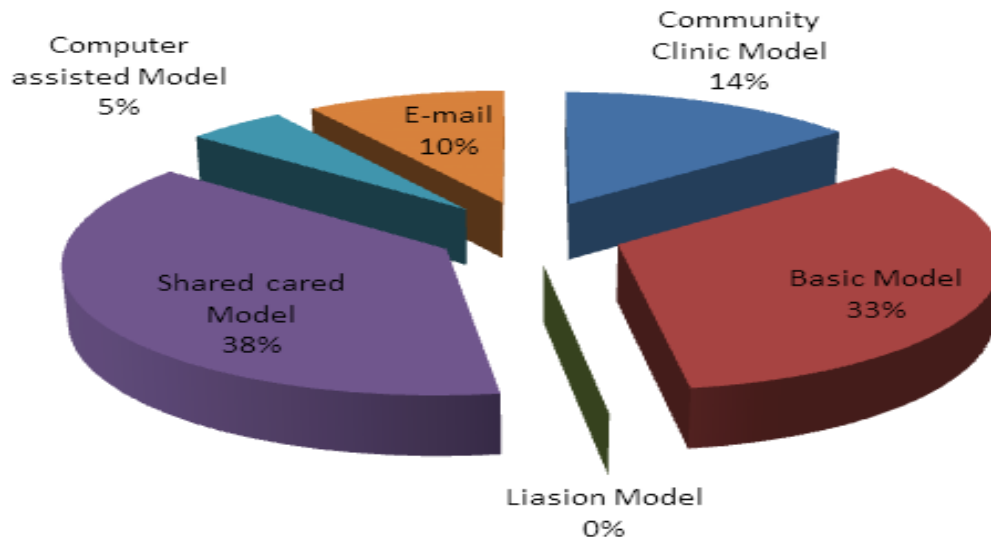
As illustrated in Figure 4.2, the questionnaire was issued to healthcare providers working in the following healthcare facilities community clinics, dispensary and health centers, level 4 and county referral hospitals and national referral hospital.

**Figure 4.2 Healthcare Facilities**



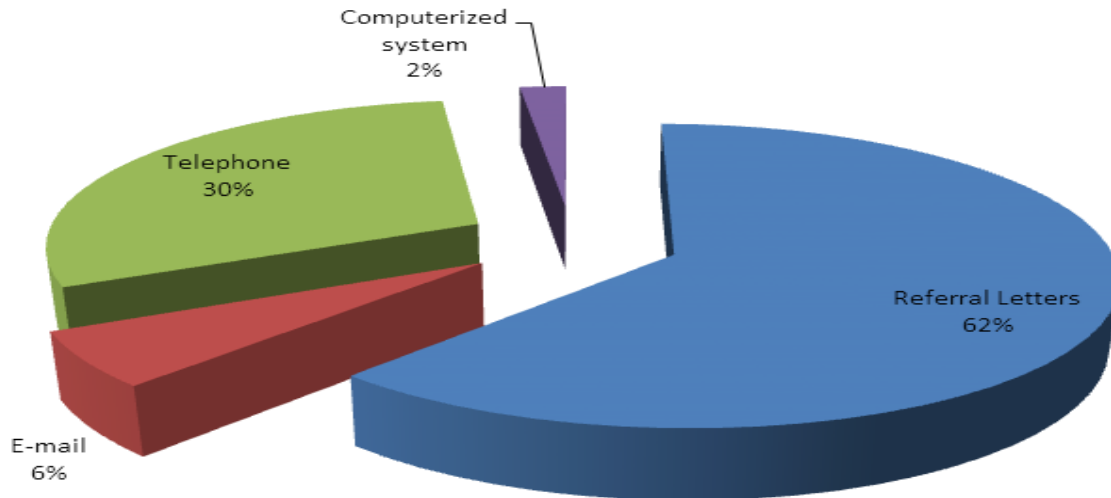
**Figure 4.3 Presence of Collaboration between Healthcare Professionals**

95% of the healthcare professionals who participated in the study acknowledged the presence and importance of collaboration between healthcare providers. This shows the importance of collaboration in the provision of healthcare as illustrated in figure 4.3.



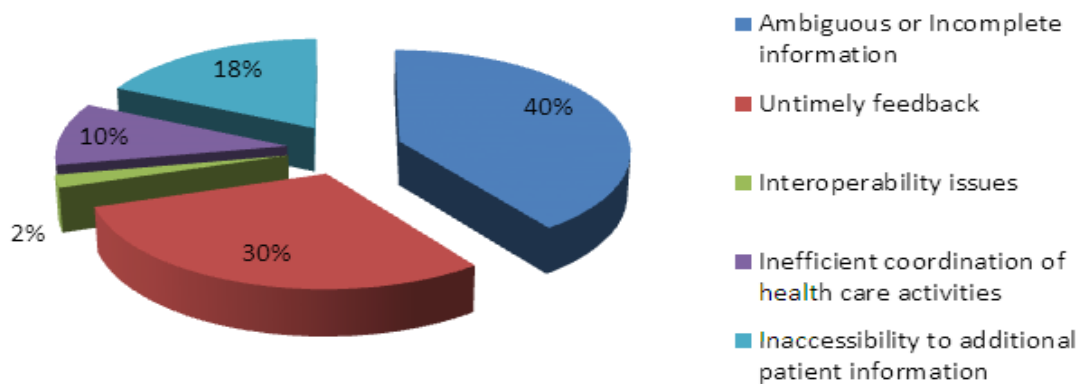
**Figure 4.4 Collaborative Methods Used in Shared Care Settings**

38% of the respondents said they used the shared care model, 33% said they used the basic model, 14% the community clinic model, 10% the email model and 5% the computer assisted model. This shows that the most used collaborative method used in shared care settings is the shared care model and is illustrated in Figure 4.4.



**Figure 4.5 Collaboration Tools Used in Shared Care Settings**

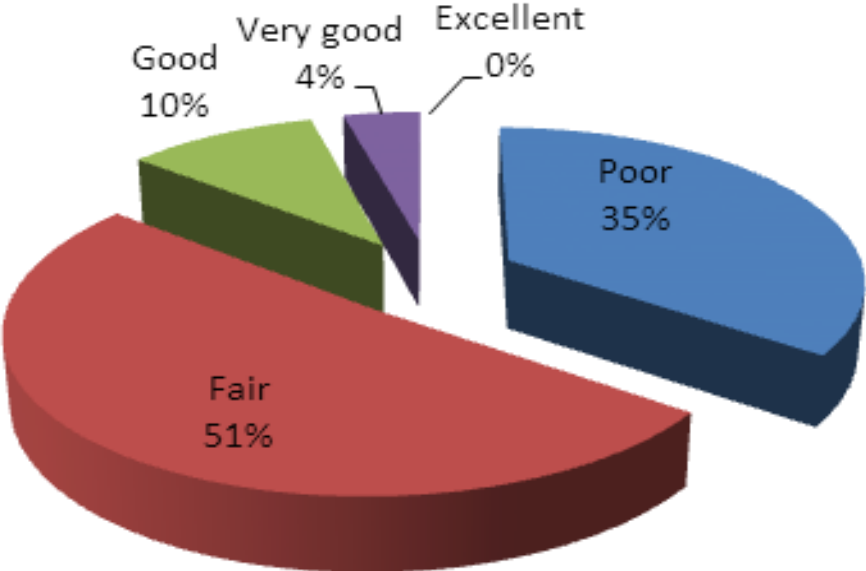
As illustrated in Figure 4.5, according to the healthcare providers who participated in the study the most used collaboration tool is the referral letter with 62%, then the telephone with 30%, then email with 6% and computerized systems being the least used collaboration tool with 2%. Although the referral letter is the most used collaboration tool, it has many limitations that hinder effective collaboration between healthcare providers.



**Figure 4.6 Challenges Respondents Face While Collaborating Using Tools in Figure 4.5**

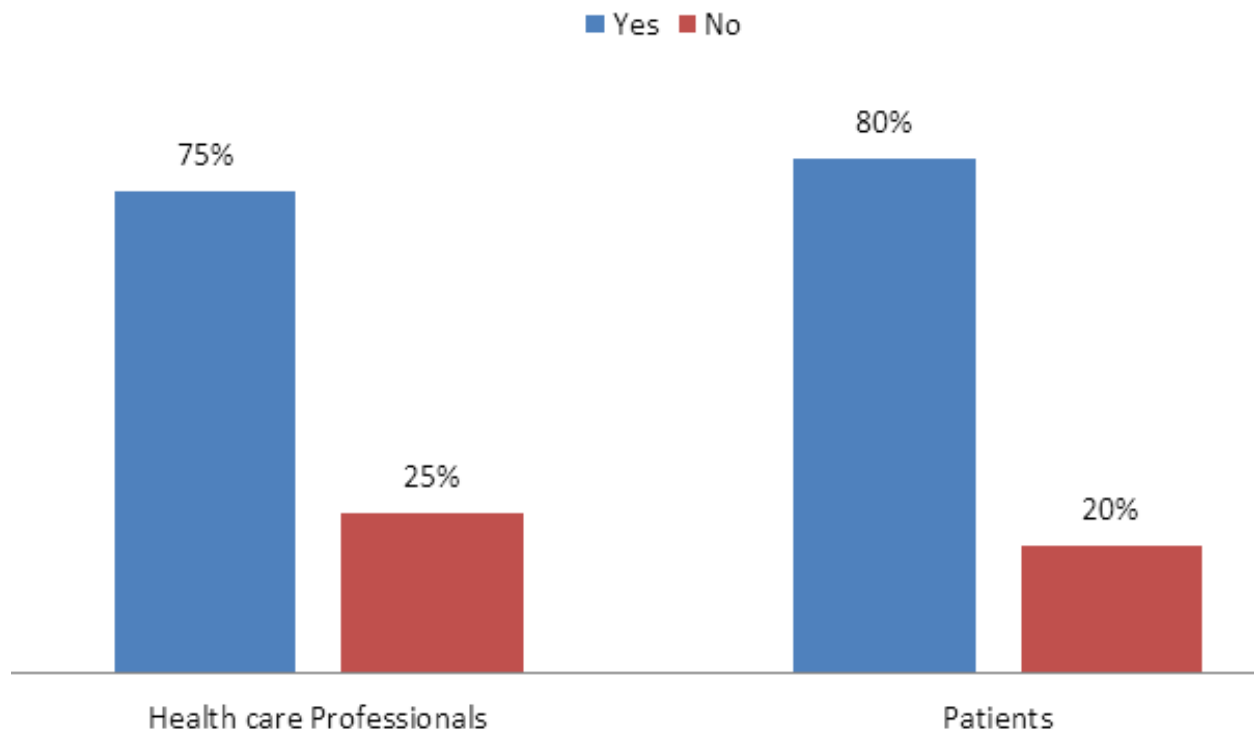
As shown in Figure 4.6, using the collaboration tools illustrated in figure 4.5 several challenges were encountered namely ambiguous or incomplete information (40%), untimely feedback (30%), inaccessibility to additional patient information (18%), inefficient coordination of

healthcare activities (10%) and interoperability issues. This finding provides a guide on what functionality the collaborative model should provide.



**Figure 4.7 Respondents Rating of the Existing Collaboration Methods**

As illustrated in Figure 4.7, 35% of the respondents said that the existing collaboration methods were poor, 51% of the respondents said that the existing collaboration methods were fair, 10% and 4% of the respondents said that the existing collaboration methods were good and very good respectively. None of the respondents said that the existing collaboration methods were excellent hence the need to develop an optimum collaboration tool for healthcare providers.



**Figure 4.8 Respondents who think the Collaborative System for Supporting Shared Care is Necessary**

As illustrated in figure 4.8 both healthcare professionals and patients acknowledge the need for an effective collaboration tool for supporting shared healthcare.

### 4.3 Requirement Analysis

Through the questionnaires administered, the study found out that the respondents needed a system that would enable healthcare professionals collaborate in order to coordinate their care activities and effectively practice shared care. A secure system through which healthcare professionals can collaborate, access patient data and medical history easily and even share notes pertaining to patient’s condition and/ or care process. The user requirements gathered from the reviewed literature and the administered questionnaires can be broken down into functional and non-functional requirements as shown in table 4.1.

**Table 4.1 Functional and Non-functional Requirements**

<b>Functional Requirements</b>	<b>Non-functional Requirements</b>
User management	Security
Patient management	Error reporting
Collaboration platform	System availability and reliability
Send Notifications	System Usability
Generate Results	System performance responsiveness
	Scalability

#### **4.3.1 Functional Requirements**

The functional requirements gathered capture the functions, capabilities and basic processes that the collaborative model should be able to execute. They include: manage users (the administrator can add, update or delete healthcare providers), add new patient (this allows the healthcare providers to register patients), check patient (this allows users select a patient and access their data and medical history), add new information (this allows the users to add or update patient data or medical history), send notifications (the system sends notifications of referrals to the referred to healthcare providers and prescription notifications to patients) collaboration platform (this allows the PHCP and SCHP to collaborate) and generate reports (the system generates different reports when required).

#### **4.3.2 Non-Functional Requirements**

Non-functional requirements of the system are the qualities that the system can do without but are desired in order to make the system user friendly, easy to learn and interactive. These qualities are: security (only authorized users should access the system), error reporting (send error logs to the system administrator to help in resolving system issues), system availability and reliability (the system should be reliable and available at any time), system usability (the system should be easy to use, easy to navigate and easy to access its core features), Performance and responsiveness (the system should be robust and should execute tasks in reasonable time), and scalability (the system should be flexible to allow future upgrades and customizations in a cost effective manner).

### **4.3.3 System Requirements**

The collaborative model for supporting shared care has the following system requirements: relational database management system (to manage the central database. The central database is used for storing and organizing data to facilitate its creation, extraction and analysis), graphical user interface (a user friendly user interface shall be developed to provide an interface for adding new users and patients, creating or updating patient data and medical history, for collaboration and extracting reports) and security (to ensure data confidentiality, integrity and authenticity security mechanisms shall be included to only grant access to authorized users. Database backups shall be done regularly to prevent data loss.)

## **4.4 System Design**

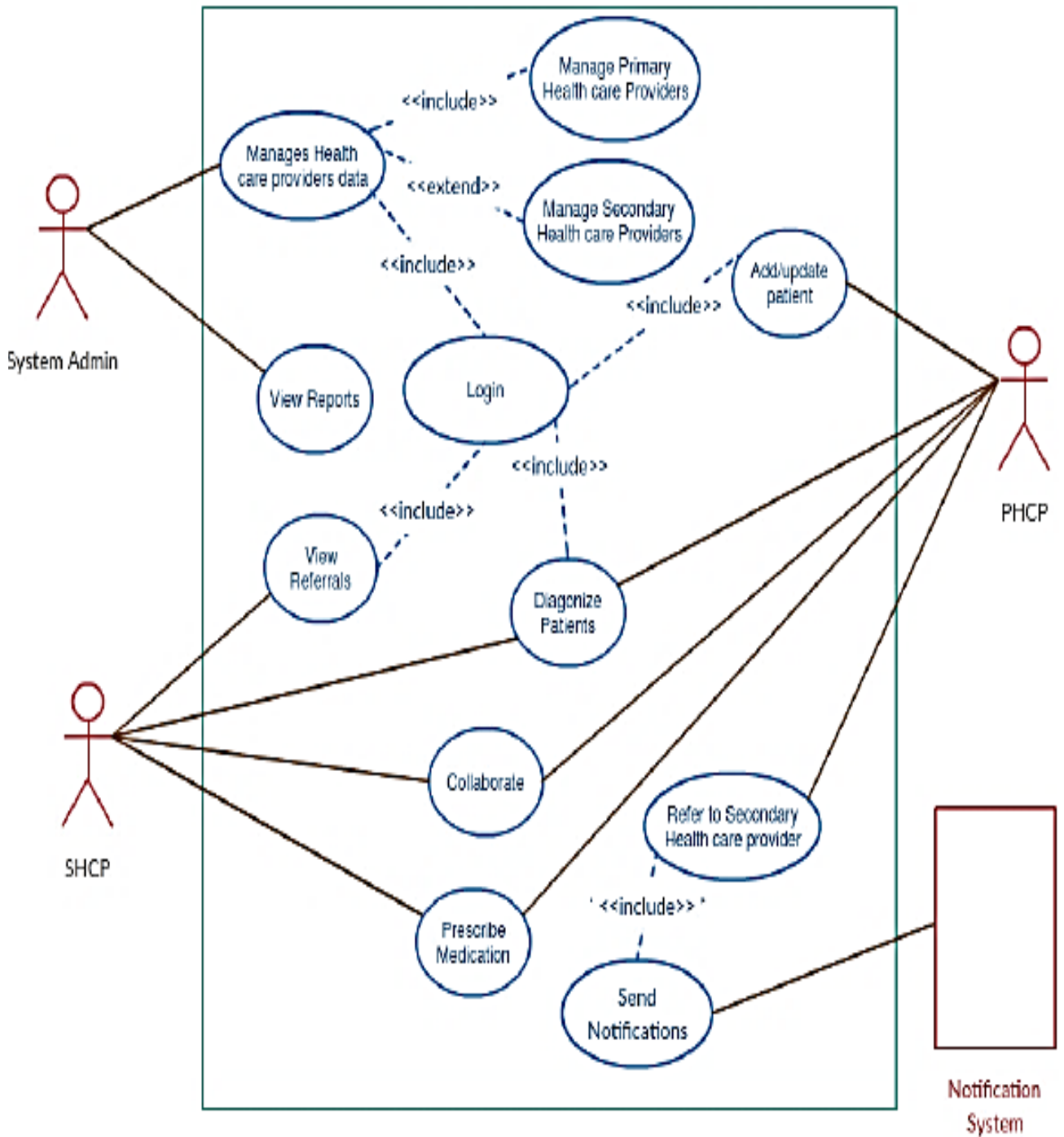
Object oriented techniques were used to refine the system requirements identified during system analysis. These requirements were merged with the researcher's specifications in order to come up with an appropriate system design with the desired functionalities to meet the research objectives. The following diagrams and their corresponding information were used to guide the actual implementation of the system.

## **4.5 Diagrammatic Representation of the Model**

### **4.5.1 Use Case Diagram**

The use case diagram described in figure 4.9 describes the user's interaction with the model. The use case diagram comprises of actors (system users) who in this study are the system administrator and healthcare professionals (both primary and secondary healthcare professionals), boundary which represents the limits to which the model operates and the use cases which are a collection of success or failure scenarios. The developed model has the following main actors: system administrator (manages the healthcare professionals and overall system management), primary healthcare professionals (adds/ updates patients data, diagnosis, prescription and referrals), secondary healthcare professionals (updates patients data, diagnosis and prescription) and an SMS gateway (sends notifications to secondary healthcare professional on the initiation of a referral by a primary healthcare professional, sends notifications to primary healthcare professional that the patient he/ she referred has been seen or treated, sends

notification to patients on initiation or discontinuation of important medications or treatments and notification message of when the secondary healthcare professionals can see them ).



**Figure 4.9 Use Case Diagram**

This use case is summarized in Table 4.2

**Table 4.2 Summary of Use Case Diagram**

<b>Actor</b>	<b>Use Case</b>
System Administrator	Manage users( healthcare professionals) View reports
Primary healthcare professionals	Register, update and delete patients Record diagnosis and prescription Initiate referrals Initiate collaboration with secondary care professional
Secondary healthcare professionals	View patient’s medical history Initiate collaboration with primary care professional Record diagnosis and prescription

**Use Case Description**

Use case: Manage users

**Primary Actor**

System administrator

**Precondition**

Login in

**Post condition**

Users successfully added, updated or deleted.

**Main Success Scenario**

**Action Intention**

1. The system administrator adds, updates or deletes healthcare professional’s data

**System responsibility**

2. Captures the healthcare professional’s data

3. Save healthcare professional's data

4. View healthcare professional's data

5. Log out

**Extensions**

If the system fails to capture the details

Restart the system

Confirm module used

Use case: Manage Patients

**Primary Actor**

Primary Healthcare professional

**Precondition**

Login in

**Post condition**

Patients successfully added or details updated, diagnosis, prescription recorded or referral initiated.

**Main Success Scenario**

**Action Intention**

1. The primary healthcare professional adds or updates patient's data and diagnosis and prescription recorded or referral initiated

**System responsibility**

2. Captures the patient's data
3. Save patient's data

4. Record diagnosis and prescription or initiate referral

5. View patient's data and medical history

**Extensions**

If the system fails to capture the details

Restart the system

Confirm module used

Use case: See / treat referred patient

**Primary Actor**

Secondary Healthcare professional

**Precondition**

Login in

**Post condition**

Patient's diagnosis, prescriptions and recommendation notes successfully added

**Main Success Scenario**

**Action Intention**

1. The secondary healthcare professional selects the desired patient data
2. Records the diagnosis, prescription and recommendations
5. Record diagnosis, prescription recorded or initiate referral
5. View patient's data and medical history

**System responsibility**

3. Captures the diagnosis, prescription and recommendations
4. Save diagnosis, prescription and recommendations data

**Extensions**

If the system fails to capture the data

Restart the system

Confirm module used

Use case: Collaborate

**Primary Actor**

System Administrator

**Precondition**

Login in

**Post condition**

Clarification and coordination of patient's diagnosis, prescriptions and care process.

Recording of recommendations and additional notes successfully to patient's medical history

**Main Success Scenario**

**Action Intention**

1. Either of the healthcare professionals initiates collaboration

**System responsibility**

2. Receive and execute the request

3. Display the collaboration interface

4. Save clarification information, recommendations and additional information

4. Record diagnosis and prescription

5. View patient's data and medical history

**Extensions**

If the system fails to display the data

Restart the system

Reselect the report category or sub category

Use case: View Reports

**Primary Actor**

System Administrator

**Precondition**

Login in

**Post condition**

View reports on number of patients seen or treated, types of diagnosis, number of referrals, number of healthcare professionals and healthcare facilities

**Main Success Scenario****Action Intention**

1. The system administrator selects the desired report category or sub category, the desired duration
4. View the results
5. Download the report

**System responsibility**

2. Receive and execute the request
3. Display the results

**Extensions**

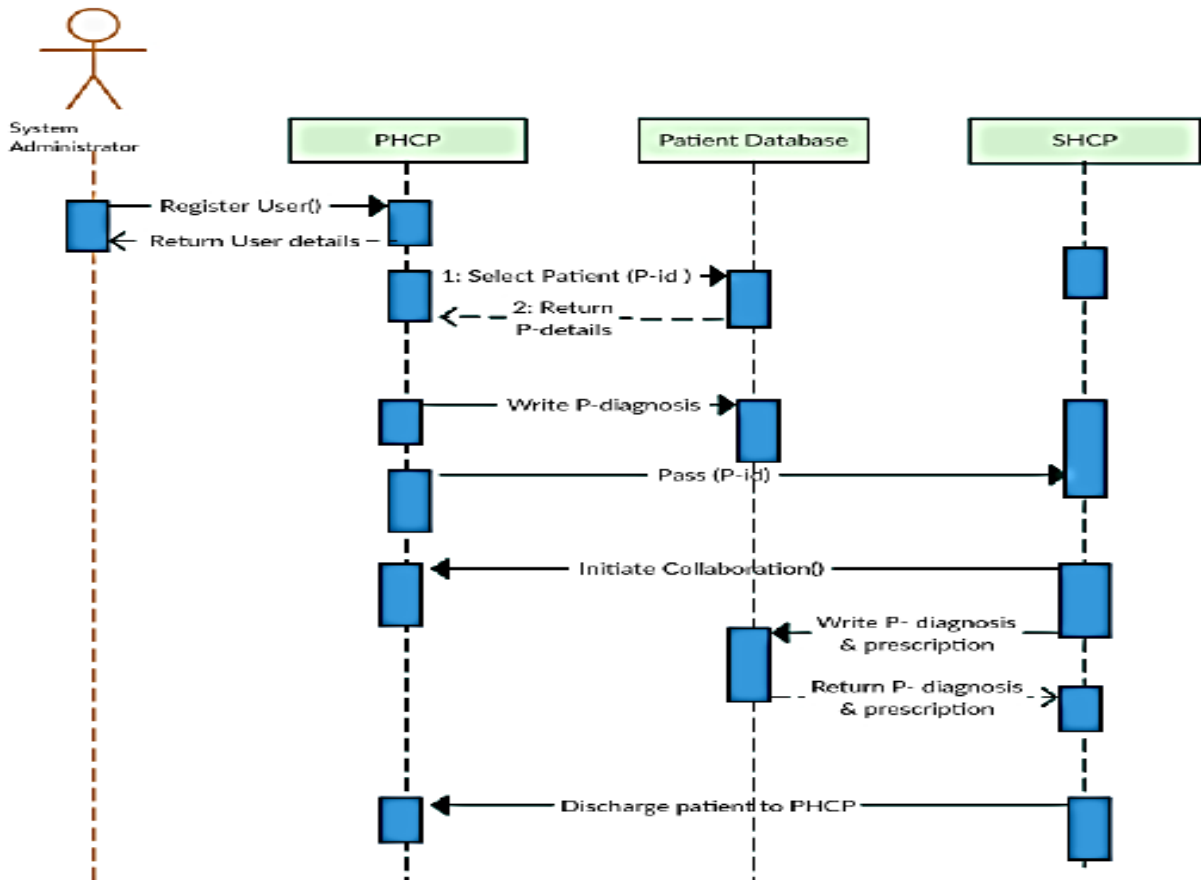
If the system fails to display the data

Restart the system

Reselect the report category or sub category

**4.5.2 Sequence Diagram**

The main feature of this model is the provision of a collaboration platform between the primary and the secondary healthcare professionals to enable them collaborate and coordinate their services in order to improve the quality and continuity of healthcare as well as the patients' safety. Figure 4.10 shows the sequence of activities that are followed.



**Figure 4.10 Sequence Diagram**

### 4.5.3 Entity Relationship Diagram

The entity relationship diagram describes the model’s data in terms of entities, attributes and relationships. The system administrator has several attributes with the user id attribute being the primary key. The relationship between the system administrator and the users (healthcare professionals) is one to many, meaning that the system administrator can manage more than one user.

The healthcare professionals have their HCP id as the primary key. The entities primary and secondary healthcare professionals borrow attributes from the healthcare professional (HCP). The two have “IS A” relationship with the healthcare professional. In addition to these attributes, the secondary healthcare provider has specialty and hospital attributes.

Patients have several attributes which describe them. These include patient id, name, age, address and contact person in case of emergency with the key attribute being patient id. The relationship between primary healthcare professionals and patients is a many to many type of a relationship as one or more primary healthcare professional can add one or more patients. There exists a many to many relationship between the secondary healthcare professionals and the patients. This is because one or more secondary healthcare professionals can see the same or different referred patients. A similar relationship exists between the primary and secondary healthcare professionals as one or more primary healthcare professional can refer patients to one or more secondary healthcare professionals.

The entity report has several attributes such as report id, date and report details with the report id as the primary key. The relationship between the system administrator and entity report is a one to many type of a relationship as one system administrator can view one or more reports. Figure 4.11 illustrates the entities in the collaborative model for supporting shared care, their attributes and how they interact with each other.

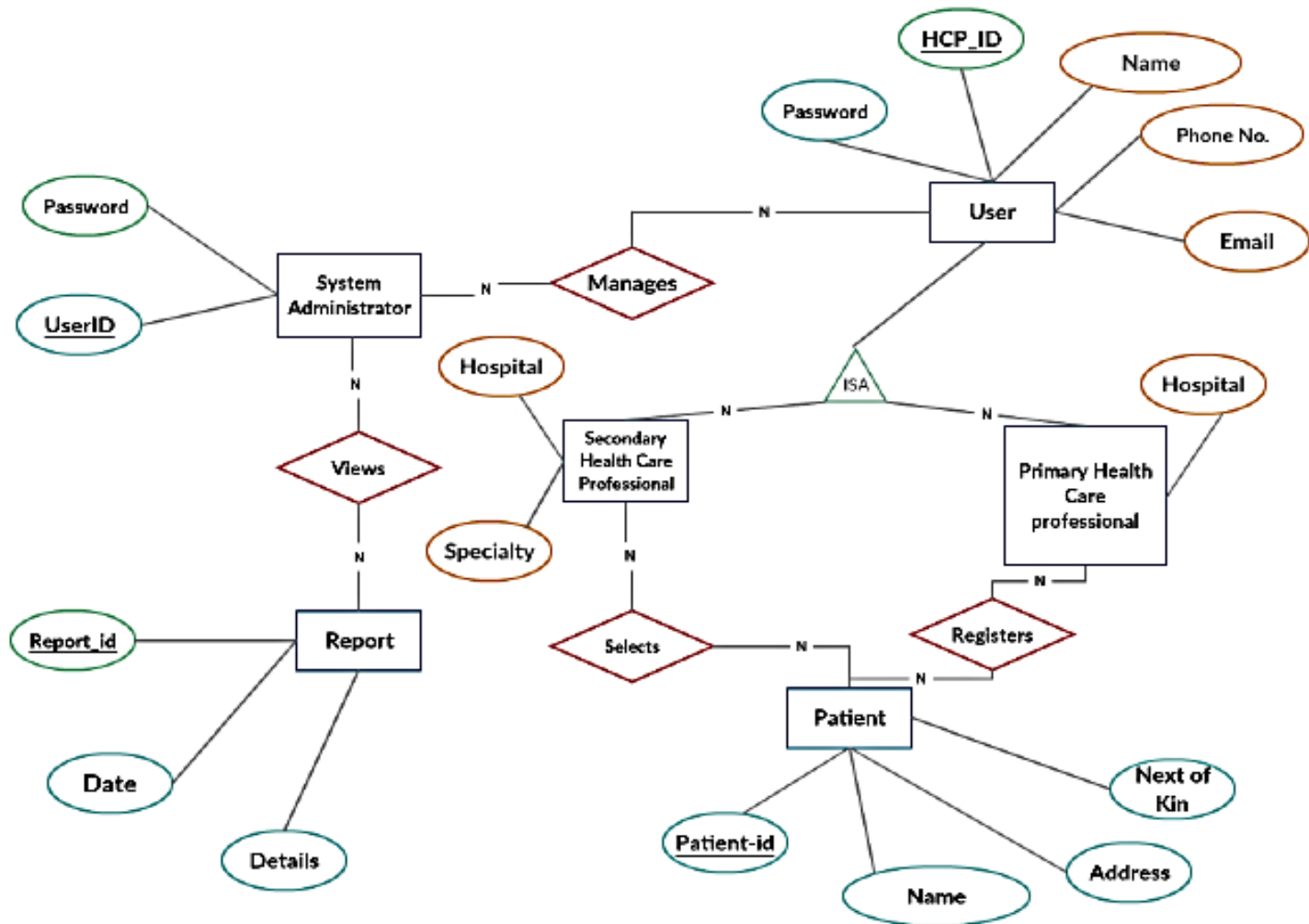


Figure 4.12 Entity Relationship Diagram

#### 4.5.4 Design Class Diagram

The class diagram in Figure 4.12 provides a visual representation of the classes in the collaborative model, their attributes, their connections and associations. The system administrator can login, add one or more users (healthcare professionals), modify or update the existing users and log out. Also after logging in the system administrator can view one to many reports. Primary healthcare professionals can login and add one or many patients, refer one or many patients to the same or different secondary healthcare professionals. The secondary healthcare professionals can login and search for referred patients. Both the primary and secondary healthcare professionals inherit login and logout functions from the superclass “user”.

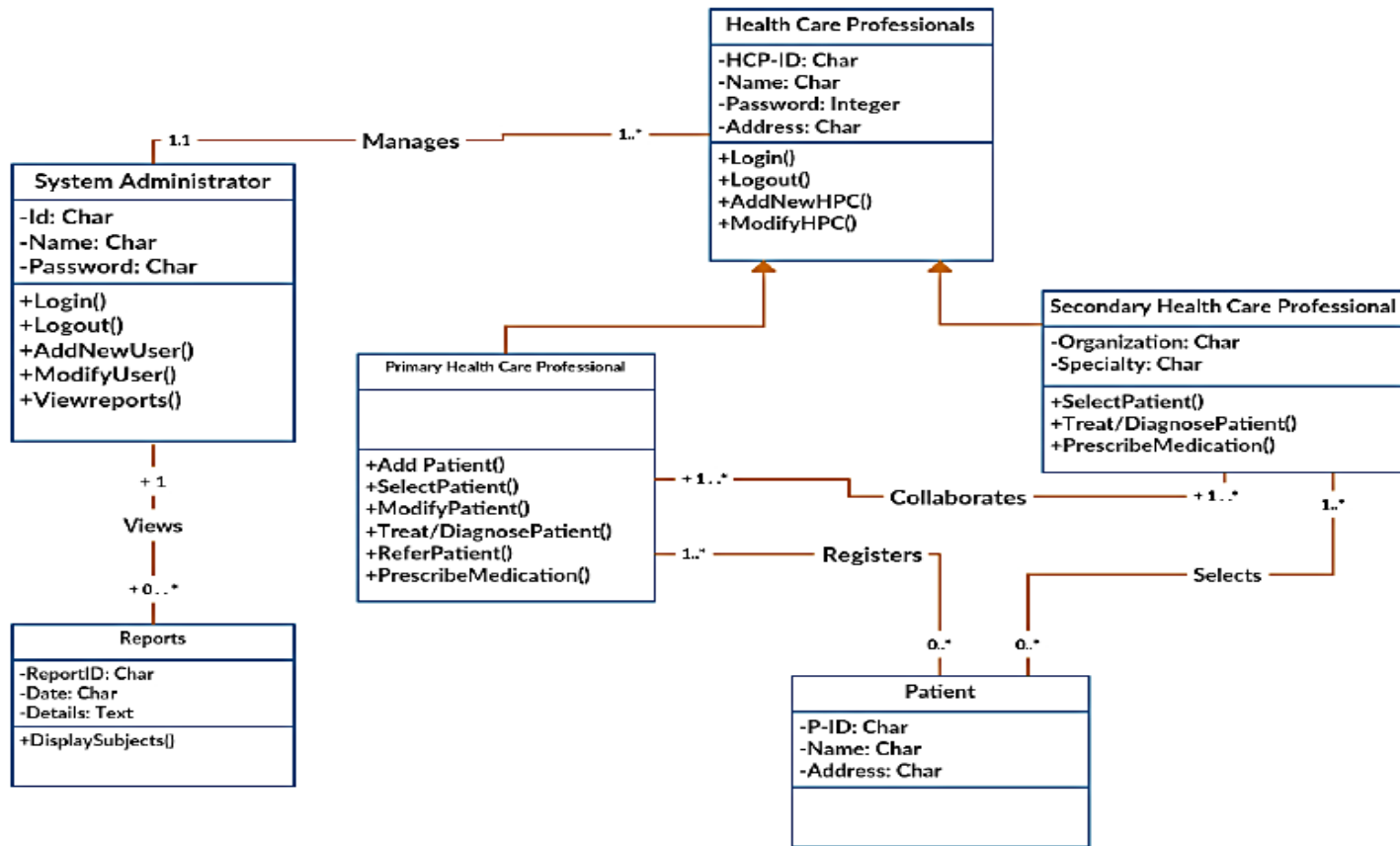
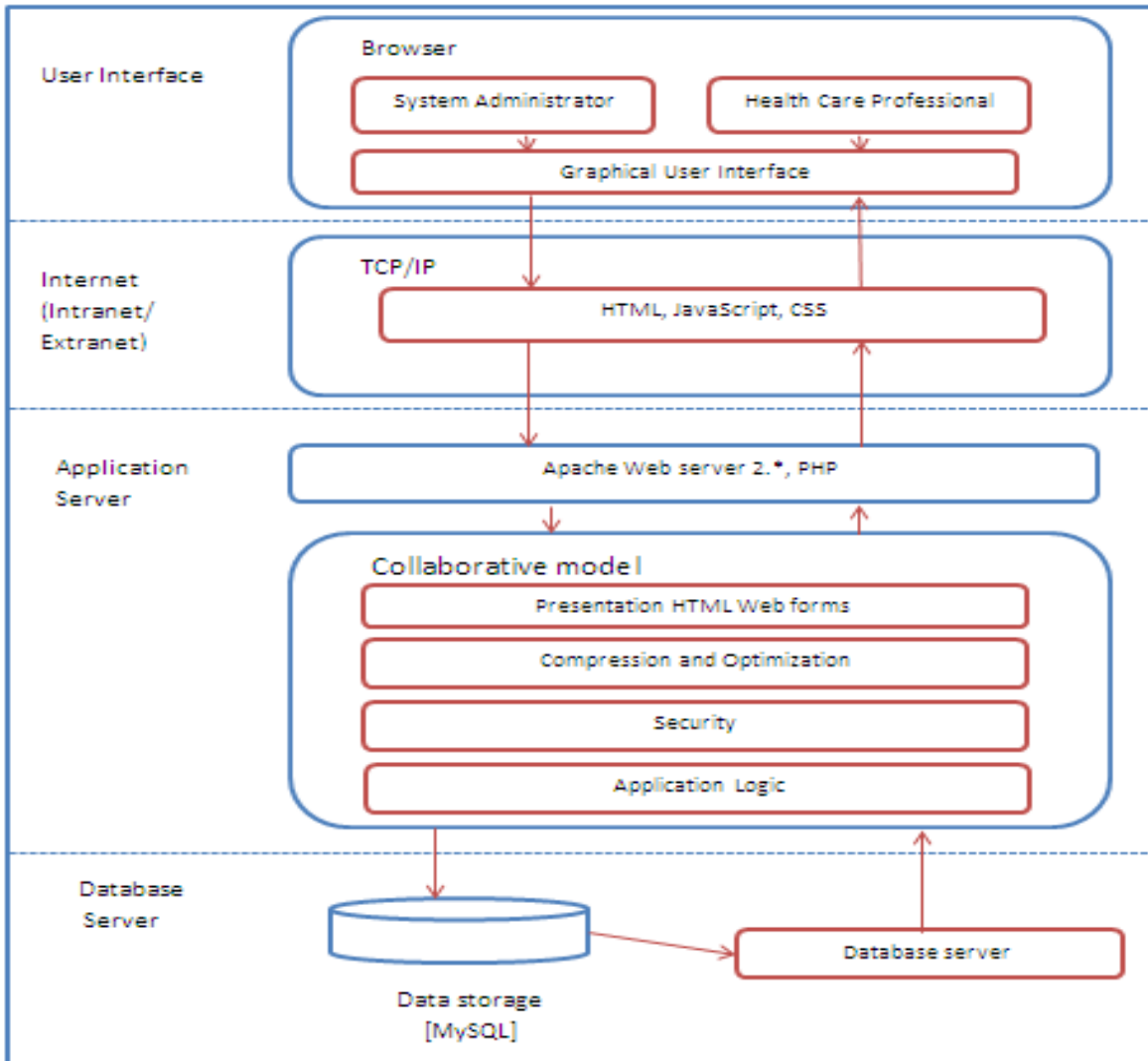


Figure 4.13 Design Class Diagram

#### 4.6 The Collaboration Model Architecture

The architecture for the collaborative model is divided into four components. These include the user interface, internet access, application server and the database server. The user interface provides the means through which the user can interact with the system and is accessible using a web browser. The user interface is browser independent as it can be accessed using any standard browser such as Google chrome, Mozilla Firefox and Internet explorer among others. The web server uses internet access to provide a secure connection for data transfer from the client browser to the server side. Standard protocols like TCP/IP and HTTP are used to enable communication between the client and the server. The application server has the functional modules that process, store and retrieve the data. The database server provides data storage and sets the functions that generate different views for different users from which reports can be produced. The architecture is illustrated in figure 4.13.



**Figure 4.14 Collaborative Model System Architecture**

## **Chapter 5: System Implementation and Testing**

### **5.1 Introduction**

This chapter focuses on the implementation and testing of the collaborative model. The model implementation section explores the different modules of the system, how they function and how they were implemented. The testing section focusses on system and usability testing.

### **5.2 System Implementation**

Laravel PHP framework, HTML 5 and MySQL were used to develop the collaborative model. The Web interface (front-end subsystem) was developed using PHP laravel framework while the back-end subsystem was developed using PHP and HTML 5. The front-end subsystem enables the users interact with the system and utilize its back-end capabilities. The back-end subsystem is comprised of the system's databases and data processing components. Back-end subsystem therefore receives data and responds to user's queries and requests. PHP was used because it is efficient and platform independent. HTML 5 was used to structure and present content in the back-end subsystem and MySQL was the relational database management system used because it is open source and cross platform.

#### **5.2.1 Web Interface (Front-end)**

The iterative design approach was used in the development of the web interface. This approach enabled the researcher overcome inherent problems of incomplete requirements as it allowed frequent iterations and subsequent feedback. The results from the iterations and the user feedback were used to improve the interface, therefore enabled more controlled improvements.

To enable the users interact with the model several interfaces were built. Each interface represented a distinct task or subtask. These are user (healthcare professionals) management, patient registration, and collaboration between the healthcare professionals.

##### **5.2.1.1 User Management**

This interface provided a convenient way of adding, updating, displaying and deleting system users (healthcare professionals). To add a system user, the system administrator clicks on "Add new" button, enters the user's details and clicks "Save Data" button. The model validates the data fields to ensure they are in the right format before being saved into the database. On this

interface a list of all registered users is also displayed. The key attributes displayed include the healthcare professional’s user id, name, phone number, email address, facility and level of practice. The edit and delete buttons are also included. To edit or update users click “Edit” button to load the data into the new form to be edited. After editing, the system administrator clicks the “Save Data” button to update the changes. Clicking the “Delete” button prompts the system administrator to confirm the deletion. Once confirmed, the delete query is run against the user’s id in the database. Figure 5.1 shows the user management interface.

	Surname	Other Names	Phone#	Email	Hospital	Specialty	Action
1	Magdalene	Josephs	0729024356	mjosephs@gertrudes.com	Gertrudes Hospital	General Practitioner (PHCP)	Edit Delete
2	Mariam	Heroe	0729036484	mheroe@gertrudes.com	Gertrudes Hospital	General Surgery	Edit Delete
3	Jacinta	Martos	0759056481	jmatoes@gertrudes.com	Gertrudes Hospital	Cardiothoracic Surgery	Edit Delete
4	John	Stevens	0728031484	jstevens@gertrudes.com	Gertrudes Hospital	Vascular Surgery	Edit Delete
5	Seth	Betry	0729036484	sbetry@gertrudes.com	Gertrudes Hospital	Cosmetic and Reconstructive Surgery	Edit Delete
6	Damaris	Samaki	0729012123	dsamaki@gertrudes.com	Gertrudes Hospital	Colorectal Surgery	Edit Delete

**Figure 5.1 User management interface**

**5.2.1.2 Patient Management**

Once the healthcare professional has been registered as a user, they can add and update patients’ details in the patients interface as shown in figure 5.2. The patient’s data captured includes patient id, name, gender, contacts and location address, next of kin and medical history. On this interface the healthcare professional can record the diagnosis and the prescribed medication by clicking the edit button. The edit button opens an interface where the healthcare provider or professional can record the patient’s diagnosis and prescription as shown in appendix E. Also on this interface the healthcare professional can write recommendations or additional notes and initiate the referral process as illustrated in appendix F.

Patients Add New

Show 10 entries Search:

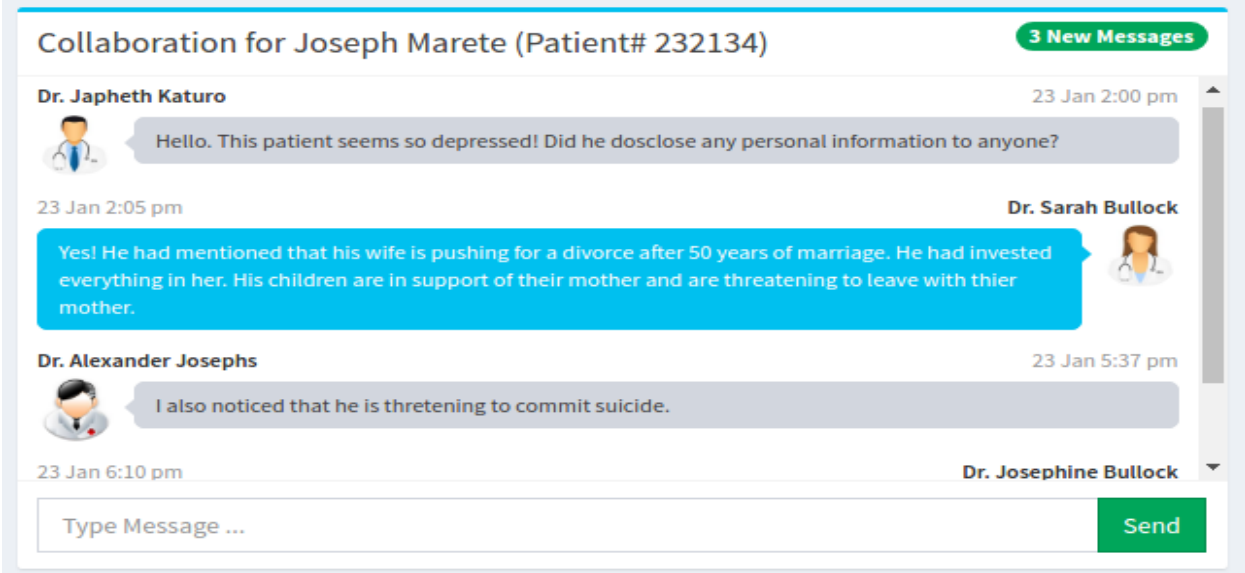
	Name	Date of Birth	County	Phone#	Next of Kin	Next of Kin's Phone	Action
1	Joseph Asusa	1980-12-11	Baringo	0729024356	Josephs	0734253647	<span>Edit</span> <span>Delete</span>
2	Saruti Jakoyo	1990-11-11	Bomet	0729036484	Lazaro	0724345678	<span>Edit</span> <span>Delete</span>
3	Makure Kasee	1993-01-12	Bungoma	0759056481	Martos	0734554237	<span>Edit</span> <span>Delete</span>
4	Joseph Marete	1997-01-02	Busia	0728031484	Stevens	07523312232	<span>Edit</span> <span>Delete</span>
5	Merita Sababa	1983-02-15	Elgeyo Marakwet	0729036484	Betry	07462343547	<span>Edit</span> <span>Delete</span>
6	Katumz Elizabeth	1999-03-03	Embu	0729012123	Samaki	0765565545	<span>Edit</span> <span>Delete</span>

Showing 1 to 6 of 6 entries Previous 1 Next

**Figure 5.2 Patient Management Interface**

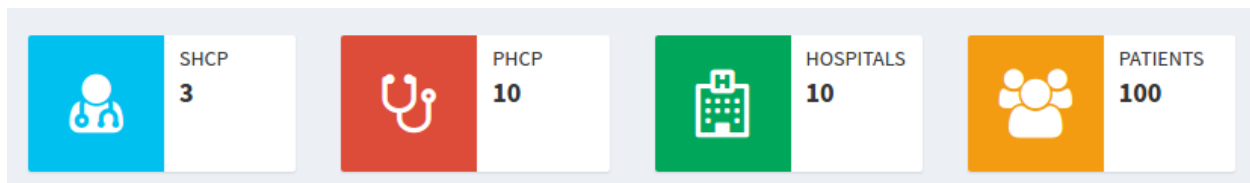
### 5.2.1.3 Collaboration between Healthcare Professionals

The key functionality of this model is collaboration. This involves the provision of a communication process that will enable the healthcare professionals to collaborate with each other in order to coordinate their activities with regards to the patient treatment and care process. Both the primary and secondary healthcare professionals can initiate collaboration. The primary healthcare professional starts the collaboration process with the secondary healthcare professional by sending a notification message of the initiated referral. The notification contains the patient id which the secondary healthcare professional can use to access the patient's medical history. After reviewing the patient's medical or after seeing the referred patient. The secondary healthcare professional can initiate collaboration with the primary healthcare professional to seek further clarification on the patient's condition, tests, prescriptions or medical history. This process enables the healthcare professionals coordinate their services and provide seamless patient care with reduced medical errors, improved quality and reduced costs. Figure 5.8 shows the collaboration interface.



**Figure 5.8 Collaboration Interface**

Based on the diagnosis and/or the collaboration session, the secondary healthcare professional can update the patient’s medical history or write additional notes or recommendations to provide a narrative that can provide more descriptions pertaining to a patient’s condition, treatment or care process.

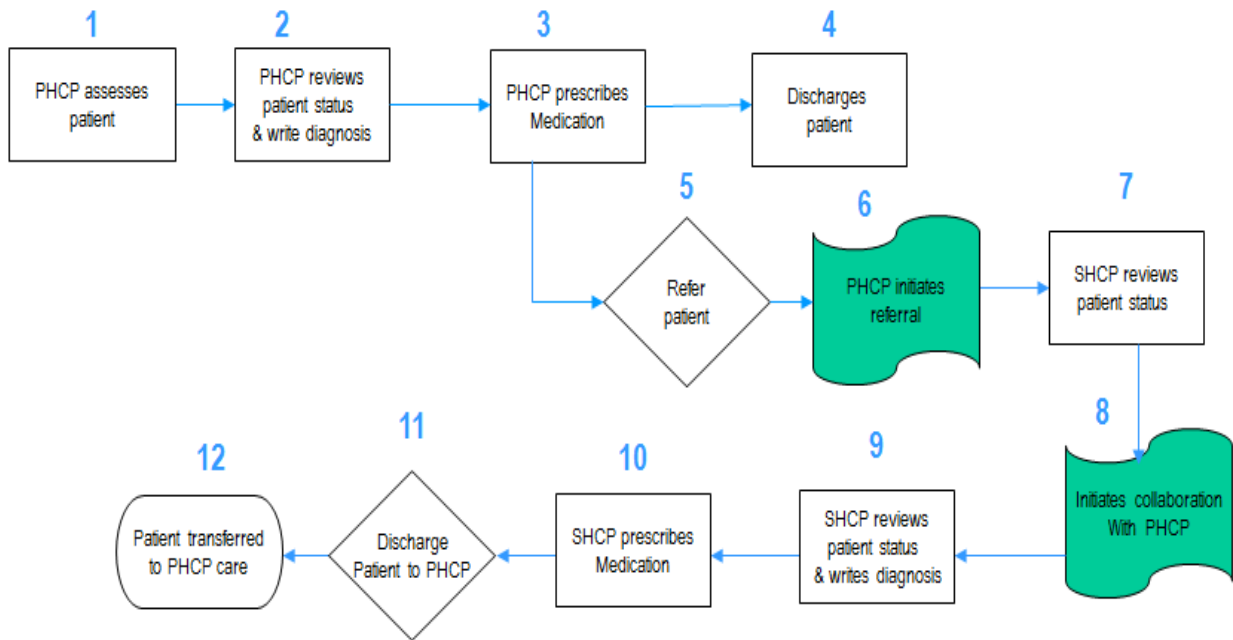


**Figure 5.9 Reports Screen Shot**

### 5.3 Model flow

After a successful login, the system administrator enters the healthcare professional’s details. These details include Healthcare professional (HCP) id, name, phone number, email address, facility, and level of practice. These details are added to the system’s database and are used by the analytical back-end system to produce various reports. Only after being registered as a user can the HCP log into the system. Upon a successful login, the healthcare professional can add or search for patients in the system and initiate collaboration with another healthcare professional

also registered as a user. All the healthcare professionals' and patients' data captured by the system is added to the system's database and is used by the analytical back-end system to produce various reports. A summary of these processes is illustrated in Figure 5.10.



**Figure 5.10: Model Flow Diagram**

### 5.4 Model Testing

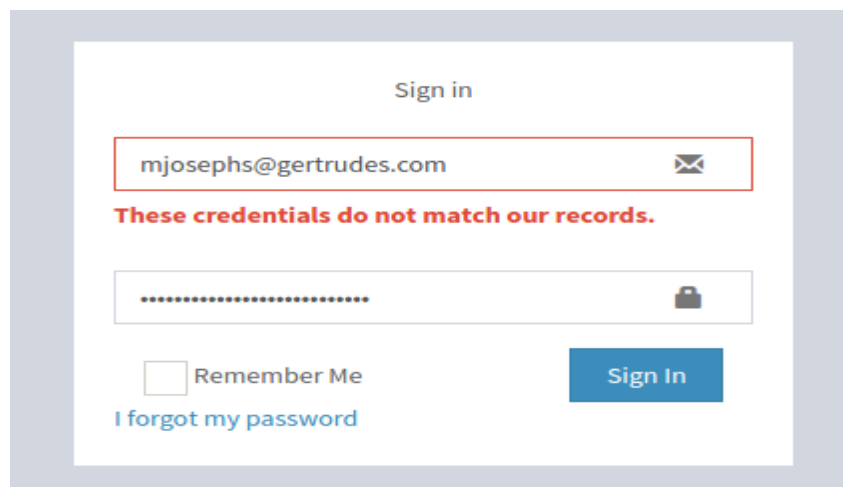
Several tests were done all through the model's development and implementation processes. These tests include: unit testing to eliminate bugs and ensure the modules functioned as expected, integration tests to verify that the modules built and tested independently can be integrated and can communicate and the system test to ensure that the functional and nonfunctional requirements of the model meet the user requirements and specifications provided. Usability test was also carried out to test the functionality of the collaborative model. This was carried out to verify and validate that the communication components function as expected, the model is easy to learn and use, the navigation flow is smooth and that the resultant system is user friendly and meets the user requirements and specifications. Some of the tests done are shown in Table 5.1.

**Table 5.1 Test Cases**

<b>ID</b>	<b>Case</b>	<b>Expected Outcomes</b>	<b>Comments</b>
<b>1.0</b>	<b>Login</b>		
<b>1.1</b>	Password or username left out	Error Dialog Box	<b>Pass</b>
<b>1.2</b>	Wrong password or username	Error Dialog Box	<b>Pass</b>
<b>2.0</b>	<b>User registration</b>		
<b>2.1</b>	Leaving out a required field	Error Dialog Box	<b>Pass</b>
<b>3.0</b>	<b>Health facility registration</b>		
<b>3.1</b>	Leaving out a required field	Error Dialog Box	<b>Pass</b>
<b>4.0</b>	<b>Patient registration</b>		
<b>4.1</b>	Leaving out a required field	Error Dialog Box	<b>Pass</b>
<b>5.0</b>	<b>Role Access</b>		
<b>5.1</b>	Accessing unauthorized page	Session destroyed. Notification dialog box	<b>Pass</b>

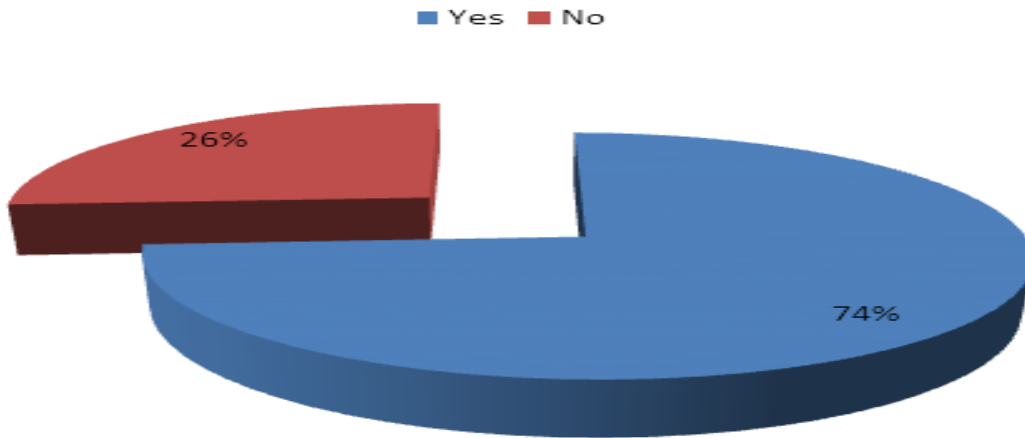
**5.4.1 Validation Results**

The collaborative model had a dynamic validation facility which checks for errors in user input. This facility displays error messages informing the user of what has gone wrong and offers guidance on how to resolve it. The fields the facility validates include username and password.



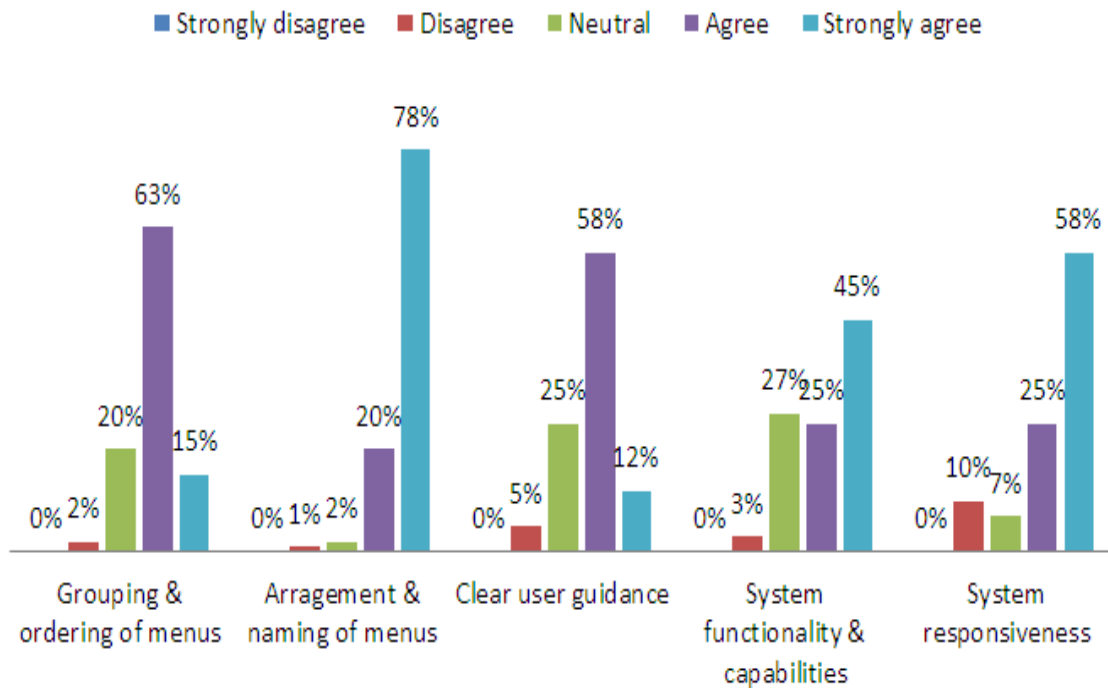
**Figure 5.11 Login Interface**

### 5.4.2 Usability Testing Results



**Figure 5.12 Respondents Who Successfully Accessed the System**

74% of the respondents were able to successfully access and use the system. 26% of the respondents were not able to use the system as they did not have internet connectivity.



**Figure 5.13 Collaboration Model Attributes Rating**

63% of the respondent agreed that the grouping ordering of menus in the model was appropriate, 78% of the respondents strongly agreed that the arrangement and naming of menus was fitting and 58% of the respondents agreed that the model provided clear user guidance. 48% of the respondents said the system functionality and capabilities solved the existing problem and 58% of the respondents found the system responsiveness acceptable. Figure 5.13 shows the distribution of these responses.

## **Chapter 6: Discussion**

### **6.1 Introduction**

After implementation the collaborative model for supporting shared care was tested to ensure both the functional and the non-functional requirements were met. The model was considered suitable compared to the other applications discussed in the study. Healthcare professionals rely on collaboration tools such as referral letters, hand written notes, Email, telephone and computerized systems to coordinate their activities and to provide continuity in the provision of healthcare services and implementation of care processes. These methods were prone to various challenges such as ambiguous or incomplete information, untimely feedback, interoperability issues, inefficient communication, inefficient coordination of healthcare activities, and inaccessibility to additional patient information. The collaborative model discussed provided a more efficient and effective platform for collaboration compared to the methods mentioned above. The discussed model also provides for notification mechanisms for healthcare professionals to inform them of referred cases. This enables the secondary healthcare providers to schedule appointments of the referred patients based on how critical their condition is. This eliminates delays in diagnosis and treatment and control of a patient's condition or disease.

### **6.2 Factors Affecting Collaborative Shared Care in Kenya**

The first objective was used to determine the factors affecting collaborative shared care in public hospitals in Kenya. Based on the findings obtained from the research and the literature reviewed it was revealed that the major factors affecting the practice of collaborative shared care are patriarchal relationships between the healthcare professionals, lack of interdisciplinary education, lack of role clarification, healthcare professional and organizational culture, proximity and information technology.

### **6.3 Collaborative Methods in Shared Care Settings**

The second objective was to analyze the collaborative methods currently used in shared settings within the public hospitals in Kenya. From the study findings, it was found out that healthcare professionals use standard referral letters, Email and telephone to collaborate and that the most used collaborative shared care method is the shared care record card model.

The research findings also showed that respondents face challenges such as ambiguous or incomplete information, untimely feedback, interoperability issues, inefficient coordination of healthcare activities and inaccessibility to additional patient information after a referral when using the above mentioned collaboration tools. The study also analyzed technologies healthcare professionals use to collaborate and identified the need and the respondents support to optimize them to support collaborative shared care.

#### **6.4 Collaborative model for Supporting Shared Care**

The third objective was to develop a collaborative for supporting shared care in public health facilities in Kenya. Research findings reveal that respondents find the development of the collaborative model for supporting shared care necessary as it will provide an appropriate and efficient platform for healthcare professionals to collaborate and effectively practice shared care. The literature reviewed discusses collaboration technologies, their elements and architecture which guided the development of the collaborative model.

#### **6.5 Testing of the Collaborative Model for Supporting Shared Care**

The last objective was to carry out testing of the collaborative model. The literature review discusses unit testing, integration testing and system testing. The system usability questionnaire in Appendix B was used to test the developed model. 74% of the respondents who participated in the system usability testing were able to access and use the system.

#### **6.6 Advantages of the Collaborative model for Supporting Shared Care**

The collaborative model can be accessed from different client machines, for example desktop computers, laptops and smart phones since it is web based. The collaborative model enables healthcare professionals to collaborate at no additional cost as opposed to using the telephone and provides real time collaboration as opposed to using standard referral letters or hand written notes. The model streamlines the delivery of healthcare services as healthcare professionals can use the same platform to: manage patients, record their medical history, diagnosis and medication; refer patients to secondary healthcare professionals and also use it to collaborate with one another and easily share patients' electronic records. The use of the analytical back end system enables the model to analyze stored data and information to produce reports on the

number of patients seen or treated, types of diagnosis, number of referrals, number of healthcare professionals and healthcare facilities. These reports can help health organizations as well as the government formulate better policies and make the correct investments with regards to healthcare in Kenya.

## **Chapter 7: Conclusion and Recommendation**

### **7.1 Conclusion**

As highlighted by several respondents, both healthcare professionals and patients face a number of challenges in facilitating and consequently implementing shared care in Kenyan public healthcare facilities. One of the major problems is the lack of collaboration among healthcare professionals involved in a patient's care process. This lack of collaboration results in the lack of or poor coordination between healthcare professionals and may lead to misdiagnosis, medical errors, misuse of resources, poor patient outcomes, unnecessary or even harmful services and increased healthcare cost (Adeley and Ofili, 2010).

The study lays its emphasis on taking advantage of easy access, wide connectivity as well as the analytical capabilities of IT related systems for the facilitation and support of collaboration among healthcare professionals and the implementation of collaborative shared care.

The Ministry of Health recognizes the need to apply technology to aid in the implementation of shared care and to facilitate collaboration among healthcare professionals and even with their patients. Shared care leads to the joint participation of primary healthcare professionals and secondary healthcare providers in a planned care delivery, informed by an enhanced information exchange over and above the normal discharge and referral letters. This results in improvement of the quality and continuity of the healthcare services provided as well as the patients' safety, thus a healthy population exists to contribute to the country's economic and technological development.

With the number of patients seen or treated at public healthcare facilities estimated to be 1,883,021 and the number of healthcare professionals estimated to be 3,038. It is pertinent to ensure that the healthcare professionals as a core healthcare resource are utilized efficiently and effectively. Technology can therefore be applied to tackle fragmentation of the healthcare process and streamline the flow of patients from lower level to higher level healthcare facilities.

The study reveals the need for effective collaboration in the delivery of healthcare services and in the practice of collaborative shared care. From the research findings, most respondents face challenges with the currently used collaboration tools as they do not effectively support collaboration between healthcare professionals based in different organizations. Using the

technologies discussed in the literature review, the collaborative model for supporting shared care was developed. The V process methodology was used to develop the system. This methodology enabled the verification and validation of the model in the early stages of development as it allows for the parallel development and testing of the system's deliverables. The system usability testing was thoroughly carried out and the respondents found it useful and easy to use. If the collaborative model is adopted it will help curb the challenges faced by healthcare professionals when collaborating and practicing collaborative shared care. It will connect healthcare professionals across public hospitals in Kenya and enable them to efficiently collaborate and securely share patients' data.

### **7.2 Contribution of the Model to Research**

Considering the challenges that healthcare professionals faced when collaborating, the model offered an improved solution compared to the commonly used collaboration tools. The collaborative model for supporting shared care provided the healthcare professionals an easily accessible, easy to learn and reliable collaboration platform. The model also helped in the implementation and practice of shared care which leads to the joint participation of primary and secondary healthcare professionals in a planned care delivery system, informed by an enhanced information exchange over and above the normal discharge and referral letters. This method of care results in the improvement of quality and continuity of the healthcare services provided as well as the patients' safety.

### **7.3 Recommendations**

The collaborative model for supporting shared care was suitable and useful to the users as per the findings of this study. However, the researcher noted that there was more that could be done in the area of collaborative shared care and therefore recommends the following. In order to create awareness and increase adoption of the collaborative model healthcare professionals need to be informed of its benefits. Secondly, the use of the collaborative model can be expanded to include emergency healthcare services.

#### **7.4 Future Work**

The researcher recommends the expansion of the collaborative model to include private healthcare facilities and healthcare professionals as this will provide a seamless flow of patients from public healthcare facilities to private healthcare facilities and vice versa. The researcher also recommends intelligence be built into the model to aid in the diagnosing of conditions and diseases as well the formulation of patient's care process.

## References

- Adeley, O. A., & Ofili, A. N. (2010). Strengthening Intersectoral Collaboration for Primary Healthcare in Developing Countries: Can the Health Sector Play Broader Roles? *Journal of Environmental and Public Health*, 6.
- Adwok, J., Kearns, E. H., & Nyary, B. (2013). Fragmentation of Healthcare Delivery Services in Africa: Responsible Roles of Financial Donors and Project Implementers. *IISTE*, 6.
- Ahmad, A. (2011). A Short Description of Social Networking Websites and Its Uses. *International Journal of Advanced Computer Science and Applications*, 2(2), 124-127.
- Aizenbud-Reshef, N., Nolan, B. T., Rubin, J., & Shaham-Gafni, Y. (2006). Model traceability. *IBM SYSTEMS JOURNAL*, 12.
- Barnum, H., & Kutzin, J. (1993). *Public hospitals in developing countries: resource use, cost, financing*. Washington DC: The World Bank.
- Basavanthappa, B. T. (2003). *Community Health Nursing*. New Delhi: Jaypee Brothers Medical Publishers (P) LTD.
- Beaulieu, M. (2000). What do patients want from their GP? Common expectations beyond cultural differences. *British Journal of General Practice*.
- Belatrix. (2015). *Functional Testing Best Practices*. Retrieved from Belatrix Software. Retrieved from <http://www.belatrixsf.com/>.
- Besley, T., & Gouvela, M. (2000). Alternative systems of healthcare provision. *Health Policy Journal*, 19, 53-58.
- Canadian Health Services Research Foundation. (2006). *Teamwork in Healthcare: Promoting Effective Teamwork in Healthcare in Canada*. Ottawa, Ontario: Canadian Health Services Research Foundation.
- Chuma, J., Ngumbau, C., Maiyo, L., Waiyaki, I., & Hart, T. (2014). *Laying The Foundation For A Robust Healthcare System In Kenya: Kenya Public Expenditure Review*. Nairobi: The World Bank .

- Cline, H. (2001). *Health Education Research*. Oxford University Press.
- Davis, K. (2005). Transformational Change: A Ten-Point Strategy to Achieve Better Healthcare. *The Commonwealth Fund*.
- De Valk et al., J. (2014). Self-referred Patients at the Emergency Department: Patient Characteristics, Motivations, and Willingness to Make a Copayment. *International Journal of Emergency Medicine*, 6.
- Doessing, A., & Burau, V. (2015). Care Coordination of Multimorbidity: A Scoping Study. *Journal of Comorbidity*, 5:15–28.
- Donalek, C. (2011). *Supervised and Unsupervised Learning*. Pasadena: Caltech Campus: Caltech Campus, Astronomy Department.
- Dustin, R. T. (2010). <http://www.inquiriesjournal.com/a?id=284>. *Inquiries Journal*, 5.
- Felici, M. (2011). *Software Design and Class Diagrams*. School of Informatics.
- Galarneau, C. (2015). Healthcare Sharing Ministries and Their Exemption From the Individual Mandate of the Affordable Care Act. *Journal of Bioethical Inquiry*, 12.
- Goodman, T. (2005). Is There A Right to Health? *Journal of Medicine & Philosophy*, 15.
- Hanover Research. (2011). *Trends in Global Distance Learning- Academy Administration Practice*. Washington, DC: Hanover Research .
- Hast, R. (2006). Health information systems – Past, present, future. *International Journal of Medical*.
- Hickman, M., Drummond, N., & Grimshaw, J. (1994). A Taxonomy of Shared Care for Chronic Disease. *Journal of Public Health*, 447-454.
- Hoffer, J. (2001). *Modern Systems Analysis and Design*.
- Hsieh, H. S. (2005, February 20). Three approaches to qualitative content analysis. Retrieved from <http://www.ncbi.nlm.nih.gov/pubmed/16204405>

- Kennedy, E. M. (2009). Healthcare as a Basic Human Right: Moving From Lip Service to Reality. *Harvard Human Rights Journal*.
- Khan, P. M., & Beg, M. M. (2013). Extended Decision Support Matrix for Selection of SDLC-Models on Traditional and Agile Software Development Projects. *Third International Conference on Advanced Computing & Communication Technologies*, (pp. 8-14). New Delhi.
- Kimberlin, C. L., & Winterstein, A. G. (2008). Validity and Reliability of Measurement Instruments. *American Society of Health-System Pharmacists*.
- Kim-hwang, J. E., Chen, A. H., Bell, D. S., Guzman, D., & Yee, H. F. (2010). Evaluating Electronic Referrals for Specialty Care at a Public Hospital. *Journal of General Internal Medicine*.
- Kraaijvanger, N., Douwe Rijpsma, D., & Van Le, H. (2015). Self-Referrals in the Emergency Department: Reasons Why Patients Attend the Emergency Department Without Consulting a General Practitioner First—A Questionnaire Study. *International Journal of Emergency Medicine*, 6.
- Kumar, C. (2012). Emerging Technology and Advanced Engineering. *International Journal of Emerging Technology and Advanced Engineering*.
- Leonard, K. L., Mliga, G. R., & Mariam, D. H. (2002). Bypassing health centres in Tanzania: revealed preferences for quality. *Journal of African Economics*.
- Lim et al., A. Y. (2015). Integrating Rheumatology Care in the Community: Can Shared Care Work. *International Journal of Integrated Care*, 12.
- Lippeveld, T., Sauerborn, R., & Bodart, C. (2000). *Design and Implementation of Health Information Systems*. Geneva: World Health Organization.
- Manser, T. (2009). Team Work and Patient Safety in Dynamic Domains of Healthcare: A review of the Literature. *Acta Anaesthesiologica Scandinavica*, 8.

- Maxson et al., P. M. (2011). Enhancing Nurse and Physician Collaboration in Clinical Decision Making Through High-Fidelity Interdisciplinary Simulation Training. *Mayo Clinic Proceedings* (pp. 31 - 36). Rochester, Minnesota: Mayo Clinic.
- McKibbon, K. A., & Fridsma, D. B. (2006). Effectiveness of Clinician-Selected Electronic Information Resources for Answering Primary Care Physicians' Information Needs. *Journal of the American Medical Informatics Association* , 13(6), 653-659.
- Mickan, S. M. (2005). Evaluating the effectiveness of healthcare teams. *Australian Health Review*, 7.
- Ministry of Health . (2013). *Kenya Health Investment Plan (2013-2017)*. Nairobi, Kenya.: Ministry of Health.
- Ministry of Health [MOH]. (2013). *Kenya Health Investment Plan (2013-2017)*. Nairobi, Kenya: Ministry of Health,.
- Ministry of Health [MOH]. (2016). *Health Sector Human Resources Strategy 2014 – 2018*. Nairobi: Ministry of Health.
- Ministry of Health. (2013). *Kenya Health Investment Plan (2013-2017)*. Nairobi, Kenya: Ministry of Health,.
- Ministry of Planning and National Development. (2007). *Kenya Vision 2030*. Nairobi, Kenya: Ministry of Planning and National Development.
- Muldoon , L. K., Hogg, W. E., & Levitt , M. (2006). Primary Care (PC) and Primary Healthcare (PHC): What is the Difference? *Canadian Journal of Public Health*.
- Mwiria, K., Ng'ethe, N., Ngome, C., Ouma-Odero, D., Wawire, V., & Wesonga, D. (2007). Public & Private Universities in Kenya: New Challenges, Issues & Achievements. *Higher Education in Africa*, 224.
- Naylor, M., & Keating, S. A. (2008). Transitional Care: Moving patients from one care setting to another. *American Journal of Nursing*, 108(9 Suppl): 58–63.

- Nov, O., & Schechter, W. (2012). Dispositional resistance to change and hospital physicians' use of electronic medical records: A multidimensional perspective. *Journal of the American Society for Information Science and Technology*, 20.
- O'Leary et al., K. J. (2011). Improving teamwork: Impact of structured interdisciplinary rounds on a hospitalist unit. *Journal of Hospitalist Medicine*, 6(2), 88-93 ).
- Oliver-Baxter , J., & Bywood , P. (2013). *Communication Between Health Professionals Across Sectors*. Adelaide: Primary Healthcare Research & Information Service.
- Pagh, R. (2006). *The Entity-Relationship Model*. Copenhagen: IT University of Copenhagen, Denmark.
- Park et al., H. A. (2006). Consumer-Centered Computer-Supported Care for Healthy People. *IOS press*.
- Pedersen, K. M., Andersen, J. S., & Sondergaard, J. (2012). General Practice and Primary Healthcare in Denmark. *Journal of the American Board of Family Medicine*, 5.
- Pisipati , S., Chow , K., & Payne , S. R. (2009). Choose and Book: An Audit of the Appropriateness of Referrals and Their Effect on Patients' Attendance to An Inner City Hospital Secondary Care Provider. *British Journal of Medical and Surgical Urology*.
- Reddy, M. C., & Jansen, B. J. (2008). A model for understanding collaborative information behavior in context: A study of two healthcare teams. *Information Processing & Management Journal*, 44(1), 256-273.
- Rod et al, S. (2015). Patients' Perspectives on the Medical Primary - Secondary Care Interface: Systematic Review and Synthesis of Qualitative Research. *BMJ Open*, 18.
- Russell, L., Doggett, J., Dawda, P., & Wells, R. (2013). *Patient Safety – Handover of Care Between Primary and Acute Care: Policy Review and Analysis*. Canberra: Australian Government, Department of Health and Ageing .
- Russell, S., & Norvig, P. (2013). *Artificial Intelligence: A Modern Approach (3rd ed.)*. London: Prentice Hall.

- Sakshay. (2013). *Advantages of choosing PHP Web development*. Retrieved March 5, 2017, from <http://www.sakshay.in>
- Salisbury, C., Johnson, L., Purdy, S., Valderas, J. M., & Montgomery, A. A. (2011). Epidemiology and Impact of Multimorbidity in Primary Care: A Retrospective Cohort Study. *British Journal of General Practice*, 61:12-21.
- Scott et al., J. G. (2008). Understanding Healing Relationships in Primary Care. *Annals of Family Medicine*, 8.
- Shi, L. (2012). The Impact of Primary Care: A Focused Review. *Scientifica*, 22.
- Singer, S. J., & et al. (2011). Defining and measuring integrated patient care: promoting the next frontier in healthcare delivery. *Medical Care Research & Review*.
- Smith, S. M., Allwright, S., & O'Dowd, T. (2007). Effectiveness of shared care across the interface between primary and specialty care in chronic disease. *The Cochrane Collaboration*.
- Townsend et al., D. (2015). Health Professionals' and Service Users' Perspectives of Shared Care for Monitoring Wet Age-Related Macular Degeneration: A Qualitative Study Alongside the ECHoES Trial. *The ESMO Open Access Journal*, 12.
- Traver, A. (2013). *The Promise of Care Coordination: Transforming Healthcare Delivery*. Washington, DC: Families USA.
- Tripathi, K. P. (2011). A Review on Knowledge-based Expert System: Concept and Architecture. *International Journal of Computer Applications*, 5.
- Valentijn, P. P., Schepman, S. M., Opheij, W., & Bruijnzeels, M. (2013). Understanding Integrated Care: A Comprehensive Conceptual Framework Based on the Integrative Functions of Primary Care. *International Journal of Integrated Care*.
- Virani, T. (2012). Interprofessional Collaborative Teams. *Canadian Health Services Research Foundation*.

- Vyt, A. (2008). *Interprofessional and Transdisciplinary Teamwork in Healthcare*. Wiley *InterScience*, 4.
- Ward, R., Stevens, C., Brentnall, P., & Briddon, J. (2008). The attitudes of healthcare staff to information technology: a comprehensive review of the research literature. *Health Information & Libraries Journal* , 25(2), 81-97.
- Werret, J. A., Helm, R. H., & Carnwell, R. (2001). The Primary and Secondary Care Interface: The Educational Needs of Nursing Staff for the Provision of Seamless care. *Journal of Advanced Nursing*, 10.
- White , F. (2015). Primary Healthcare and Public Health: Foundations of Universal Health Systems. *Medical Principles and Practice*, 14.
- World Health Organization [UN]. (1978). *Primary Healthcare*. Geneva, Switzerland: World Health Organization.
- Younger, P. (2010). Internet-based information-seeking behaviour amongst doctors and nurses: a short review of the literature. *Health Information and Libraries Journal* , 27(1), 2-10.

# Appendices

## Appendix A: Turnitin Originality Report

Feedback Studio - Mozilla Firefox  
https://ev.turnitin.com/app/carta/en\_us/?u=1029365245&lang=en\_us&student\_user=1&ts=1&o=795265686

feedback studio Mariam Heroe Salim thesis

**Match Overview**

**15%**

Match 1 of 19

Match	Source	Percentage
1	Submitted to Strathmore University Student Paper	3%
2	ecommons.luc.edu Internet Source	1%
3	almenpraksis.ku.dk Internet Source	<1%
4	Submitted to Trinity College Student Paper	<1%
5	www.who.int Internet Source	<1%
6	Submitted to University of Nairobi Student Paper	<1%
7	Fezzani, 'A few discussions...' Publication	<1%

A Collaborative Model for Supporting Shared Care in Kenya

MARIAM SALIM HEROE

Submitted in Partial Fulfillment of the Requirements for the Degree in Master of Science in Information Technology at Strathmore University

Page: 1 of 77 Word Count: 13343 Return to Turnitin Classic 6:04 PM 04/07/17

## Appendix B: User Requirements Questionnaire

### Healthcare Professional Questionnaire

Dear Respondent,

I am a student at Strathmore University pursuing a Master of Science in Information Technology (IT). I am currently conducting a study on A COLLABORATIVE MODEL FOR SUPPORTING SHARED CARE IN KENYA.

You have been selected to form part of this study. I kindly request you to complete the questionnaire below. The information requested is needed for academic purposes only and will be treated in strict confidence.

Kind Regards,

Mariam Salim Heroe.

#### Section A: Respondent details

(Please select the appropriate response to the questions by ticking (✓) in the box.)

##### A1. Please indicate your level of practice

*Tick (✓) only one box.*

- |                  |                          |
|------------------|--------------------------|
| Nurse            | <input type="checkbox"/> |
| Clinical officer | <input type="checkbox"/> |
| Doctor           | <input type="checkbox"/> |

##### A2. Please indicate the level of facility you practice at

*Tick (✓) only one box.*

- |                                       |                          |
|---------------------------------------|--------------------------|
| Community clinic                      | <input type="checkbox"/> |
| Dispensaries and health centers       | <input type="checkbox"/> |
| Level 4 and county referral hospitals | <input type="checkbox"/> |
| National Referral hospital            | <input type="checkbox"/> |

**Section B: Factors affecting collaborative shared care in Kenya**

**B1. Is there collaboration between healthcare professionals?**

*Tick (✓) only one box.*

- Yes
- No

**B2. Please indicate the collaborative method used in shared care settings.**

*Tick (✓) all that apply.*

- Community clinics
- Basic model
- Liaison model
- Shared care record card
- Computer assisted shared care
- Electronic email

**B3. Please indicate which tools used for collaboration in shared care settings.**

*Tick (✓) all that apply.*

- Standard referral letters
- Email
- Telephone
- Computerized systems
- Other

**B4. What challenges did you face while using the collaboration methods?**

*Tick (✓) all that apply.*

- Ambiguous or Incomplete information
- Untimely feedback
- Interoperability issues
- Inefficient coordination of healthcare activities
- Inaccessibility to additional patient information after a referral

**Section C: Collaborative model for supporting shared care**

**C1. How would you rate the effectiveness of the existing collaboration methods?**

*Tick (✓) only one box.*

- Poor
- Fair
- Good
- Very good
- Excellent

**C2. Do you think a collaborative model for supporting shared care is necessary?**

*Tick (✓) only one box.*

- Yes
- No

## Appendix C: User Requirements Questionnaire

### Patient Questionnaire

Dear Respondent,

I am a student at Strathmore University pursuing a Master of Science in Information Technology (IT). I am currently conducting a study on A COLLABORATIVE MODEL FOR SUPPORTING SHARED CARE IN KENYA.

You have been selected to form part of this study. I kindly request you to complete the questionnaire below. The information requested is needed for academic purposes only and will be treated in strict confidence.

Kind Regards,

Mariam Salim Heroe.

#### Section A: Respondent details

(Please select the appropriate response to the questions by ticking (✓) in the box.)

##### A1. Please indicate if you have ever been referred to another healthcare facility.

*Tick (✓) only one box.*

Yes           

No            

##### A2. If your answer above is 'Yes', please indicate why you were referred.

---

---

#### Section B: Factors affecting collaborative shared care in Kenya

**B1. Please indicate what was needed when you were referred.**

*Tick (✓) all that apply.*

- Referring healthcare provider details
- Referring healthcare provider's notes
- Patient medical history
- Previous tests results
- Patient general details
- Other

**B2. Please indicate which referral tool was used.**

*Tick (✓) only one box.*

- Referral letters
- Email
- Telephone
- Computerized systems
- Other

**B3. What challenges did you face in facilitating this collaboration?**

---

---

---

**Section C: Collaborative model for supporting shared care**

**C1. How would you rate the effectiveness of the collaboration process in coordinating your care process?**

*Tick (✓) only one box.*

- |           |                          |
|-----------|--------------------------|
| Poor      | <input type="checkbox"/> |
| Fair      | <input type="checkbox"/> |
| Good      | <input type="checkbox"/> |
| Very good | <input type="checkbox"/> |
| Excellent | <input type="checkbox"/> |

**C2. Do you think a collaborative model for supporting shared care is necessary?**

*Tick (✓) only one box.*

- |     |                          |
|-----|--------------------------|
| Yes | <input type="checkbox"/> |
| No  | <input type="checkbox"/> |

## Appendix D: System Usability Questionnaire

### System Usability Questionnaire

Dear Respondent,

I am a student at Strathmore University pursuing a Master of Science in Information Technology (IT). I am currently conducting a study on A COLLABORATIVE MODEL FOR SUPPORTING SHARED CARE IN KENYA.

You have been selected to form part of this study. I kindly request you to complete the questionnaire below. The information requested is needed for academic purposes only and will be treated in strict confidence.

Kind Regards,

Mariam Salim Heroe.

(Please select the appropriate response to the questions by ticking (✓) in the box.)

#### 1. Were you able to access the system?

*Tick (✓) only one box.*

Yes     

No       

#### 2. If your answer above is 'No', kindly list the problems you encountered.

---

---

#### 3. How would you rate the following system attributes?

Tick each attribute appropriately. Tick (✓) only one box per row.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The grouping and ordering of menus for easy learning and use.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The arrangement and naming of menus for ease of finding core functionalities.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The system provides clear user guidance and help.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The system has all the functionalities and capabilities necessary for collaboration.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The system responsiveness is acceptable as it completes the assigned tasks in reasonable time.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**4. Any comments, suggestions, or recommendations about the system.**

---



---



---

## Appendix E: Patient Diagnosis and Prescription Interface

Diagnosis Patient: Joseph Marete (Patient# 232134) - x

✂️ 📄 📌 📌 📌 ⬅️ ➡️ ABC 🔗 🗣️ 🚩 🖼️ 📄 📄 📄 Ω 🔗 Source

**B I S I<sub>x</sub>** ☰ ☷ ☹️ ☹️ ☹️ ☹️ ☹️ Styles Format ?

The patient is exhibits a high degree of stress...

Prescription Patient: Joseph Marete (Patient# 232134) - x

Specialty Required(Please select one) ▼

✂️ 📄 📌 📌 📌 ⬅️ ➡️ ABC 🔗 🗣️ 🚩 🖼️ 📄 📄 📄 Ω 🔗 Source

**B I S I<sub>x</sub>** ☰ ☷ ☹️ ☹️ ☹️ ☹️ ☹️ Styles Format ?

Deep rest is required for this patient in addition to psychiatric advice.

## Appendix F: Patient Referral Process Interface

Referrals

	Name	Required Specialty	Action
1	Joseph Asusa	Psychiatric	<a href="#">Refer</a>
2	Saruti Jakoyo	Psychiatric	<a href="#">Refer</a>
3	Makure Kasee	Psychiatric	<a href="#">Refer</a>
4	Joseph Marete	Psychiatric	<a href="#">Refer</a>
5	Merita Sababa	Psychiatric	<a href="#">Refer</a>
6	Katumz Elizabeth	Psychiatric	<a href="#">Refer</a>

Hospital Specialties [Add New](#)

Show  entries Search:

	Hospital	Level	Specialty	Action
1	Gertrudes Hospital	Level 5	General Surgery	<a href="#">Edit</a> <a href="#">Delete</a>
2	Gertrudes Hospital	Level 5	Cardiothoracic Surgery	<a href="#">Edit</a> <a href="#">Delete</a>
3	Gertrudes Hospital	Level 5	Vascular Surgery	<a href="#">Edit</a> <a href="#">Delete</a>
4	Gertrudes Hospital	Level 5	Cosmetic and Reconstructive Surgery	<a href="#">Edit</a> <a href="#">Delete</a>
5	Gertrudes Hospital	Level 5	Colorectal Surgery	<a href="#">Edit</a> <a href="#">Delete</a>
6	Gertrudes Hospital	Level 5	Surgical oncology	<a href="#">Edit</a> <a href="#">Delete</a>
7	Gertrudes Hospital	Level 5	Transplant Surgery	<a href="#">Edit</a> <a href="#">Delete</a>

Showing 1 to 7 of 7 entries Previous **1** Next

**Refer to** ✕

Health Care Provider:

[Close](#) [Save changes](#)

isa			
yo		Psychiatric	
see		Psychiatric	
rete		Psychiatric	