UNIVERSITY OF NAIROBI

COLLEGE OF BIOLOGICAL AND PHYSICAL SCIENCES

SCHOOL OF COMPUTING AND INFORMATICS

Implementing a Patient eReferral Booking System

MARTIN MURIKI

P51/12010/2018

Supervisor

Prof. Peter W. Wagacha

August 2020

A Research Project Submitted in Partial Fulfillment of the Requirements for the Degree of Master of Science in Applied Computing of the University of Nairobi

DECLARATION

This research project is my original work and has not been presented for award of any degree in any University to thee best of my knowledge.

Name: Martin Muriki

……. ……

Signature Date

This research project has been submitted for examination with my approval as University Supervisor.

Name: Prof. Peter Waiganjo Wagacha

… …… …9th September 2020…

Signature. Date.

Acknowledgements

I would like to express my gratitude to my supervisor; Prof. Peter Waiganjo Wagacha for the guidance and direction throughout the research of this research and to all who supported me throughout this process I highly appreciated and I value the lessons learnt during this research.

To all the Informatics and Computing School staff, I am grateful for the contribution that you made in the various ways that you did throughout the semester.

I would like to express my special gratitude to my fellow colleagues for your support and contributions. To my family and ABF, your invaluable contribution and support was noticed and it is highly appreciated, thank you all. To all the staff of the various institutions that I had an opportunity to visit, I just want to thank you for providing the information that you did by responding to my questions and also by providing data.

Finally, I thank Almighty God for granting me the opportunity to undertake this course.

Abstract

Background: Poor communication and coordination of care between primary care and specialty care providers leads to major inefficiencies in health care delivery. As a signatory of the Millennium Declaration, Kenya is committed to achieve the targets of MDGs 4–6 which include: access to affordable healthcare. Like many other developed countries, Kenya faces a big challenge in terms of misappropriation of funds and poor service delivery to its citizens. Most of the government facilities are ill equipped even to cater for the bare minimum care.

In 2020, the number of people in need of specialized medical care due to corona virus (covid-19) was in excess of 20 million worldwide with nearly 5 million hospitalized. This goes to show how important good referral systems are.

A good referral system, as an essential part of primary health care, is fundamentally important for the provision of optimal health services. The goal of establishing a functional referral system has yet to be achieved in Kenya. This study aimed to explore health expert's viewpoints about challenges of developing and implementing referral system in Kenya.

The researcher developed a Web-based electronic referral system (eReferral) that enabled patients to chat with their healthcare providers, book appointments and make follow ups.

Methods: the eReferral system was evaluated in three ways, firstly: use of questionnaires, interviews and focus group questions were administered and analyzed to get user views. This was to enable the researcher to assess attitudes toward eReferral and to identify best practices in implementing the system. Secondly, analysis of healthcare documents and records to get a clear picture of the working environment and how business processes are carried out. Thirdly, to design a model eReferral system to project the system's implications on healthcare costs and utilization of services.

Results: by using this eReferral system there was a great reduction of the turnaround time between booking an appointment, diagnosis, treatment and discharge. This led to reduced cost incurred in travelling to go to healthcare facilities to make a booking and seeking treatment. The clinicians were also aware of expected appointments and thus able to prepare in advance.

eReferral also enabled acceleration of more urgent care, with clinics having up to 40 percent of referrals expedited.

There was significant improvements by Primary care providers reporting that eReferral improved quality of care for their patients with the correct ICT infrastructure.

There was improved communication between the different levels of healthcare facilities and this enabled efficient submission and management of referral requests. Contributing factors for this adoption was a user friendly GUI, availability of cheap smartphones and internet access.

Conclusion: the use of ICT in managing referral processes is important to ensure an effective and efficient process for service delivery for a comprehensive reform is recommended.

Keywords: *consultation, eReferral system, referral process, HBM, DSS.*

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List of Acronyms

CDC	Centers for Disease Control and Prevention
CDS	Clinical Decision Support
CHW	Community Health Worker
CHV	Community Health Volunteers
DSS	Decision support systems
EHR	Electronic Health Record
EMR	Electronic Medical Record
eReferral	Electronic Referral system
HC	Health Center
HCF	HealthCare Facility
HCW	Health Care Worker
HIS	Health Information System
HO	Hospital
HP	Health Provider
HTML	Hyper Text Mark-up Language
HTTP	Hyper Text Transfer Protocol
KEPH	Kenya Essential Package for Health
IPD	Inpatient Department
IT	Information Technology
KHSSP 2012–2018	Kenya Health Sector Strategic and Investment Plan
M&E	Monitoring and Evaluation
MDGs	Millennium Development Goals
mHealth	Mobile Health
MIS	Management Information Systems
MOH	Ministry of Health
NHS	United Kingdom National Health Service
NLP	Natural Language Processing
OPD	Outpatient Department
SMS	Short Message Service
URL	Unified Resource Locator
WHO	World Health Organization
WWW	World Wide Web

Definition of Terms

Artificial Intelligence:

Ability of a computer to perform human tasks in an intelligent manner such as speech recognition and decision making.

Client movement:

It's whereby a patient seeks additional medical treatment in a medical facility with the capability.

Client parameters movement:

Use of eHealth to enable move client information movement to enable supportive diagnosis in higher level health facilities.

Consultation:

Looking for professional opinion and report of findings by the referring physician

Counter-referral:

Its whereby the receiving facility sends the client back to his/her initiating facility with a report indicating the services provided and if there's need for a follow up.

eHealth:

Use of ICTs such as computers, mobile phones and radios to provide healthcare services and information.

Emergency referrals:

It's when a patient has an emergency conditions that threaten life, limb, or eye sight.

Expert:

A trained health care provider with knowledgeable skills in a particular area of expertise

Inappropriate referrals:

Referrals that lack quality of communication, incomplete referral forms, or accompanying documentation.

Initiating facility:

The facility that initiates a referral process by preparing a referral slip to communicate the client's condition and status.

Level of care:

The Kenyan health system is divided into levels of care, defined as community, primary care, County and national referral services.

mHealth:

New form of electronic health that makes use of mobile technologies such as mobile phones and tablets to provide healthcare services and information.

Non-urgent or routine referral:

A referral process used to seek a second opinion, routine admissions, a higher-level investigation and client management.

Receiving facility:

An organization, service, or community unit that accepts a referred client or specimen from an initiating facility.

Referral:

A request to assume care of a patient

Referral system:

A comprehensive health care system used to manage client health care needs by referring clients from an initiating facility to an organization, service, or community unit that can better provide the level of care needed.

Expertise referral:

Outreaches by medical specialist for non-emergency cases so as to teach patients in need of care in an efficient and cost-effective manner.

Specimen movement:

A referral process used to move a specimen to another health facility for analysis purposes.

Transfer:

A management process used to move a client from one facility to another.

Source: MOH 2014-2018

CHAPTER 1: INTRODUCTION

1.1 Background of the Study

The Ministry of Health (MOH) developed the Kenya Health Sector Referral Strategy 2014–2018 that defines referral as a mechanism to comprehensively manage clients' health needs by using resources beyond those available where they access care. The scope of referral services defined in the strategy includes movement of clients, specimens, services and experts, and client parameters. Kenya's vision 2030 was set up by the government of Kenya in the year 2010 by his Excellency Mwai Kibaki to propel Kenya's economy into the 21st century. When the Jubilee government took over for a second term in 2017 they came up with 4 main pillars including: healthcare food security, affordable housing and manufacturing. The Kenya health sector referral strategy 2014 - 2030 identifies various health system requirements for a well-functioning system. For a successful referral, the strategy notes that there must be geographical access to referral care facilities.

It is in line with this that the referral hospitals were set up in all the 47 counties and at least there was to be a level 5 hospital per county. The provisional hospitals were renamed to county hospitals and served as either level 5 or 6 referral hospitals.

For a successful referral system, there must be locally accessible referral health facilities. These health care facilities must be adequately equipped, having trained personnel and the services provided must be affordable. Essential drugs, supplies and equipment must be readily available to serve the patients.

Primarily healthcare seekers are required to seek health care from healthcare facilities near them starting with the lowest level to the highest level. But the nature of their illness may dictate a referral to a higher level, which is more equipped to treat their existing medical condition.

Currently there are 5 referral hospitals in Kenya: Kenyatta national hospital, Mathare Mental hospital, Kenyatta university referral hospital, Kenya spinal injury hospital and Moi and teaching referral hospital. These hospitals are predominantly supposed to serve as referral hospitals but patients refer themselves without following the laid down referral procedures. Mostly this is because patients believe that services and facilities at the referral hospitals is better.

The main challenge of referral system is tracing feedback and making a follow up of cases. It's important to monitor the patients' where bouts in the referral process, know what stage the patient is at and monitor the clinical diagnoses.

The proposed area of study is Kiambu County. Kiambu has an estimated population of 3 million individuals (KNBS, 2019). The study seeks to understand how healthcare providers monitor

referral cases and make an evaluation on the same and how ICT technology can be used to track this referral process.

International Telecommunication Union (ITU) global statistics predict that by the end of 2018, mobile penetration rate is expected to reach 96% (ITU 2014) with a 90% penetration rate in developing countries. Mobile-broadband penetration report indicate that it is approaching 32%. In the 2019 Kenya Census ICT survey revealed that about 90% of Kenyans have access to smart phones with internet connectivity regardless of the mode of acquisition (KNBS & CAK 2019).

By first understanding how the referral system work then we can be able to relate and understand how the referral process works in details. This study sort to demonstrate how web-based technologies together with mobile based architecture can be used to effectively facilitate these objectives.

With quality information available on timely manner, it's possible for all stakeholders to monitor the patient progress from doctors' notes, prescriptions and other medical recommendations by all involved stakeholders.

1.2 Problem Statement

Kenyan hospitals mostly operate different types of health information systems and these systems are not linked together for each is autonomous in its own way. This information is not centrally shared and accessed and as a result of this there is need to develop a web-based spatial management information system that is constantly updated and also collated and available on the web for easy access by all the stakeholders.

Patients seek for a more advanced medical attention in healthcare facilities more equipped than where they are being diagnosed, if the current facilities don't have the capability to sort out their issue. Patients may be referred to more than one health facility and tracking their movement and providing a feedback to the referring facility becomes a challenge when there is no effective monitoring system.

The referring facility may need to be updated on the patient progress once the patient was referred to a higher level when they come back routine checkups and such. The diagnosis and treatment done by the referral facilities is vital for continuity and reference purposes in that the referring clinical officers will need to peruse patient medical records and clinical notes thereby ensuring that they are at par with the patients' current condition.

The solution for this is a secure Web-based electronic referral system ("eReferral") for submitting electronic referral requests to specialty clinics. Rather than submitting referral requests by email,

post or telephone, the referring provider completes an Internet-based form with the patient's relevant history and the referring provider's consult question.

1.3 Objectives of the Study

1.3.1 Overall Objective

This study was carried out to investigate the challenges facing management of referral cases in Kenyan healthcare facilities.

The overall objective of this study was to develop an efficient web-based referral management and decision support system for patient referral using Kiambu County as a case study.

1.3.2 Specific Objectives

1. Identify the patient referral management challenges in healthcare in Kenya.
2. Identify appropriate health models that can support the provision of DSS for/to manage patient referral.
3. Develop an efficient DSS Model that supports the management patient referral.
4. Develop and evaluate a DSS to manage patient referral for Kiambu County.

1.4 Research Questions

1. What are the challenges of managing patient referral in healthcare in Kenya?
2. What are the appropriate health models that can support the provision of DSS for/to manage patient referral?
3. How do we develop an efficient DSS Model that supports the management patient referral?

1.5 Justification for the Study

The KHSSP 2012–2018 has proposed strategies, standards and guidelines to strengthen the referral system in Kenya as a way of improving efficiency in the health system and improving service delivery.

The current heterogeneous systems make it hard for referring facilities to monitor the progress and stages their patients are in. This makes it harder to monitor what the other HCWs did thereby leading to repeat processes or confusion.

The use of one central database system to monitor and analyze patient details progress is of great essence. To integrate eReferral into healthcare system, there is need to align the artefacts into stakeholders' needs and healthcare processes in low-resource settings (Beale & Heard 2007).

1.6 Scope and Limitations of the Study

This study will only cover Kiambu County and since eReferral has the potential to transform healthcare delivery in a cost-effective manner the study will be limited to Kiambu due to time and resource constraints.

1.7 Summary of Research Report

In chapter one the objectives of this research paper were laid out with a brief review of the current situation of Kenyan healthcare systems being carried out. A comparison was made on the usage of healthcare and mobile technology and a relationship drawn. The chapter also reviewed other global statistics in order to try and relate the findings to our problem. The researcher also defines key terms used in eReferral concept in order to better understand the proceeding chapters,

The second chapter will cover in detail some previous studies that have been done on eReferral and all the technological issues that involve the adoption of a new technology. A conceptual framework based on the study has been derived for further analysis. The third chapter describes the methodology and the tools that have been used for data collection and analysis. The fourth chapter describes in detail the research findings, analysis and the process of validating the proposed framework while chapter five summarizes and concludes the research findings in a comprehensive manner and suggest some recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter focus on previous literature relating to referral systems in different places around the world. Through the universal health coverage policy agenda, the government of Kenya aims at ensuring access to quality health services at a reasonable cost and in a timely manner. This was one of the four pillars of the jubilee government when it came to power in its second term. This is an ambitious project noting that nearly 80% of the population do not have any form of insurance policy and the best they can manage is NHIF coverage.

Nutbeam (1998) defines health as "a state of complete physical, social and mental wellbeing and not merely the absence of disease or infirmity". Good health is a valuable resource that should be cherished always. fig 1 below shows the process that a patient undergoes.

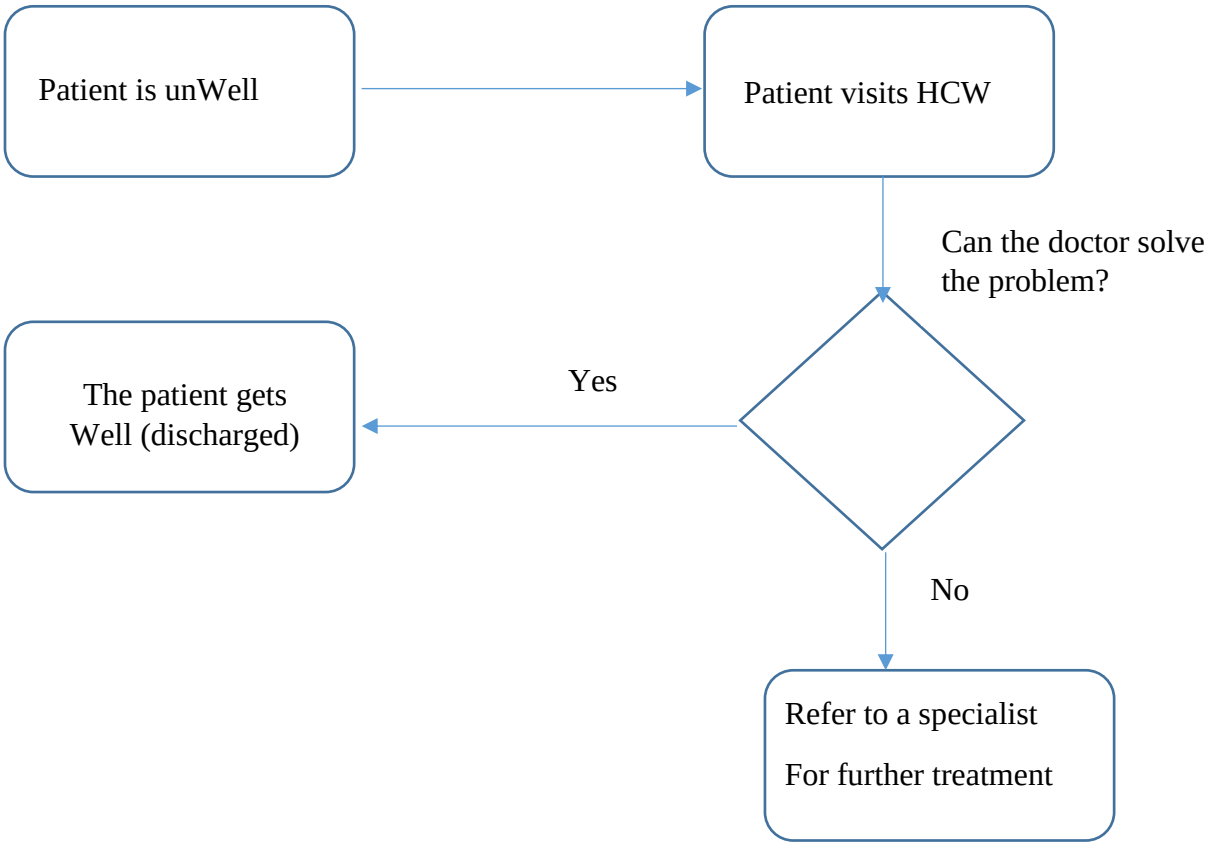


Fig 1: referral process

2.1 Levels of Health Care Facilities in Kenya

Public health aims at enhancing quality of life, prolonging life and improving health in the community (Nutbeam 1998). There are six levels of health care facilities in Kenya, namely:

LEVEL 1 – Community Facilities they are run by certified medical clinical officers and are at the community level. They offer basic services and are sparingly equipped.

LEVEL 2 – Health Dispensaries they are the primary care facilities run by clinical officers (COs): they comprise of clinics, health centres, dispensaries and maternity homes. The dispensaries in the cities act like a health centres in level 3, difference being that dispensaries do not have in-patient facilities.

LEVEL 3 – Health Centers these are small hospitals with minimal facilities, even though they offer services like the big hospitals being run by at least one doctor, clinical officers and nurses.

LEVEL 4 – County Hospitals they are hospitals that offer holistic services and are ran by a medic director. In many counties there's just one hospital and in principle offer the same services as the Level 3 hospitals, plus X-Ray services. For cases they can't handle, they issue referral letters to other higher level facilities (level 5 &6).

LEVEL 5 – County Referral Hospitals

Formerly referred to as provincial hospitals and are run by CEOs who are medics by profession and have over 100 beds capacity for their in-patient. In Nairobi Mama Lucy Hospital and Mbagathi Hospital (under KNH) both double up as county referral hospitals and Level 4 hospitals.

LEVEL 6 – National Referral Hospitals

In Kenya there are five Teaching and Research referral hospitals: Mathari Hospital, Kenyatta National Hospital, Moi Teaching and Referral Hospital, Kenyatta university referral hospital and the National Spinal Injury Referral Hospital. The range of services is the same as those of Level 5, but they offer specialized treatments.

Mathari hospital is a specialized national referral mostly focusing on specialized mental services while Kenyatta National Hospital and Moi Teaching and Referral hospital offer specialized consultations in curative care.

National Spinal Injury Referral offers specialized services in orthopedic and spinal injuries.

The national government manages these three hospitals.

Comparison of Services offered in different levels of health facilities

Level 1	Level 2	Level 3	Level 5
Treatment of minor ailments like diarrhea	Outpatient services	Maternity in-patient services with a ward	Ultrasound
TB screening, home visits and contact tracing	VCT services	Curative services	CT-Scan
Screening of malnutrition	Tuberculosis (TB) services	Laboratory services	Surgery
Malaria testing.	Laboratory Services	Dental	Pharmacy
Blood pressure and blood glucose testing	MCH Baby Clinics	Counselling	Physiotherapy
VCT HIV & AIDS testing	Antenatal and Postnatal services	Pharmacy	Orthopedics
PreNatal and PostNatal care	Pharmacy	TB Clinics	Occupational Therapy
Issuance of referral letters to other facilities	Counselling services	Diabetes & hypertension clinics	They issue referral letters to Level 6 facilities
	Curative treatment	HIV Care	
	issue referral letters to other facilities	Baby well clinics	
		Antenatal and postnatal services	
		They issue referral letters to other facilities	

Table 1: Level 1-3 health facilities

British Journals of marketing studies (2002), states that most physicians receive inadequate training on how to refer and provide feedback to the relevant stakeholders in order to enhance monitoring and evaluation. Feedback is of essence in order to provide accountability.
Study of electronic medical records (EMRs) is very vital in determining the procedures used by healthcare facilities in coordinating referral processes. There is need for a follow up documentation so as to monitor a patient's progress in this referral chain.

The Health Referral Chain

Different levels of healthcare (public, private and Faith Based Organizations) offer different care based on how equipped they are and therefore higher level facilities (Levels 4 & 5) offer referral services for lower levels (Levels 1, 2 & 3).

Normally, a patient is referred to the next level healthcare facility but in case of emergency, there may be referrals from lower level facilities direct to county referral facilities.

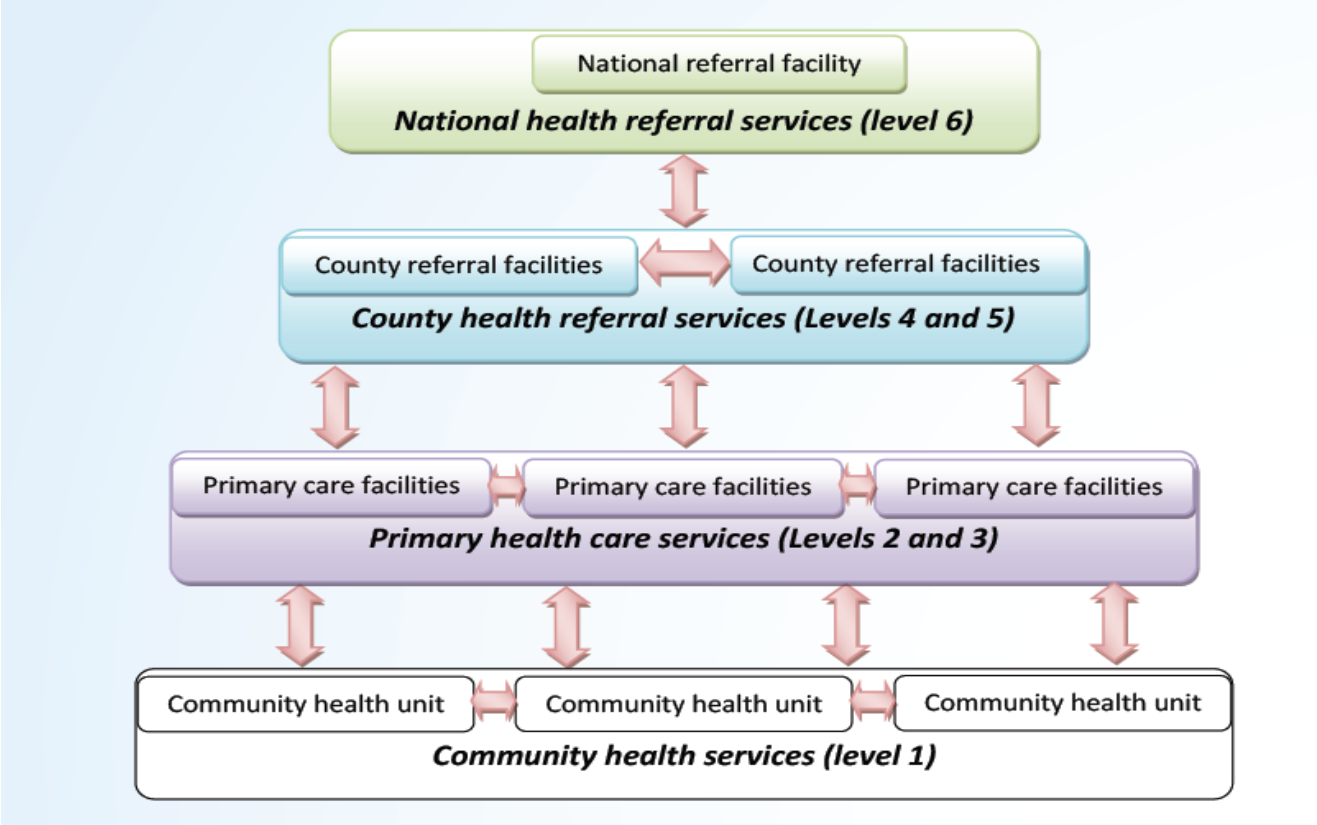


Figure 2: Referral linkages between different levels of care. Source: MOH REFERRAL GUIDE 2014

Reasons for Referral

Below are some of the referral reasons:

- To seek specialized care for chronic acute condition such as diabetics.
- To get additional services not available in other facilities.
- To seek on the clock inpatient care for acute illnesses.
- To seek a different specialized opinion and diagnosis.
- To respond pandemics such as covid19.
- To test client specimens with available modern equipment.

Referral Coordination Structure

The referral coordination unit runs across both the national and county levels and is under a coordinating team as shown below.

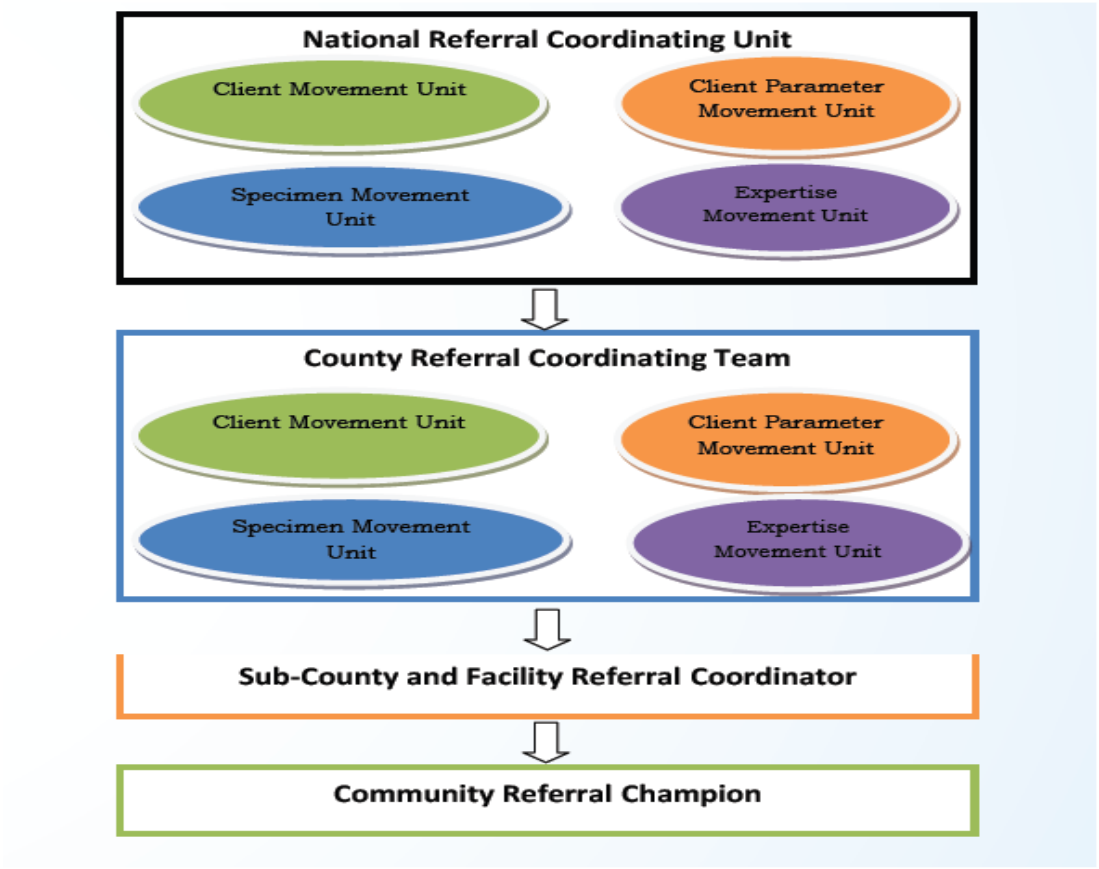


Figure 3: Coordination of the referral system. Source MOH Kenya Referral Strategy 2014

2.2 Characteristics of a Referral System:

Linking the different levels of healthcare facilities is very crucial in managing patient follow up. This ensures proper monitoring and one can be able to evaluate the patient's progress and can be able to trace any issue that may arise in between. Referral hospitals are of higher statue than the preceding healthcare facilities in terms of facilities, expertise and emergency service delivery. All healthcare facilities are linked together and the chain of referral strictly observed.

Patients that seek medical attention from level one hospitals will be referred to level two hospitals. Those in level two to be referred to level three and so on. This ensures that level five and six hospitals are not over worked by providing services that could be easily taken care of at lower facilities. But depending on the patient condition, then it will be possible to refer a patient to a higher level by jumping other intermediate levels. For example a patient who is diagnosed

with cancer at level one can directly be referred to level five hospital that has the necessary facilities.

Patients are referred to the next level by their healthcare practitioners by use of a referral slip detailing the patient's medical condition and the specialized care being sort. Previous diagnosis and tests done to the patient should be stated in details. This enables tracking of the patient's diagnosis and referring to doctor's notes. Lower level health facilities should be updated on a regular basis on the patient progress so as to enable conduct a follow up when the patient returns to the lower health facility in future.

2.2.1 Objectives of the referral strategy according to Kenya Health Sector Referral Strategy 2014–2018.

MOH Kenya estimates that most of the Kenyan population is either peri-urban or rural with a low income and no medical insurance cover other than NHIF. KHSRS 2014 ensures that health care policies are implemented in the following ways:

- "Coordination and standardization of referral services
- Continuity of care across the different levels of care
- Cost-effectiveness of health services provided to Kenyan citizens
- Promotion of universal coverage and equity in provision of health services
- Health care planning through performance monitoring of the referral system"

2.2.2 Electronic Health Record EHRs

An electronic health record is patient health information stored in an electronic manner in a computer device for ease of access. It contains the patient's demographic data, clinical history medication and allergies, immunization status, vital signs, laboratory test results, progress notes, radiology images, and billing information and other relevant data that regard to the patient and can be shared in different setups and transferable in a network information system.

The main objectives of EHRs are: order management, patient support, administrative reporting and decision support.

Goals and objectives of electronic health records

A workshop held in South Africa (2007) made a report that formed the basis of the National Strategic Framework for EHR in South Africa. The Department of Health defined the goals of the EHS as:

- To integrate health record systems in the country by bringing together all the different health information systems
- To develop a population health care base
- To improve governance, planning, administration and management of health systems at all levels
- To improve the efficiency of health service delivery both personal care and public health services
- To enable national monitoring and evaluation of health trends
- To achieve comprehensive privacy and confidentiality requirements of the citizens

Definition of e-Referrals

To refer is ―to direct someone to somebody or someone else for information, help, treatment or judgment. e-referrals means the transmission of an electronic document, such as a text document or PDF which can be received and viewed by the referee on their computer. This enables for a seamless transfer of patient's clinical data from one healthcare provider to secondary health provider / practitioner.

2.3 Related Works

In the literature review, the researcher looked at some of the already implemented eReferral systems in Europe and USA such as:

Country		Project Name	Country		Project Name
1	Finland	Oulu region	4	Canada	Manitoba eReferral
2	Denmark	Medcon	5	Australia	Brisbane Ereferral BISEP
3	Scotland	Scottish CIG	6	USA	SFGH, Mayo clinic, HCA

Table2: related work

2.3.1 USA - HCA (Hospital Corporation of America)

HCA has 163 hospitals throughout USA and England and incorporates AirStrip mobile app that enables physicians to view real-time ECGs electrocardiograms and access patients' data on their smartphones. AirStrip promotes quality patient care and enables remote monitoring technology such as during labour and delivery (Suzanne wiesner). This system allows improved communication between nurses, physicians and caregivers to monitor patients and immediately respond to patients' needs according to Rockdale Medical Center in metro Atlanta.

The advantages of this system is that it shortens consultation time, reduce ICU length of stay and reduce unnecessary hospital admissions. Cardiologists can use this system to remotely review, edit and confirm ECGs.

Fig 4: AirStrip mobile app source: AirStrip.com

2.3.2. Ghana DHIMS

Ghana health service has set up an eHealth strategy in 2010 aimed at improving access to healthcare services in remote or rural areas thereby reducing the wait-time for medical treatment. HINARI enables doctors in Ghana to gain access to a large pool of biomedical and health literatures for its referral cases. DHIMS 2 - District health Information Management System,

was developed to aggregate nationwide data in response to realtime reporting thereby improving data collection, reporting and analysis. DMIS2 has an electronic database, enable report generation, GIS Interface and graph capability. There are over 22 ehealthh projects in Ghana (Afrikumah 2014) most of them donor funded that are aimed at service delivery. Such systems include Motech, Onetouch medicareline, Moorfields Eye Hospital, Mobile teledermatology, eHealth Initiative, Mahiri Mobile, **Kenko Doctors** among others.

2.3.3. Egypt – DrBridge

Egypt has an estimated population of 95M (WHO, 2016) with a total expenditure on healthcare per capital standing at $594 and health expenditure of GDP being 5.6 (WHO 2014).

The Egyptian startup company DrBridge launched its first eReferal booking app that aimed at linking patients and doctors for effective service delivery. The app enables generation of patient EMR, measurement of clinical performance, enables doctors to make digital reports and view patient history. The vezeeta app make appointment booking easy by essentially listing available appointments as per doctor and thereafter sends a text to the doctor confirming the appointment. Upcoming features include: reminders, chat, followups and sms text messages.

2.3.4 Uganda - Medikwick

Mediwick app is used in Uganda by patients to find doctors nearby and allows them to make online bookings. The patients browses for available doctors and choose one of interest to them and also one can have access to other healthcare services such as ambulances, etc. This ease of access to qualified medical personnel has reduced the number of self-diagnosis and treatment at homes

2.3.5 Nigeria – DokiLink & Lafiya

Nigeria has an estimated population of 185M (WHO, 2018), with a gross national income per capital of $ 5,360 and a total expenditure on health per capital of $ 217 (WHO, 2014).

DokiLink is a Nigerian startup company that enables an online booking platform for patients to browse doctors and book appointments. The system has a doctor's calendar that enable patients to search for available slots and the doctor receives a notification of successful appointments.

Lafiya telehealth services apart from providing booking services also provides video and voice chats consultations home and community health services and digital prescriptions.

Comparison of eReferral systems

The researcher made a comparison of data content and clinical value between electronic system and paper based referral system.

	eReferral system	Paper based referral context
1.	Ease of booking- all you need is a smartphone with internet connection.	You have to present yourself to a healthcare facility for manual booking
2.	Saves time taken to make a booking, since there are no long queues waiting for a human to book you	Long queues, long distances and inconveniences are encountered when going to health facilities to book appointments.
3.	Less cost involved, such as transport cost to the health care facility are eliminated.	There is wastage of time and money due to the time taken to travel to health facilities.
4.	Less redundancy- data duplication is reduced	Cases of data duplication are common
5.	Fast searching – it's easier to search for a given record even in a large pool of data	Manual process of searching for a given record is cumbersome.
6.	Calling specialists to discuss patient condition	There is only physical meeting between a doctor and their patients.
7.	Automated routine booking is possible	Each subsequent booking is done manually and updated on a book
8.	Ease of patient follow-up management	Paper trail is hard to follow
9.	Ease of rectifying data	Hard to change records wrongly entered
10.	Availability – data is available 24x7 and accessible from any location.	Data is available on master copy book and the only way to get this data is by duplication in hardcopy
11.	Urgent specialist appointment is possible and the doctors are instantly notified.	No automatic notification of appointments to the doctors

Table3: Comparison of eReferral systems

Thus, from the above comparison, the eReferral system has more merits than the paper-based system in all aspects. eReferral systems have the advantage of improved monitoring, availability of data on the fly unlike the paper-based system.

Decision Support Systems (DSS)

Decision support systems DSS are interactive software-based systems intended to help system users in decision-making by accessing large volumes of information generated from various related information systems involved in organizational business processes. DSS uses the summary information, raw data, documents, personal knowledge, and/or business models to help in decision-making and solve problems.

In the case of uncertainty modelling approach, various mathematical approaches have been developed such as the Fuzzy set theory (Zadeh, 1965), rough set theory (Pawlak, 1982) and Bayesian network (Spiegel halter, Myles, Jones, & Abrams, 1999). However, the fuzzy set theory is considered the best-suited method in handling linguistic uncertainties (Zadeh, 1972).

Fuzzy logic and rule based approach are tools used to represent different forms of knowledge in a fuzzy rule-based eReferral system with the fuzzification approach leading to better outcomes compared to the conventional practice. Mostly, doctors in emergency rooms usually refer their patients to other experts, thus establishing the need for practical guidelines in decision making.

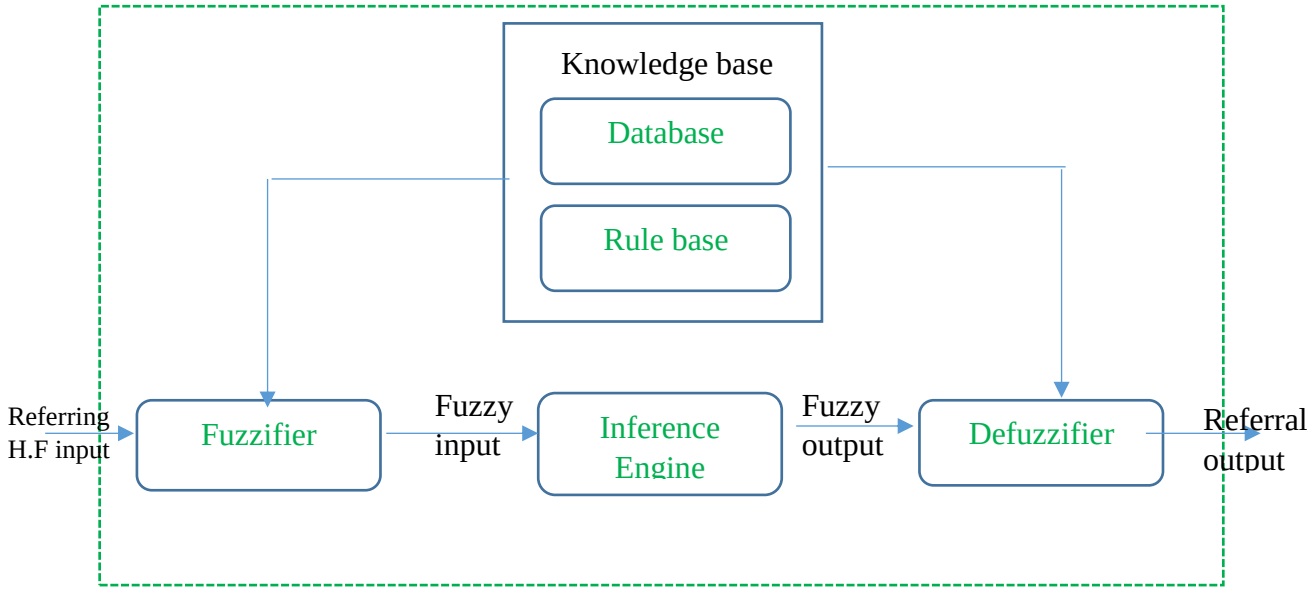


Fig5: DSS

Fuzzy Expert System for Patient Referral

From literature, the utilization of fuzzy rule-based method as a decision support system for electronic referral were explored, and has four main components namely; the knowledge base, the fuzzification, the inference engine and defuzzification . Knowledge is developed based on clinical data and observations, medical diagnosis expert opinion.

There are many suitable methods to develop an Expert System, however for referral process, the rule-based deduction method is considered, due to the following existing criteria of the case problem:

- Need to identify the nearest hospital from the current healthcare facility.
- Nearest healthcare facility with the necessary medical equipment facilities
- Nearest healthcare facility with the required specialist
- Nearest healthcare facility with a vacant bed.

Knowledge Acquisition and Representation

Knowledge Acquisition is a process of extracting, structuring and synchronizing knowledge that was gathered from various sources such as by experts in the domain of interest, textbooks, technical papers, databases, reports and the environment. The process of Knowledge Acquisition on eReferral information began with self-reading on the issues of eReferral by researching information from the internet, as well as referring to medical books and journals.

Fuzzy Inference Engine

The inference engine is used to make an inference or reasoning by mapping inputs to a particular output by use of fuzzy logic by determining the rules that are needed for selection by matching the knowledge base. More than one inputs are used in combination with the antecedent part of IF-THEN.

Fuzzification determines to what extent an input data belongs to a given fuzzy set through the membership functions. This can be done using singleton fuzzifiers, Gaussian fuzzifiers, and trapezoidal or triangular fuzzifiers by mapping inputs into fuzzy set with different membership functions.

Defuzzification Process

Defuzzification is the last step in this process and involves coming up with a result/ output by use of a centroid or maximum defuzzifier method. As the aggregation output is defined within a range value, the defuzzification process is required to resolve the issue by offering a recommended referral healthcare facility based on the supplied factors.

Modelling Decision support system

Expert Systems use AI and a DB of expert knowledge which helps in machine learning by processing human language and reasoning based on some rules presented. Expert systems help in making informed decisions, analysis, estimating strategies among others.

Expert Systems can be classified into two; those that based on rules, known as rule-based expert systems, and those that based on probabilistic graphical models or normative systems. Rule-based expert systems uses prior knowledge based rules in decision making by taking knowledge from human experts such a medical personnel in terms of rules and converting it into rules for data input to reproduce the expert's problem solving in a given domain..

Probabilistic expert systems incorporate the usage of statistics and AI Rule-based by using database management systems and knowledge-based systems (KBSs) with the DBMSs being used for storing, retrieving, manipulating patient data. Expert Systems are used to perform diagnoses based on patient data since they represent the way experts' reason and provide solution to problem at hand (Mahesh, 2009).

DSS system can be modelled by use of Rough set theory (Pawlak, 1982), Bayesian network (Spiegelhalter, Myles, Jones, & Abrams, 1999) or by Fuzzy logic theory (Zadeh, 1965). Fuzzy theory combined with rule-based approach is a better option since it does not depend on a binary number 1 or 0 for true or false but can have an in-between result such as 0.48 for instance.

The necessity of the fuzzification approach in medical diagnosis Expert Systems is to overcome the problem of capturing subjective or ambiguous evaluations that are made in medical diagnosis leading to better outcomes (Ali & Singh, 2010).

Knowledge Acquisition Process

The knowledge base is the repository of the expert system since all the essential facts for constructing the rules are contained in the knowledge base. This knowledge is main source of rules for the Expert Systems. The knowledge is represented in the form of rules.

Table 1: Rule-base for the proposed DSS

1. IF (disease severity high) THEN refer
2. IF (commodities) THEN refer
3. IF (No specialized medical facilities) THEN refer
4. IF (no specialized personnel) THEN refer
5. IF (presence of a bed) THEN refer
6. IF (HCW Recommend) THEN refer
7. IF (condition deteriorates) THEN refer

Knowledge Representation (KR)

Knowledge Representation involves designing computer based representations verified and gained through knowledge acquisition, to solve complex problems. The knowledge gathered is presented in the form of a mathematical formulation consisting of fuzzy sets, function and fuzzy rule-based engine.

Model Development

A sample model was developed based on fuzzy set theory and rule-based Expert System. The model consists of a fuzzy knowledge base, an inference engine that includes fuzzification, fuzzy inference rule, and defuzzification.

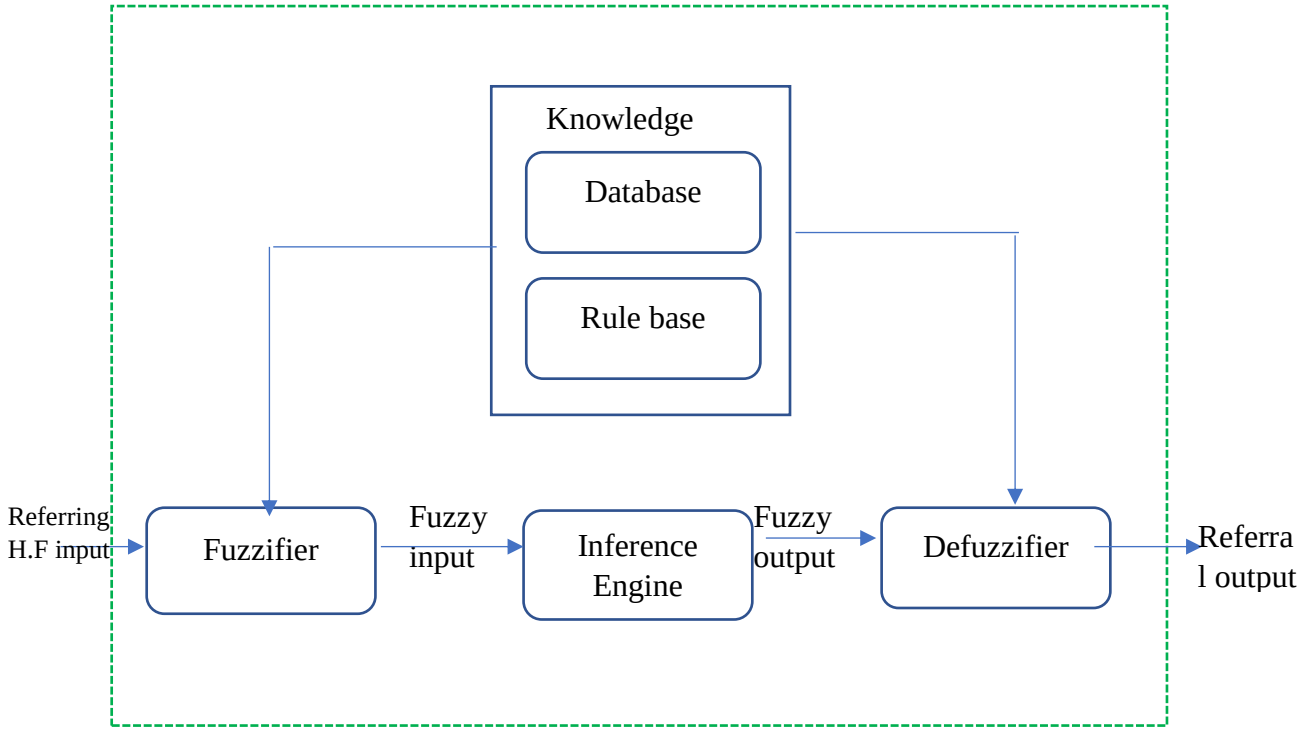


Fig 6: system components

Fuzzy Knowledge Base

The fuzzy knowledge base was developed with the help of the medical experts' past experiences as well as references to the current referral guideline. The rules were written in the format of <IF (antecedent) THEN (consequent)>. For example, *if (patient has underling conditions) AND (patient's condition deteriorates) AND (Health facility has no specialized personnel) AND (Health facility has no specialized equipment) THEN (Refer patient).*

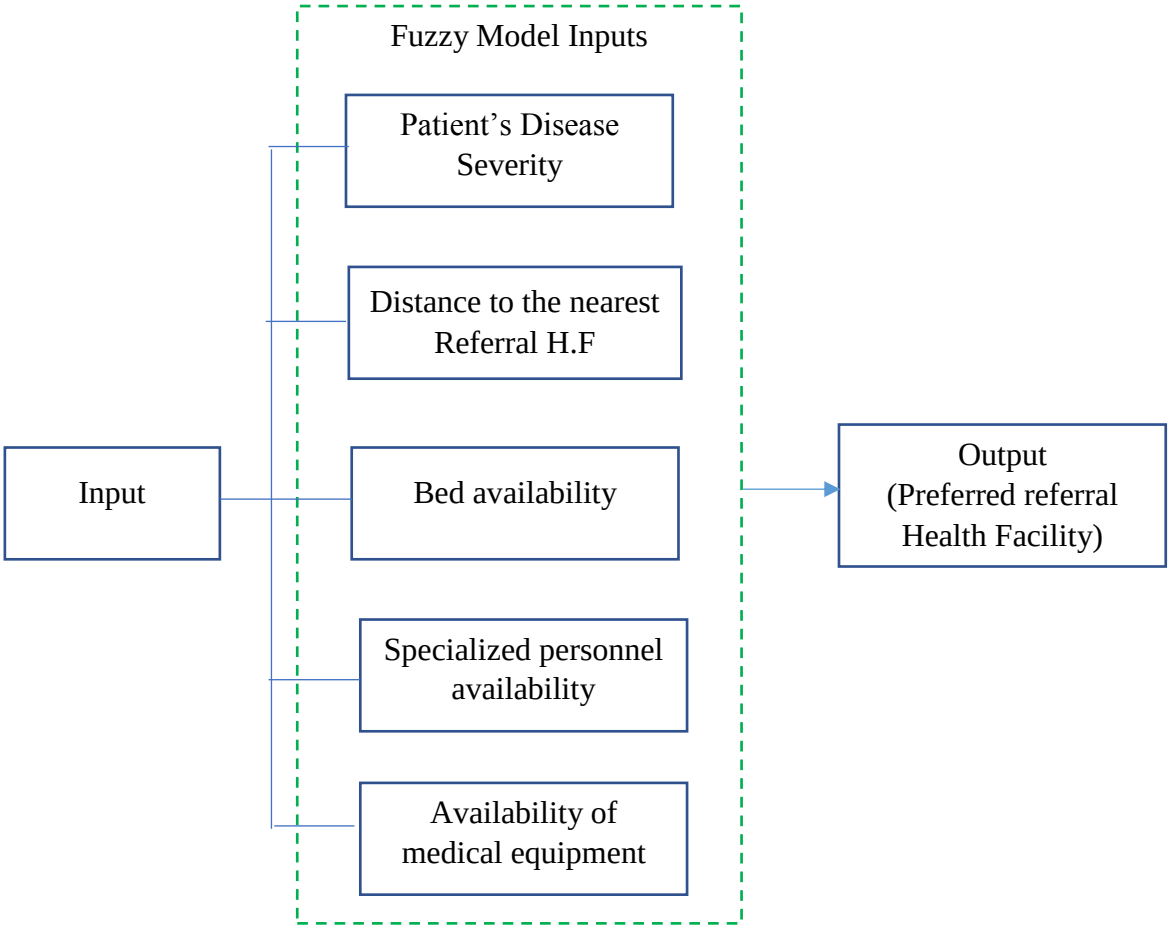


Fig 7: systems input variables

Fuzzification Process

The system input variables are transformed into fuzzy sets. Fuzzification process determines the linguistic variables (words uttered naturally) and membership functions of each fuzzy set in the range of 1 and 0. Below are the linguistic variables for each fuzzy variable:

- disease severity high {severe, not severe}
- commodities {underlying condition, no underlying conditions}
- specialized medical facilities {available, not available}
- specialized personnel {available, not available}
- presence of a bed {available, not available}
- HCW Recommendation {refer, not to refer}
- condition deteriorates {stable, worse}
- nearest referral hospital {close, moderate distance, far}

Theoretical Framework

2.4 Theoretical models that have been studied in connection to Referral and healthcare acceptance.

2.4.1 Guiding frameworks

The review was conducted under the guiding framework of Anderson's behavioral model developed by Ronald M. Andersen in 1968 and is now in its 6th revision. This model of health services utilization, has been widely used as a conceptual framework for understanding access to and utilization of health services.

The second model that was reviewed was the Health Belief Model developed by social psychologists Irwin M. Rosenstock, Godfrey M. Hochbaum, S. Stephen Kegeles, and Howard Leventhal at the U.S. Public Health Service in the 1950s.

The third model that was reviewed was the Theory of Reasoned Action/Planned Behavior that represents a social psychological approach to understanding and predicting the determinants of health behavior. Its states that the intention to do a given behaviour is determined by the actual performance of that behaviour since behaviour is under volition control and people are rational beings.

2.4.2 Andersen healthcare utilization model

The **Andersen healthcare utilization model** was developed by Ronald M. Andersen in 1968 to demonstrate the factors that promotes utilization of health services. Use of health services is a function of their predisposition to use services, ie factors which enable or impede use, and their need for care. The adoption of health services is mainly determined by three factors namely: predisposing factors, enabling factors, and need. Predisposing factors can be characteristics such as race, age, and health beliefs. For instance, an individual who believes health services are an effective treatment for an ailment is more likely to seek care. Need represents both perceived and actual need for health care services.

The motivation for this model development was to offer measures of access based on the presence of enabling resources, allowing the individual to seek care if needed. Realized access is the actual use of care. Equitable access is driven by demographic characteristics and need whereas inequitable access is a result of social structure, health beliefs, and enabling resources.

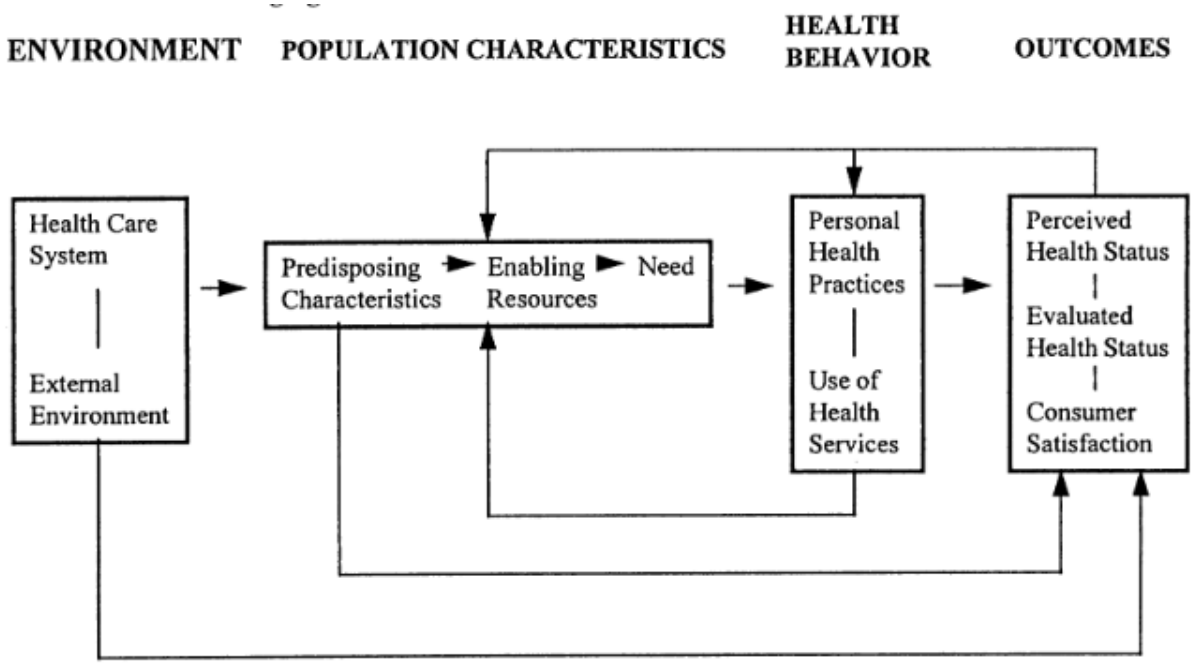


Fig 8: ***Andersen healthcare utilization model***

2.4.3 The Health Belief Model

The Health Belief Model is used to explain and predict individual changes in health behaviors. This model focuses on individual beliefs about health conditions, which predict individual health-related behaviors. It defines the key factors that influence health behaviors such as an individual's perceived threat to sickness or disease (perceived susceptibility), belief of consequence (perceived severity), potential positive benefits of action (perceived benefits), perceived barriers to action, exposure to factors that prompt action (cues to action), and confidence in ability to succeed (self-efficacy).

Considerations for Implementation

The five key action-related components that determine the ability of the HBM to identify key decision-making points that influence health behaviors are:

- Conducting a health needs assessment to gather information to determine who is at risk
- To help understand perceived severity associated with risk behaviors in a clear and unambiguous manner.
- Highlighting the benefits to action by communicating to the steps that are involved in taking the recommended action
- Identifying and reducing barriers to action by providing assistance
- Providing support that enhances self-efficacy and the likelihood of successful behavior changes.

These actions represent key elements of the HBM and can be used to design or adapt health promotion or disease prevention programs. It is important to identify "cues to action" that are meaningful and appropriate for the target population.

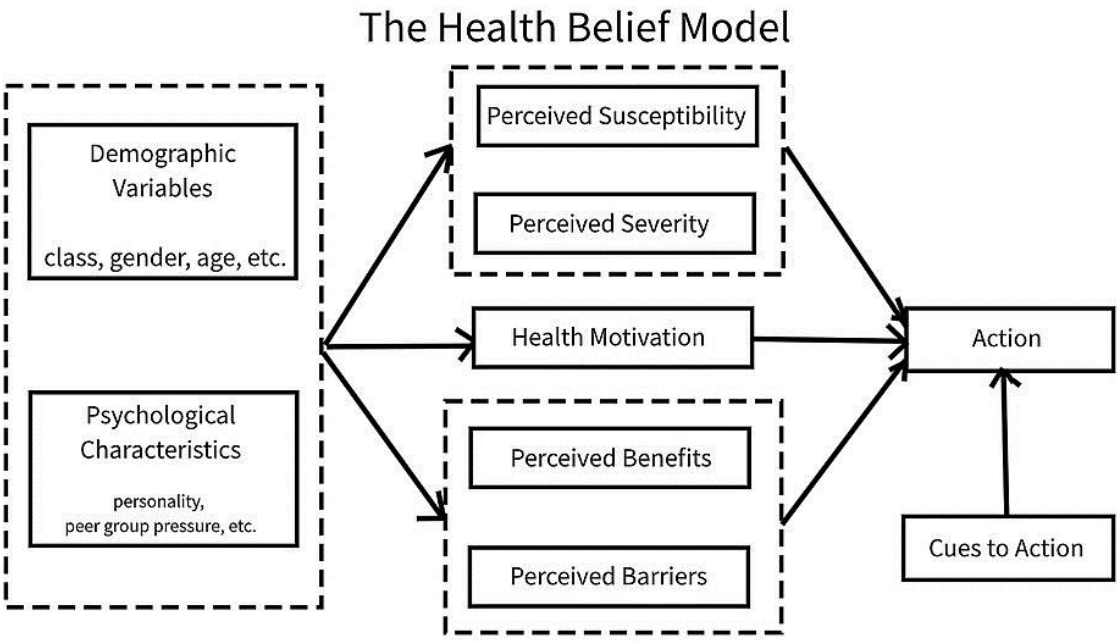


Fig 9: health belief model

2.4.4 The Theory of Reasoned Action (TRA)

Reasoned action approach integrates prediction and change of human social behavior. It states that "attitudes towards the behavior, perceived norms, and perceived behavioral control determine people's intentions, while people's intentions predict their behaviors" all based on beliefs. Attitude is the result of the strength of behavioral beliefs reflecting positive and negative outcomes.

Table 4: TRA

Constructs	**Description**
Behavioral Intention	Perceived likelihood of performing the behavior
Attitudes	The product of the behavioral belief multiplied by its evaluation
Behavioral Belief	Evaluation of the likelihood that performance of the behavior is associated with certain outcomes
Evaluation of B.B.	How good or how bad those outcomes would be
Subjective Norm	The product of the normative belief multiplied by the motivation to comply
Normative Belief	Perception of how much each personal contact approves or disapproves of the behavior
Motivation to Comply	Motivation to do what each personal contact person wants
Perceived Behavioral Control	The product of the control belief multiplied by the perceived power
Control Belief	Perceived likelihood of each facilitating or constraining condition occurring
Perceived Power	Perceived effect of each condition in making the performance of the behavior easier or more difficult

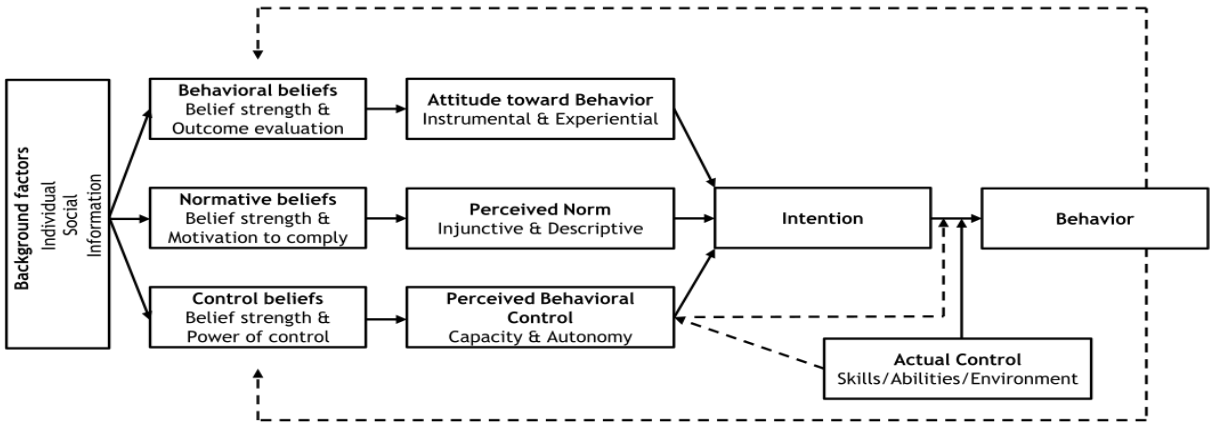


Fig 10: TRA

2.5 Conceptual framework

The researcher integrated the Anderson and Adey model with the health belief model to understand patients' referral behavior in analyzing health services utilization (Andersen RM, 2008). **Individual beliefs** include patients' perceived severity of disease, their trust in primary care providers in terms of actual quality of care provided, perceived barriers and self-efficacy.

Perceived barriers to obtain better and specialty care is one predictor of patient preference for higher-level hospitals. Patients may tend to proactively seek higher-tiered hospitals due to social class and income. Other factors include distance to the nearest county hospital, and the availability of bed capacity.

At **the individual level, predisposing factors** reflect influences coming from four aspects of life: demographics (sex, age, marital status, and household size), social factors, genetics, and beliefs. Women unlike men tend to utilize healthcare system even in the least of situations whereas men tend to brush off medical conditions as being petty till conditions worsen.

Individual-level enabling factors include two categories: financing and organizational factors. The most important financing factors include income and health insurance coverage. Wealthier individuals use significantly more healthcare resources than their less-wealthy counterparts.

Organization of health services is determined by availability of a regular source of medical care or transportation to that source. Most facilities don't have medical ambulance vehicles and patients rely on personal means such as boda bodas and matatus. The most commonly chosen measures in the reviewed studies were transportation, time and method.

Need Factors are self-perceived health status and health status evaluated by medical professionals. Because the severity of illness is one of the most important factors that affects healthcare utilization.

Conceptual framework

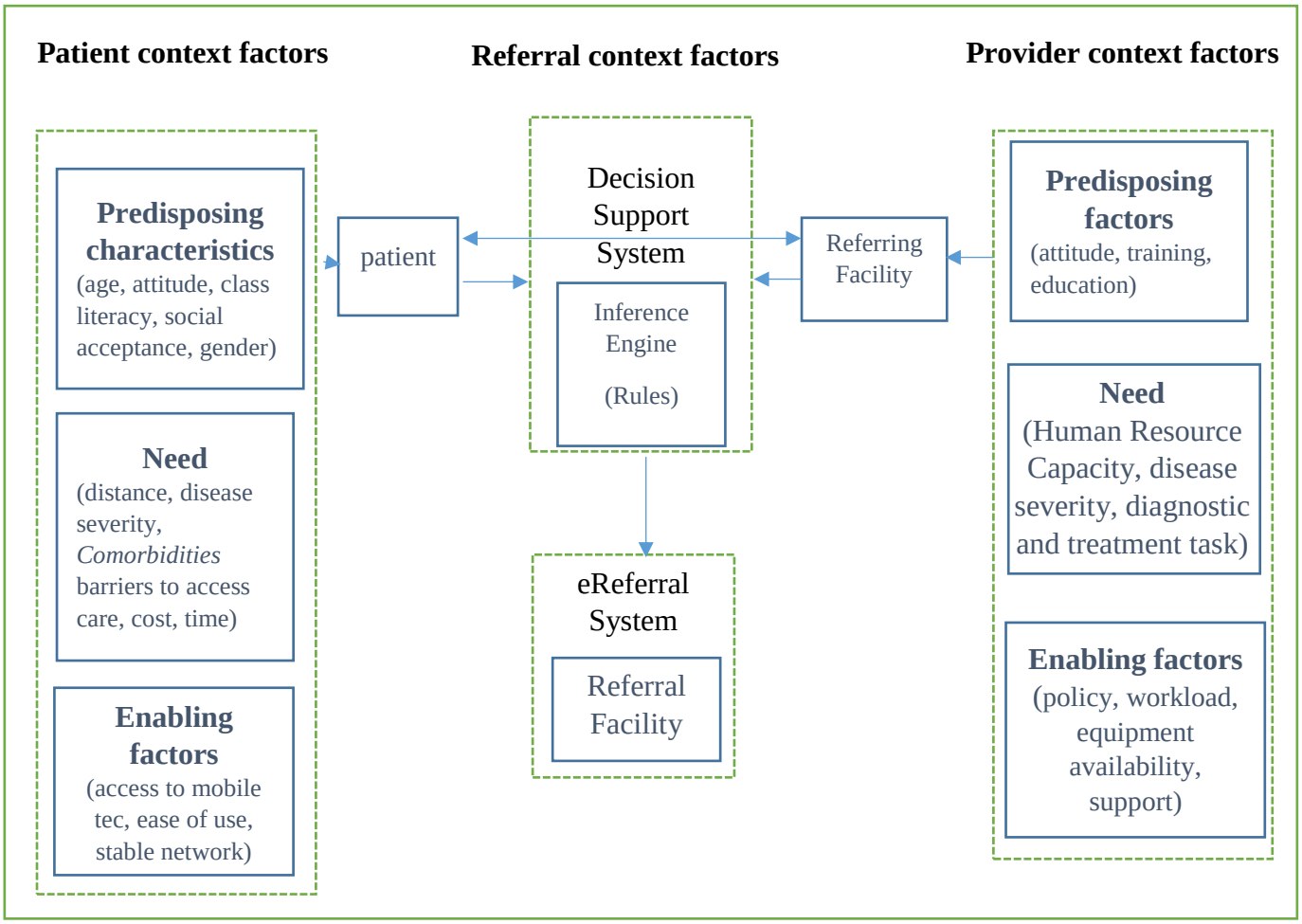


Fig 11: conceptual framework

2.6 Conclusion

Perceived Benefits. Even though a person may have a serious health condition (perceived threat), whether this perception leads to behavior change will be influenced by the person's beliefs regarding perceived benefits of the various available actions for reducing the disease threat. Financial wellbeing also determines whether someone is likely to seek medical interventions or not. Thus, unless these individuals accept that the perceived actions are potentially beneficial in reducing the threat, that's when they will seek help.

Perceived Barriers. Negative aspects of healthcare action may limit uptake of healthcare such as cost-benefit analysis when individuals weigh the action's expected benefits with perceived barriers. Andersen's model and his conceptualization of predisposing characteristics, enabling resources, and need helped to focus the analysis on the role of the context in explaining why eReferral interventions contribute to improved access.

This context has indirect influence on access to health services facilitated by eReferral interventions. At this stage, Davis's Technology Acceptance Model and his conceptualization of perceived usefulness and perceived ease of use contributed to understanding the mechanisms that link the context to improved eReferral based access to healthcare.

The two models of Andersen and Davis were then integrated into a framework for understanding the contribution of eReferral interventions to improved access to care for patients who required referral services.

The **context factors** influence the perceptions of patients and providers concerning how useful they find the eReferral intervention in comparison with other forms of service delivery, such as traditional face-to-face contacts or alternative computer-based telemedicine. Similarly, these factors also influence the perceived ease of use of eReferral in comparison with other options for service delivery. If interventions are perceived to be useful and easy to use, this will lead to the continuous use of eReferral interventions thereby leading to better patient access to care.

CHAPTER 3: METHODOLOGY

3.0 Introduction

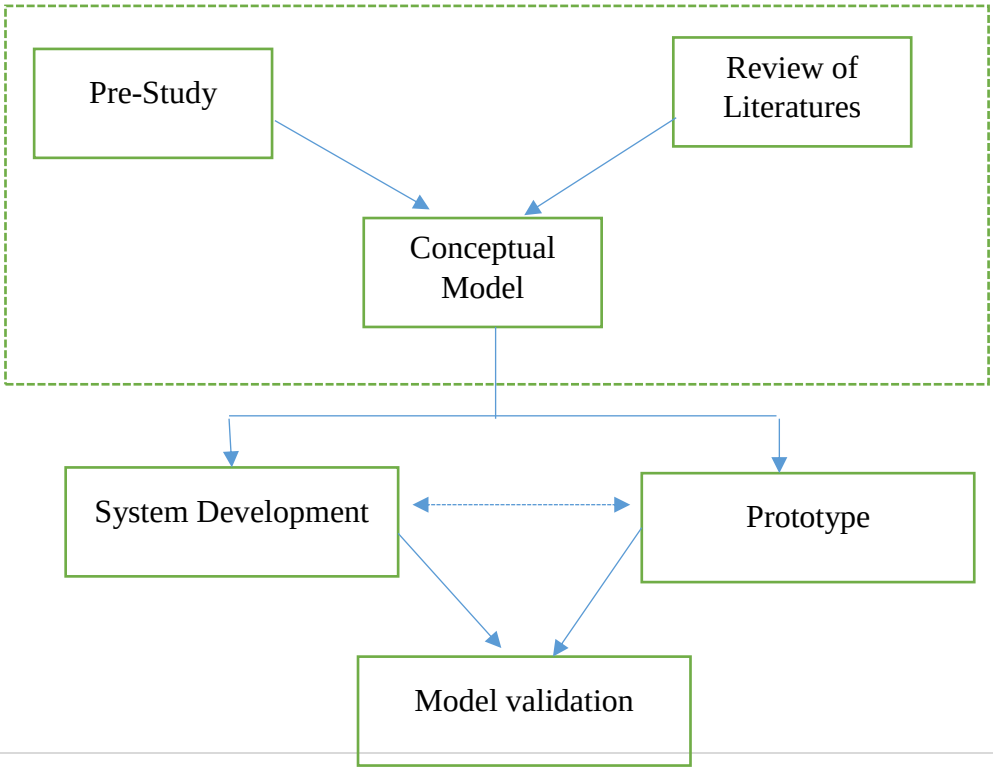
This chapter highlights the various research methodologies in conducting the study and the techniques to be used in obtaining research data and how data was processed to obtain the subsequent recommendations. The aspects to be covered in this chapter include the description of the study area, data sources and tools, data collection, processing and analysis.
In this chapter the researcher demonstrates the practical application of Anderson and Adey model with the health belief model by configuring appropriate technologies in ICT with healthcare. To translate the model to tangible results, we used human-centred design to develop an eReferral care prototype named *rufaaCare.*

The prefix ***Rufaa*** is a Swahili name for refer and care was gotten from the word healthcare which is taking care of the patients. The socio-technical approach used in this study was used to create a blueprint for designing a eReferral system in a low income setting.

3.1 Anderson and Adey model with the health belief model operationalization

A conceptual model was delivered from the literature review, pre-study experience and consultation with healthcare experts. A pre study was curried out to visualize the referral process in different referral healthcare facilities in Nairobi Kenya. The researcher interviewed different stakeholders. The ***fig 11*** below illustrates the process used to come up with the model.

fig 11 : *system operationalization*



3.1.1 System Development Blueprints

Davis and Venkatesh (2004) demonstrated that pre-prototyping usefulness of a system prior to implementation predicts its future acceptance and use. This study employed a similar model-driven approach to scale-up deployment of eReferal system that is usable. A **black box** software design was used in the initial stage whereby the researcher had to observe the behavior of the inputs and outputs.

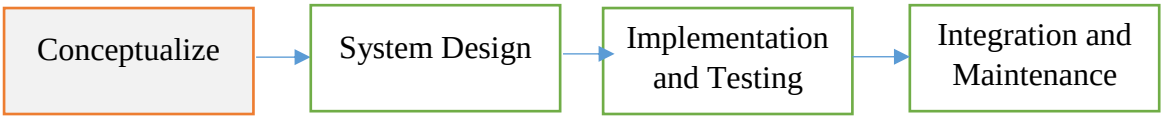


Fig 12: SDLC

3.1.2 Individual Characteristics Blueprint

Based on the literature review carried out, the new model incorporates a new aspect of Attitude and self-efficacy as factors that influence intention to use technology and the actual technological usage. Individual characterizes inform on the workflow outcomes.

3.2 The Study Area

Kiambu County is one of the forty-seven counties in Kenya, its part of the greater Nairobi metropolitan bordering Nairobi and Kajiado Counties to the South, Machakos to the East, Murang'a to the North and North East, Nyandarua to the North West, and Nakuru to the West. Kiambu County has twelve sub-counties and several wards within these sub-counties. Figure 13 below is a map illustrating the extent of the study area.

Fig 13: study area – Kiambu county Map

The proposed area of study is the Kiambu County. Kiambu County is also the capital city of Kenya with an estimated population of 2,417,735 (Kenya National Bureau of Statistics (KNBS), 2019), seated on an area of 696 Km2 and was founded in 1899. Table 2 below has listed down all the constituencies in the Kiambu County and the wards within each of these constituencies can be found in the appendix section.

Table 5: Kiambu sub counties

Sub – county		Sub – county	
1	Githunguri	7	Gatundu South
2	Kiambaa	8	Ruiru
3	Kabete	9	Kikuyu
4	Limuru	10	Juja
5	Lari	11	Thika Town
6	Gatundu North	12	Kiambu town

Table 6: Distribution of Population by Sex and Sub-County (KNBS 2019)

Sub-County	Male	Female	Intersex	Total
Gatundu North	54,189	55,678	3	109,870
Gatundu South	60,384	61,714	5	122,103
Githunguri	82,037	83,187	8	165,232
Juja	148,446	152,480	22	300,948
Kabete	97,794	101,845	14	199,653
Kiambaa	115,690	120,695	15	236,400
Kiambu	69,661	76,225	17	145,903
Kikuyu	90,919	96,198	5	187,122
Lari	67,061	68,238	4	135,303
Limuru	79,632	79,682		159,314
Ruiru.	180,947	190,144	20	371,111
Thika East	19,688	19,264	4	38,956
Thika West	1 2 0 , 6 9 8	125,104	18	245,820
Total	**1,187,146**	**1,230,454**	**135**	**2,417,735**

Health

The county has a total of 505 health facilities, of this 108 are public, 64 are faith based and 333 are private health facilities. Kiambu has 2,652 health personnel of different cadre with a doctor/population ratio of 1:6667, while the nurse population ratio is at 1;1110. The immunization coverage is at 89%.

HIV prevalence is at 5.6% below the national 5.9% (HIV estimates released in 2016) and the county is ranked 6th in terms of HIV burden

Table 7: Health Facilities by Ownership (MOH 2020)

	Government	***FBO**	**Private**	**TOTAL**
Hospitals	14	11	26	51
Health centres	33	8	0	41
Dispensaries	72	21	0	93
Clinics	0	0	147	147
Total	**119**	**40**	**173**	**332**

3.3 Research Methodology

This research work has three components that comprise of:

- Information gathering on the perceptions around patient referral – this enabled us to identify the issues that limit referral systems in Kenya.
- Design and development of a working prototype.
- Testing of the prototype – this enabled us test our concept around the use of technology in developing referral systems.

3.4 Information Gathering

This research study is based on information gathered on the perception of tracking referral cases and the use of technology in Kenya. The use of technology in this case refers to the use of computerized systems for referral cases from a lower hospital to a higher level hospital thereby enabling tracking and effective feedback mechanism.

For this research a mix of the qualitative, quantitative and the participatory research methods will be used to verify the hypothesis that technology can be used to efficiently and effectively handle referral cases. Questionnaires, interview guides and record analysis was used to collect data for this research.

3.4.1 Population and Sampling

Population

The objective of this research was to come up with a solution that will enable proper tracking and monitoring of patient progress in the referral chain thereby providing a positive feedback to the referring health facility. The study targeted health facilities in Kiambu County, which has over 300 health care facilities of different levels.

Sample Size

A sample is a subset of a population i.e the number of items to be selected from the entire population. The formula approaches to determining the sample size. The sample size for the participants was calculated using Yamane‟s formula (Yamane, 1967).

$$n = \frac{N}{1+N\,(E)^2}$$

Sample size for preliminary study is 100 Participants

3.4.2 Data Acquisition and Collection

The following data acquisition and collection methods were used for the collection of data for this study.

3.4.2.1 Interviews

Interviews were held at different levels of health facilities with different stakeholders such as nurses, clinical officers, administrators and record officers. This was to help understanding what structures and systems the facilities currently had in place, how they work, how effective they have been in the referral process and what future plans they have.

Face to face interviews were conducted and interviews were used to establish existing problems being faced.

3.4.2.2 Observation

The researcher took time to observe the working environment of the referral cases and was taken through the whole process from receiving a referred patient to recording them into the RIS. This involved carefully watching and listening to the different stakeholders in the process.

3.4.2.3 Questionnaires

For the preliminary study, closed and open ended questionnaire questions were used in this study. A series of questions was drafted to find out what are the challenges faced by patients and medical practitioners in regards to referral process. The researcher sort to collect such views and develop a system that would aid in making this referral process easier.

3.4.2.4 Document Review

Study and review of material from the different health care facilities was vital in that it helps to have a feel of how the process works. This method was used to determine the benefits and challenges and the data collected using this method was used to forecast what benefits the healthcare facilities could gain and what challenges it could face with the introduction of the new system.

This involved analyzing existing information found on published literature, healthcare documents and related websites. The data collected was mainly on SOPs and the existing hospital Management Systems.

3.4.3 Data Analysis and Interpretation

The data collected for both the preliminary and the prototype testing was both quantitative and qualitative and a statistical analysis using Statistical Package for Social Sciences (SPSS) was performed. Results of the pre-study were analyzed and lead to the formulation of the research objectives and questions. For the qualitative analysis, the text data obtained through the interviews, questionnaires, observations and documents reviewed was coded and analyzed for themes to enable analysis using SPSS.

3.4.4 Ethical Considerations

Before conducting this study, the respondents were informed of what the research project was about, its research goals and objectives and they gave their consent before filling in the questionnaires, answering interview questions and taking part in group discussions. All respondents were guaranteed confidentiality since they did not identify themselves using their names on the questionnaires.

Formal clearance was received from University of Nairobi as well as Kiambu County Health Research department, head of the institution where the study was carried out. The researcher explained to the respondents about the research and that the study was for academic purposes

only. The participants had informed consent to make the choice to participate or not. They were guaranteed that their privacy was protected by strict standard of anonymity.

3.4.5 Summary of Methodology used

Objective	Methodology
Research Objectives	
To understand the referral process, challenges and implementation by the healthcare facilities.	Survey (Interviews, Questionnaires, Focus Group Discussions, Immersion)
To identify merits for using ICTs to improve the referral system in Kenya.	Survey (Interviews, Questionnaires, Focus Group Discussions), Document Review
System Objectives	
To create and maintain an eReferral MIS to enable tracking of patient progress and feedback.	Rapid Application Development and SOA methods to come up with a MIS prototype
To test the concept of acceptability of the eReferral system by the users.	Use of SMS technologies to create awareness and provide education Questionnaire to test if the prototype meets eReferral needs.

Table 8: Objectives and Methodology

3.5 System Design and Development

In order to successfully develop the proposed system, WATERFALL methodology, which is a linear approach to software development, was used. A true Waterfall development project follows distinct stages of software development, and each stage generally finishes before the next one can begin.

Davis and Venkatesh (2004) demonstrated that pre-prototyping usefulness of a system prior to implementation predicts its future acceptance and use. This study employed a similar model-driven approach to scale-up deployment of eReferal system that is usable. A **black box** software design was used in the initial stage whereby the researcher had to observe the behavior of the inputs and outputs.

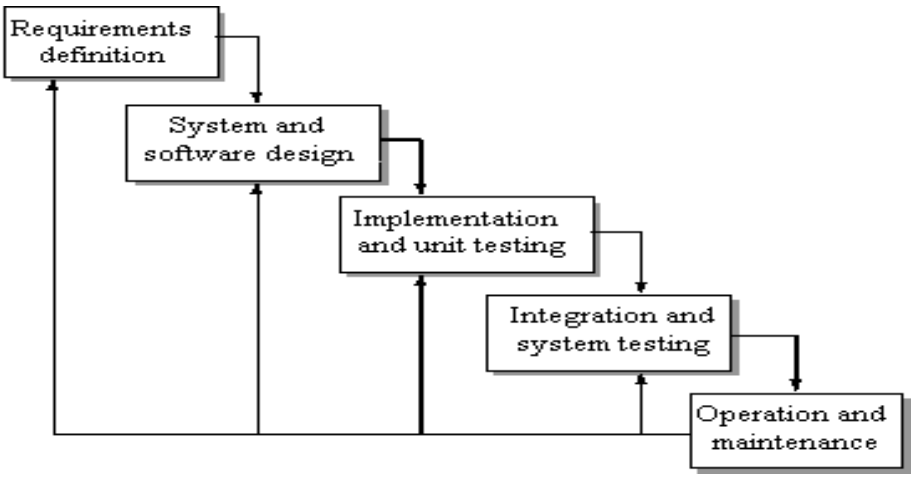


Fig 14. Iterative waterfall model

Data collected from phase 1 was used in deriving the design principles of the system. According to British hypertension society it is impossible to provide a definition of hypertension as BP is a continuous variable within the population, having a skewed normal distribution. As a result in the design stage, the following parameters were used as the yardstick to measure the hypertension level of the patient.

3.6 Pilot-Testing of the System

3.6.1 Performance Testing

Mobile application performance on mobile devices is of great essence in any device and is measured in three categories:

- ✓ Device performance
- ✓ Server / API performance
- ✓ Network performance

Device performance:

1. **App startup:** how long does the app take to start up. This is the first performance parameter that the user uses to judge your app with. The rule is that after the user taps the app icon the first screen should be shown in 1-3 seconds.
2. **Battery time while using the app:** some app consume more power than others when in use and heat the phone. This factor adds to the app performance and this could happen when the app is using more phone resources creating an overload to the CPU.
3. **Memory consumption:** some functionality increase the memory consumption.

Server / API Performance: the response time from the API and server is critical to performance. For server performance we shall check the following:

1. **Data to and from the server:** the app should be efficient when handling data to and from the server by not taking a lot of time when loading data. Data should be displayed in the relevant format. This conversion should not take a long time.
2. **API Calls generated from Apps:** the number of calls from the app to the server should be less and for better performance these calls should be made for the same functionality.
3. **Server Down Time:** incase the DB is unavailable or down the data can be saved in the native DB which should be able to be availed when need be. Alternatively we will have a backup server for RAID redundancy purposes.

Network performance: the performance of the app on different networks. We measured the following factors:

1. **Jitters:** this is when there is delay in receiving data especially in wireless and packet communication. You need to show the appropriate alert incase of such jitters.
2. **Packet loss:** incase of packet loss, then the app should be able to resend the request for the information or generate an alert for the same.
3. **Network speeds:** the app was tested on 2G, 3G, 4G and WIFI networks to access the app performance.

Troubleshooting Mobile Application Performance

- ✓ **Lag response:** mostly caused by RAM and Cache causing delays. The user has to kill unnecessary processes or clear the cache. Also connectivity issues can be a cause.
- ✓ **unResponsive App:** app restarting, freezing or un responding may be fixed by optimizing code, creating patches and updates, automatic restores, wiping cache etc.

Testing Tools Used

ROBOTIUM and **MONKEY RUNNER**: monkey runner for instance can run tests on the real devices connected to the PC or an emulator. The API allows controlling a smartphone from the android code.

3.6.2 System Testing

Before deploying the mobile eReferral system, system testing was done to confirm that all code modules worked as specified, and that the system as a whole performed adequately on the mobile device. Firebase performance monitoring (firebase.google.com) was used to gain insight into app's performance issues. It helps to understand the performance characteristics of iOS, android and web apps. The performance monitoring SDK is used to collect performance data from the apps then review and analyse the data in Firebase console.

This helps to understand where and when the performance of the app can be improved so that the researcher can make improvements and use the data for performance monitoring. Firebase automatically measures app startup time, HTTP NETWORK request and much more.

3.6.3 Usability and Utility Testing

Mobile app usability goes along way in enhancing end user acceptability though acceptability differs with different users in terms of knowledge, goals, interests, environment, tech-survey etc. The first thing we looked at was the ***Overall App Simplicity*** in terms of the GUI Interface so at to cater for the needs of all skill level of users. It should be straight forward and easy to use and navigate.

The second aspect the researcher looked at was ***Helpful Error Scenarios*** whereby errors should be easy to understand and easy to recover from such errors. For instance the user should be alerted that there is no disk space to install the app or there is an update available and that the user cannot use the current version till updated from PlayStore.

The third aspect the researcher looked at was ***workflow efficiency*** whereby the users could synchronize their appointments to enable them not to remember many details at a go. This leads to user ***satisfaction*** whereby the users can be able to carry out several tasks and get some satisfaction out of it knowing that they have achieved their objectives.

In this phase, 10 HCW and 5 Patients were enrolled for the study for duration of 4 weeks to assess the usability and utility of the eReferral system. A questionnaire was administered to all participants to access usability of the system.

3.7 Post-Hoc Analysis

This is the analysis of data after the study has been concluded and trying to find patterns that were not primarily part of the objectives using data already collected in this study.

3.8 Data Validation Strategies

Total Data Quality Management (TDQM), data quality is increasingly being recognized as an important issue (Ballou & Pazer, 1985) whereby data integrity in DBMS (Brodie, 1980) in terms of detection, measurement, correction and prevention of defects is paramount.

We identify data relevance, strengths and limitations in terms of coherent data validation.

In order to maximize the trustworthiness of research findings the researcher used the likert scale approach to gauge the respondents' satisfaction.

CHAPTER FOUR – DESIGN AND ANALYSIS

4.0 Introduction

In this chapter the researcher looks at how the proposed system is developed. The system is developed using the following technologies and incorporates an Expert System to assist in Decision Support.

4.1.0 Current System

Most healthcare facilities use either a paper-based system or have their own inhouse built EHR. These individual systems are autonomous and not interoperable. Some facilities also use open systems such as the DHIMS.

4.1.1. Proposed System

The proposed system is web based and incorporates distribution in a network for accessibility. The system also has biometric capabilities where the patients can register their biometric features and thus there is no need to carry identification documents with them always.

4.2 Technologies

Below are the languages used in the design of this project:

4.2.1 MYSQL.

MySQL – this is an open-source Structured Query Language for relational database management systems used in web applications to store and retrieve info in a DB.

4.2.2 PHP.

PHP- this is **hypertext preprocessor,** an open source server-side scripting language designed for web development since its fast, flexible pragmatic. Its used to make dynamic and interactive sites.

4.2.3 CSS

CSS- Cascading Style Sheets (CSS) is a style sheet language primarily used for style presentation in markup languages. It describes the layout, colour and fonts of the web pages allowing for different screen sizes.

4.3 System Functionality

The functions of the eReferral system can be divided into three categories namely:-data collection and transmission whereby the patients/ healthcare worker can input necessary data such as demographic info and diagnosis, data presentation and SMS generation.

4.3.1 Data Collection

Data collection is mainly done through the android application interface and web portal. On successful login the patient accesses the Dashboard tab from where they can input symptoms and post them to a remote database hosted on a remote server. Data transmission is possible after an HTTP connection has been established with the webserver. PHP is responsible for handling server-side processing. The data collected is inserted into **a** table within the **Referral** DB.

4.3.2 Data Presentation/Visualization

All the system data is stored on a remote database hosted on a remote server. For instance when a patient/doctor/admin tries to login, an HTTP connection is established with the webserver. The PHP routine retrieves username and password from the users' table and authenticates this info and gives an alert message.

On the other hand, when a doctor wants to view the chat history of a patient, he will select a particular patient and request for information from the webserver. The PHP routine retrieves the patient Clinical data from the DB table based on the patient ID and displays the chat conversation.

4.3.3 SMS Generation

The TWILLIO application generates SMS alerts generated from the patients' and doctors' module. For the patients, SMS are generated at the point of booking Doctor's appointment by confirming that the appointment was successfully set. Every time a patient sends an enquiry the system notifies the doctor. The doctor can then analyze the patient's enquiry and provide feedback on the course of action. The feedback is sent in form of SMS and the patient will receive alert on his/her mobile phone.

4.4 System Description

4.4.1 Client Side

The client processing is handled by HTML, CSS and JavaScript languages. The dashboard can be accessed by the patient, doctor or administrator. Mobile device can be used to access the system by all parties. This is usually the pages that system users interact with mostly.

4.4.2 Server Side

In order to handle server side processing an open source web server (WAMPSERVER) which can operate on any operating system such as Windows, Linux and UNIX was used. The Web server allows for server side scripting of Web pages. In the local testing process of the system WAMP version 3.0 was used. PHP server side scripting language was used to develop the back end

4.4.3 Database Administration

The system database was built on using MySQL database. Database creation and management was achieved using PHP MyAdmin which is a component of WAMP server. The database is called **REFERAL** and it contains the 3 tables: - users, Diagnosis and appointment table. The users table contains basic and login information about the different users registered by either the administrator or doctor to access the system. On the other hand, the Diagnosis table handles all the data (Enquiries) sent by the patient. The appointment table handles all the appointment requests made by either the doctor or the patient.

4.5 Prototype Design

The web-based platform was developed using PHP. A doctor can login to the online web portal and make appointments and diagnosis and can be able to check on the previous chats. Patients on the other hand can use their mobile phones to view the Doctor's prescriptions and such. When the administrator logs in to the system, he/she is able to access the administrator's dashboard from where he/she can register a new doctor and view all the users of the system. On the other hand, the doctor will access the doctor's dashboard where he/she can register new patients and review the vital signs of each patient and provide feedback.

The development of this prototype was based on Google DialogFlow for bot and Google Maps API for the DSS map interaction.

4.6 Process Flow

System users open a web browser which takes them to home page with a login screen. This page contains the options to either login or to register for new users who want to sign up. To sign in the user enters a username and password and on clicking the login button a web connection is established with the remote PHP sever for validation. If the credentials are correct, the server sends a successful login message. The application then launches a welcome screen and then displays the patient's dashboard.

The patient's dashboard consists of APPOINTMENT, CHAT and REFERRAL HISTORY tabs. On the CHAT tab the patient will be able to see the conversations and diagnostics previously done with the doctor. The system has the capability to teleconference by use of Zoom API. The APPOINTMENT tab provides a form where the patient can book an appointment with the doctor if need arises.

On the other hand, the doctors will access the doctor's dashboard. The doctor's dashboard consists of REGISTRATION, CHAT and PATIENTS tabs. The REGISTRATION tab will be used for registering new patients. The PATIENTS tab will show a list of patients from where the doctor can be able to review the REFERRAL history of each patient and provide feedback.

The administrator will access the admin dashboard. This consists of REGISTRATION CHAT and USERS tabs. The registration tab is for registering new users while the USERs tab will show a list of all registered users.

4.7 Prototype Implementation

In this chapter we present a web-based system that can be accessed by most devices to enable in the referral system. The development of this prototype was based on the understanding from the literature review and the scenario of how referral systems work in the developing and developed world. Below are some of the service architecture used in implementing the system:

1. **Web service:** the system is web based with a back end for connecting to the DBMS to store and retrieve data.
2. **Google Cloud Pub:** the bot uses HTTP to send messages by use of google cloud Hangout chat.
3. **API scripts:** Google maps API was used to inform the DSS in terms of hospital distance.
4. **Natural language processing:** DialogFlow is most commonly used for creating natural language Bots. This lets you create intelligent agents using intents. NLP Technology is a synchronous process whereby the user makes a request and the bot provides the response.

System Overview

This is the overall decomposition of the system into its components based on the identified objectives. The system consists of a database and the tasks that can be performed at each level.

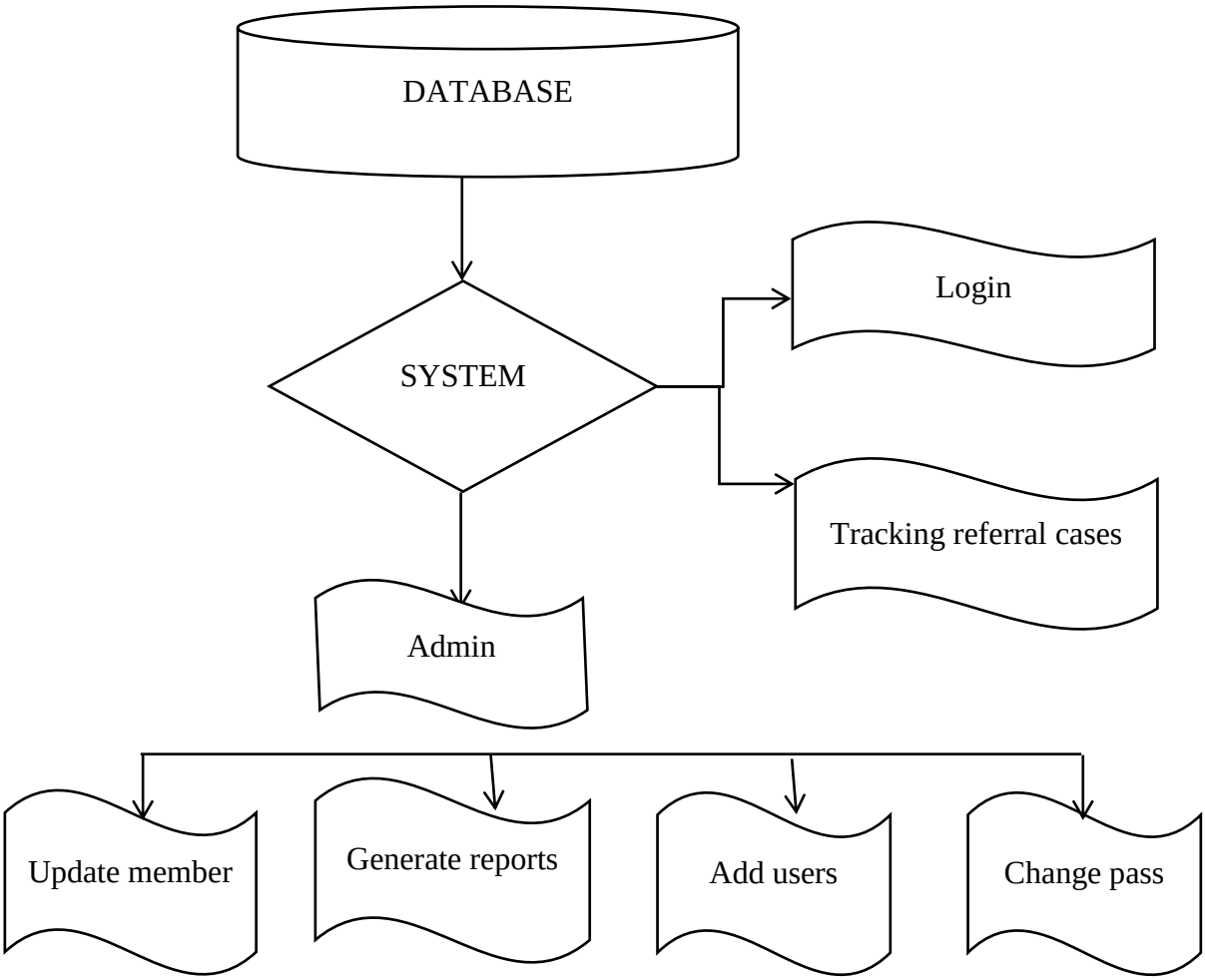


Fig 16: system overview

4.7.1 Use Case Diagrams

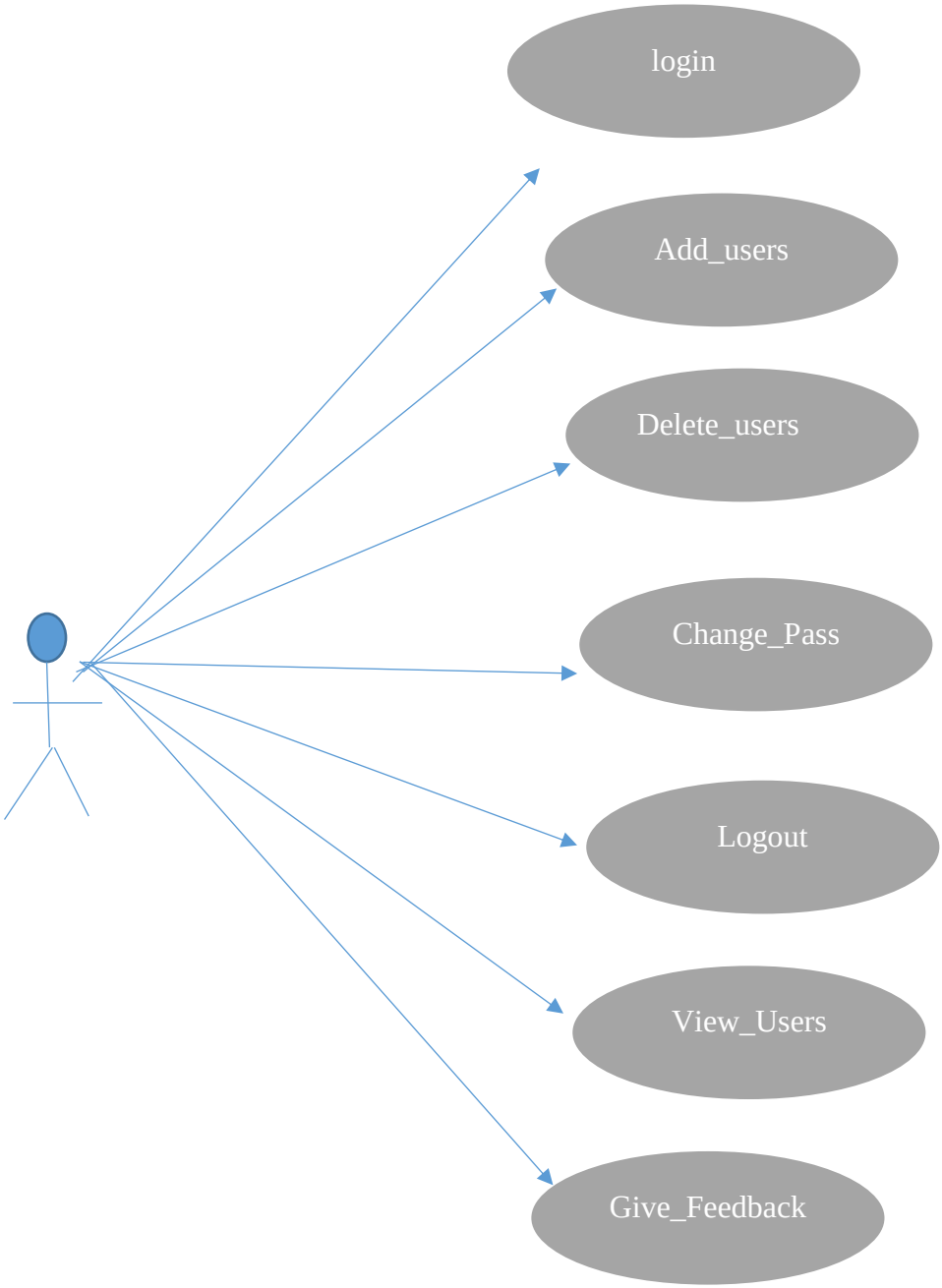


Fig 18: Use Case Diagrams

4.7.2 Entity-Relationship Diagrams (ERD)

ER diagram involves database entities, attributes, primary keys and the relationship between entities. Data is then normalized into 1st, 2nd and 3rd normal form for efficient data storage and retrieval.

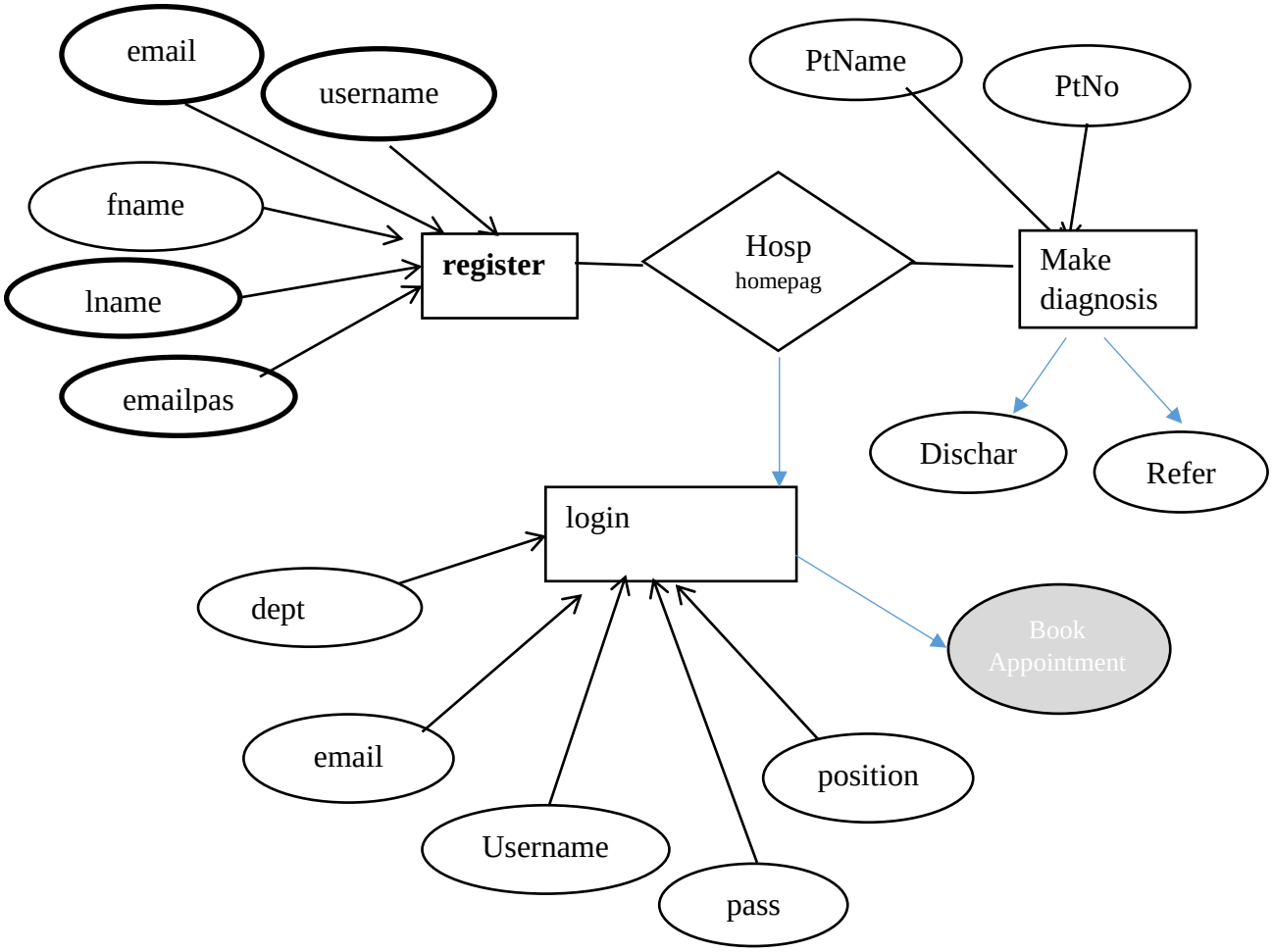


Fig 19 Entity-Relationship Diagrams (ERD)

4.7.3 Contextual Diagram

It defines the boundaries between the system and its environment by showing interacting entities at a high level system view. It shows the flow of information from the system and external components.

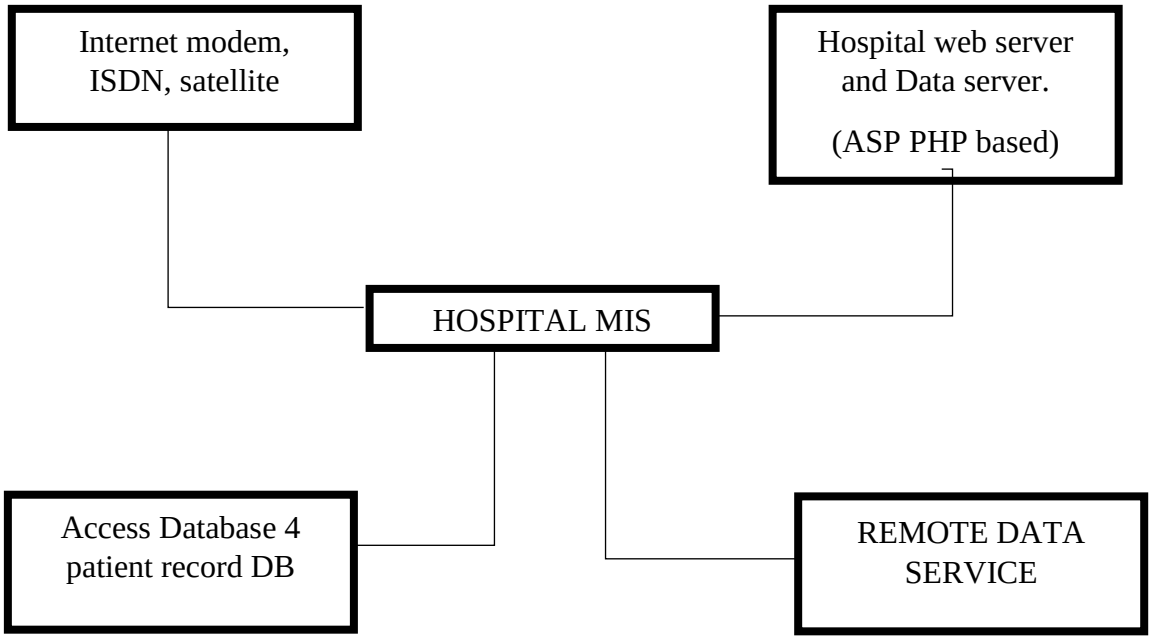


Fig 20 Contextual diagram

4.8 Process Flow

Below is a data flow diagram (DFD) of the booking Bot showing some of the steps followed when making a booking.

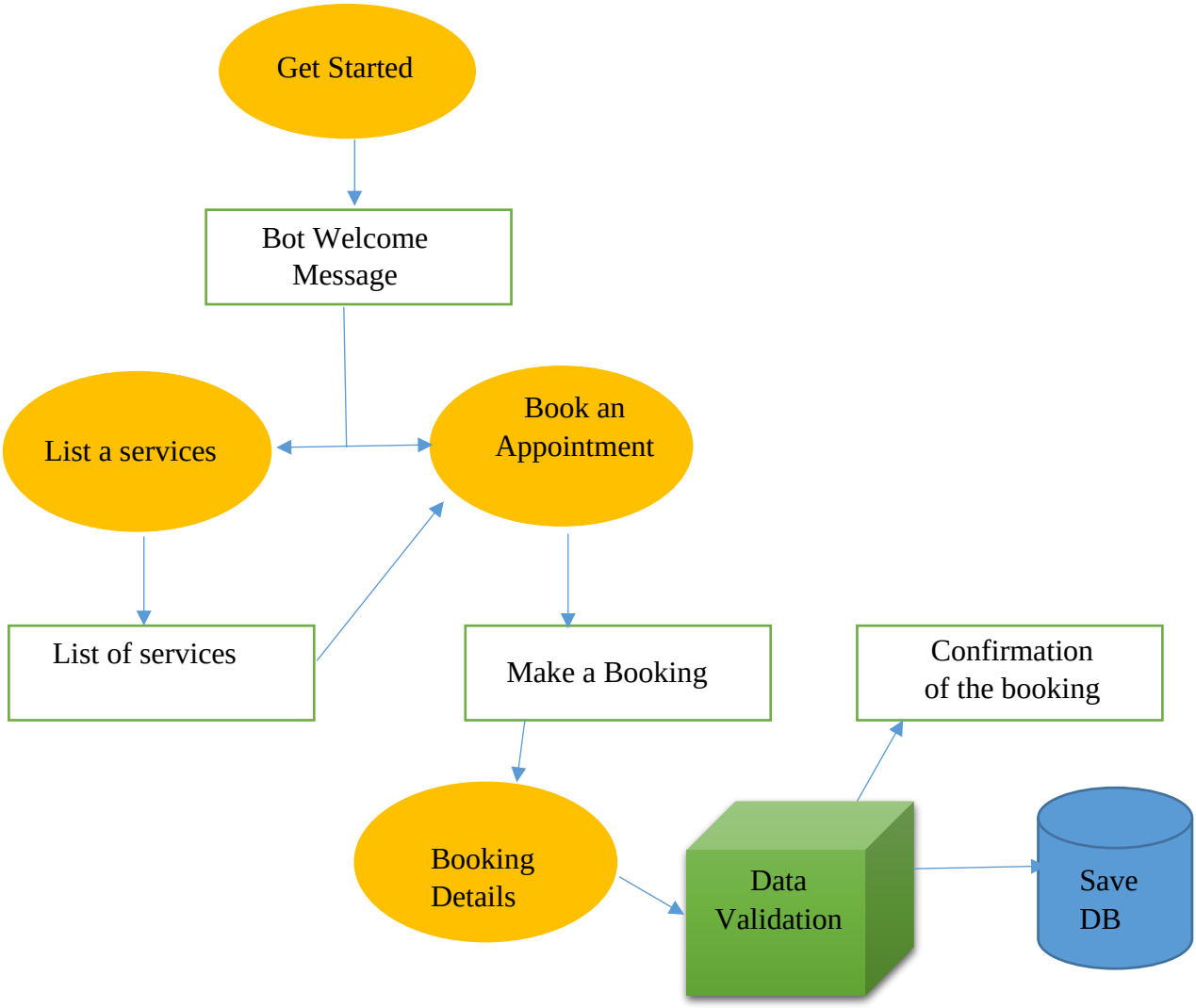


Fig 21: Process Flow

4.9.1 Login Module

The system user opens a web browser and enters the URL address that directs them to the home page that serves as a login page. Here the patient, doctor and system admin can login. The user is required to enter their login credentials so as to be able to access the system and if the user doesn't have the login credentials then they are requested to create an account.

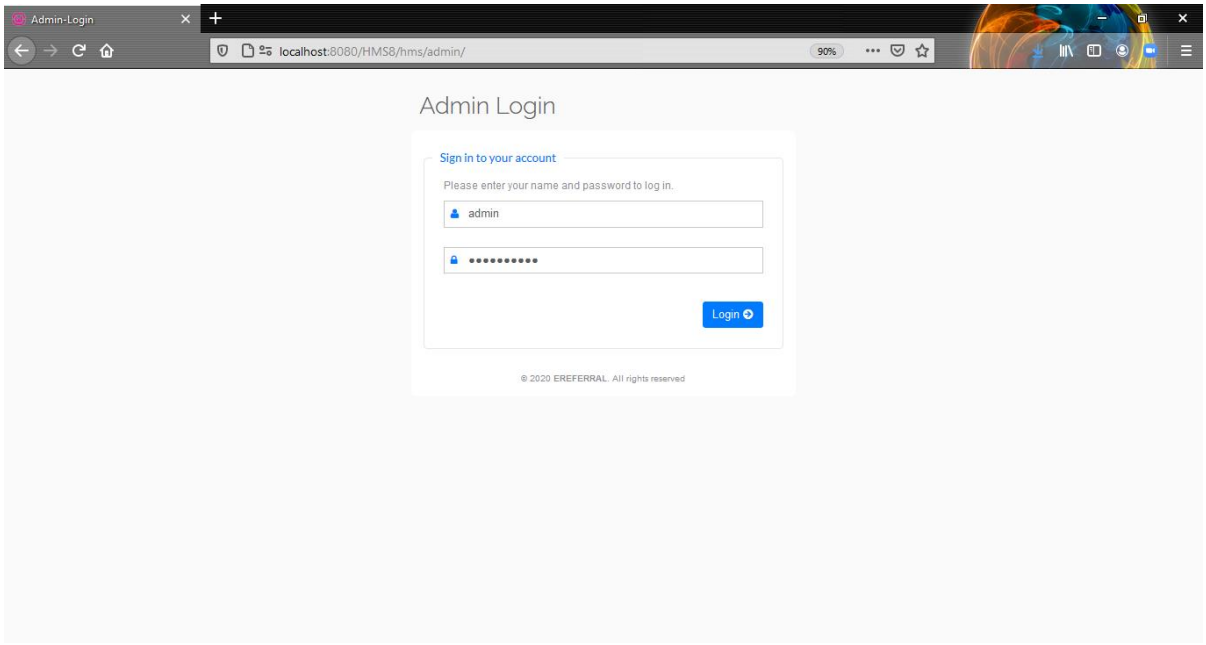


Fig 22: login page

4.9.2 User Registration Page

New users can register themselves by creating an account in the registration page by filling in their personal details together with the username and password. This will be used to login to the system thereafter.

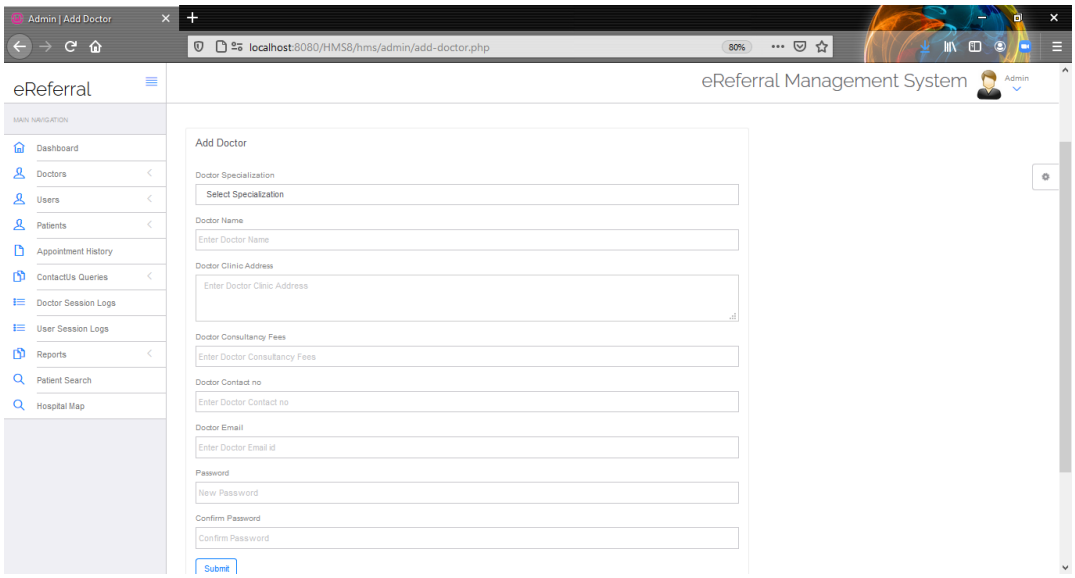


Fig 23: registration page

4.10 Output Design

4.10.1 Dashboard

The dashboard is the first page that the logged in users and they can navigate to other pages from here. The users can be able to chat with each other, make appointments and video call.

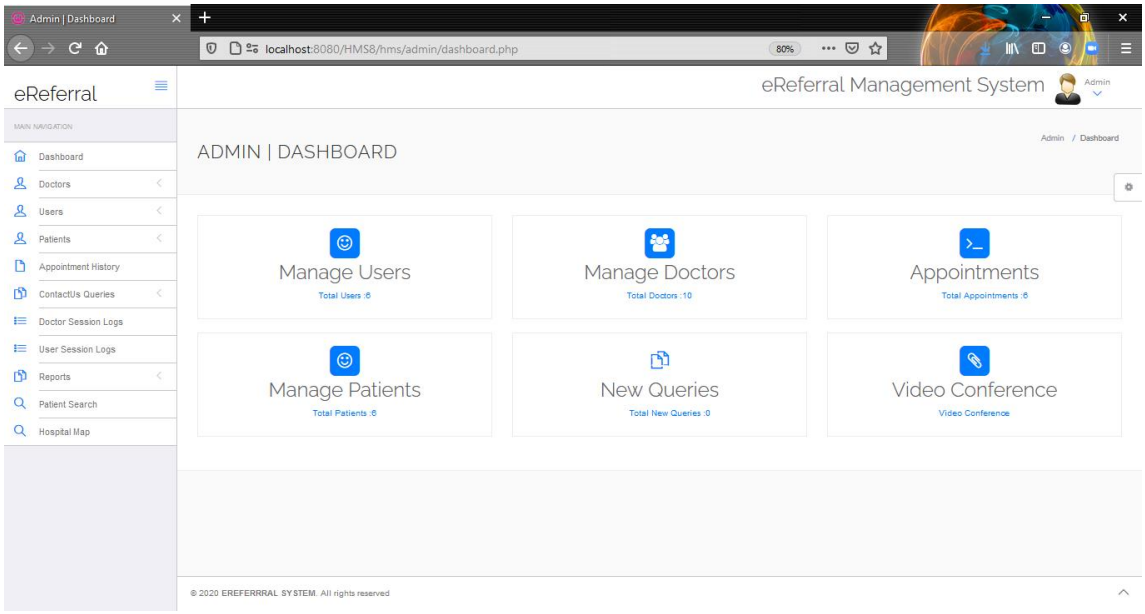


Fig 24: home page

4.10.2 Search Patients

A doctor can be able to view appointments he has and be able to search for patients easily.

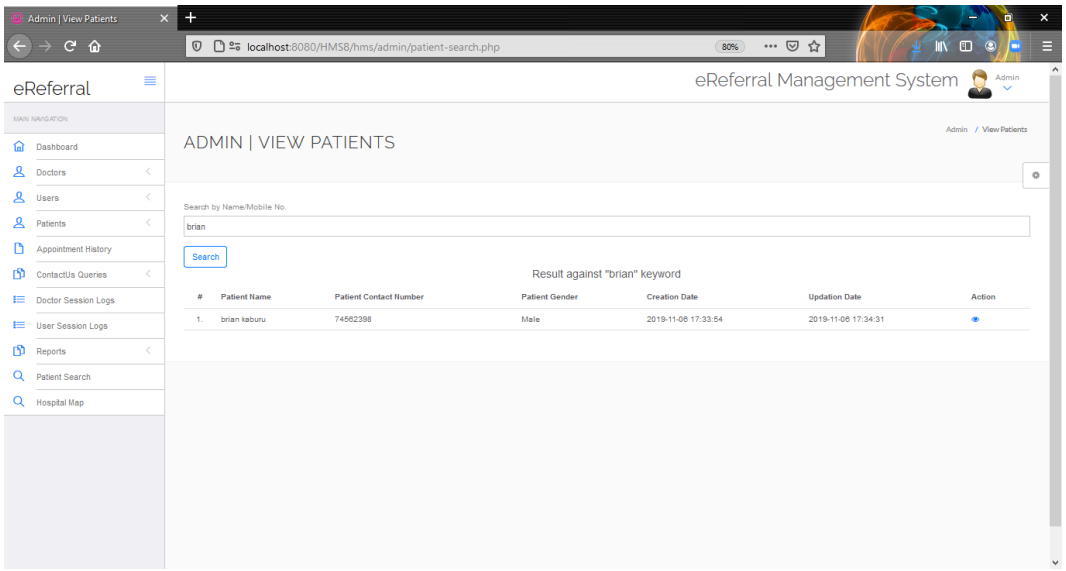


Fig 25: search page

4.11 Preliminary Study

4.11.1 Results and Findings

A sample was randomly selected and a total of 30 respondents took part in the survey. It consisted of 13 men and 17 women from Nairobi and its environs. The data was collected from 1st Feb to 28 Feb 2020, questionnaires were used to collect primary data from all respondents and interview guide from health administrators and nursing officers in charge in sampled facilities done through face to face interviews.

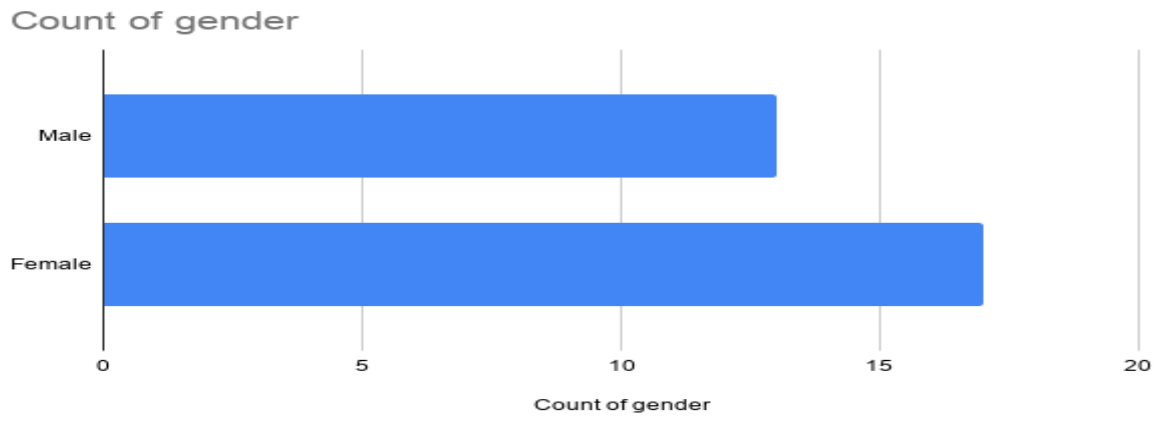
Cadre	**Population**
Dentists	712
Clinical Officers	7043
Nurses	34381
Pharmacists	890
Lab Tech	4863
Nutritionists	713
Physiotherapists	911

Table 9 Total number of health workers estimated to be active. Source 2011/2012 Workforce Review, Kenya MOH

Results

Response rate

A total of 30 (30%) of the respondents participated in the study out of the sampled 100 giving a response rate of 50%. The respondents included consultants, medical officers, nurses, medical lab techs and hospital admin, from twelve sampled sub counties in Kiambu County. The Statistical Package for Social Sciences (SPSS version 20.0) was used to run descriptive statistics.



Response rate

Feedback Mechanism

The researcher wanted to find out whether the health facility had functional ICT systems for referral cases and tracking patient progress and feedbacks.

Based on the study findings, a majority of 70.0% indicated majority of health facilities in Kiambu County had no specialized referral ICT systems, though they had either open source HIS, while the remaining 30% had in-house developed systems. The study concludes that a majority of the health facilities had no interpolated referral systems that enabled inter facility interaction. Thus it was hard for a referring facility to effectively make a clinical follow up.

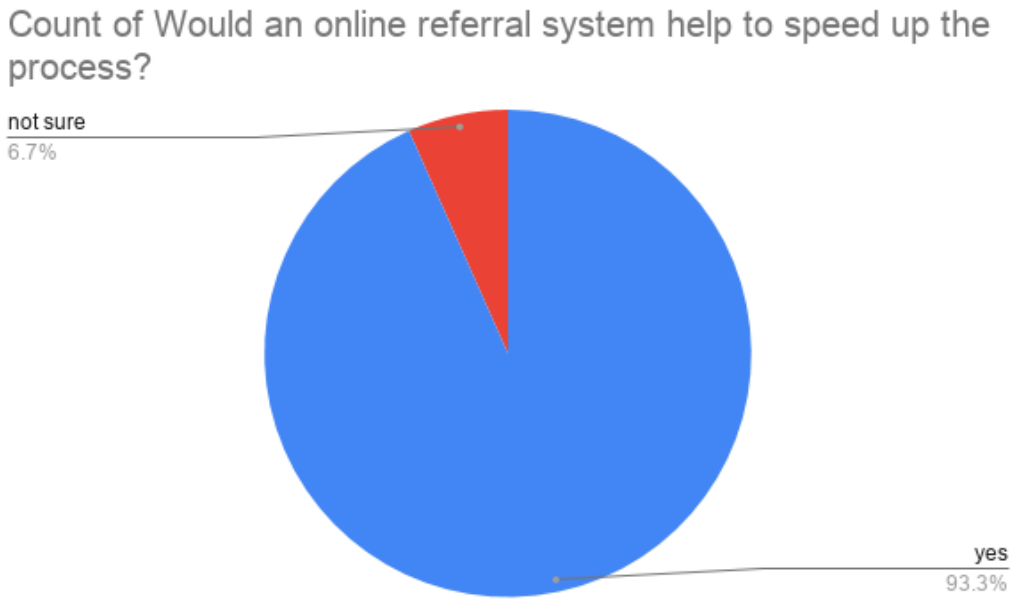


Fig 27: Feedback Mechanism

Geographical access

The researcher wanted to establish whether the health facilities had transportation facilities for patient pick up from one region to the health facility. According to the analysis of the findings, from data above a majority 82% of the respondents indicated there was no transport facilities for patient referral, while the remaining 18% of the respondents stated that they had ambulance vehicles at their disposal. Only level 5 and 6 Health facilities had ambulances.

Therefore it was concluded that most institutions in Kiambu County lacked transportation facilities for patients on referrals and the patients had to look for their own private means. 80% of the respondents either used Matatus or Bodaboda to access the referral facilities. It can be concluded that the availability of ambulances for referral cases, transportations of patients and specialist, equipment, specimen and essential drugs at the referral hospitals was not sufficient.

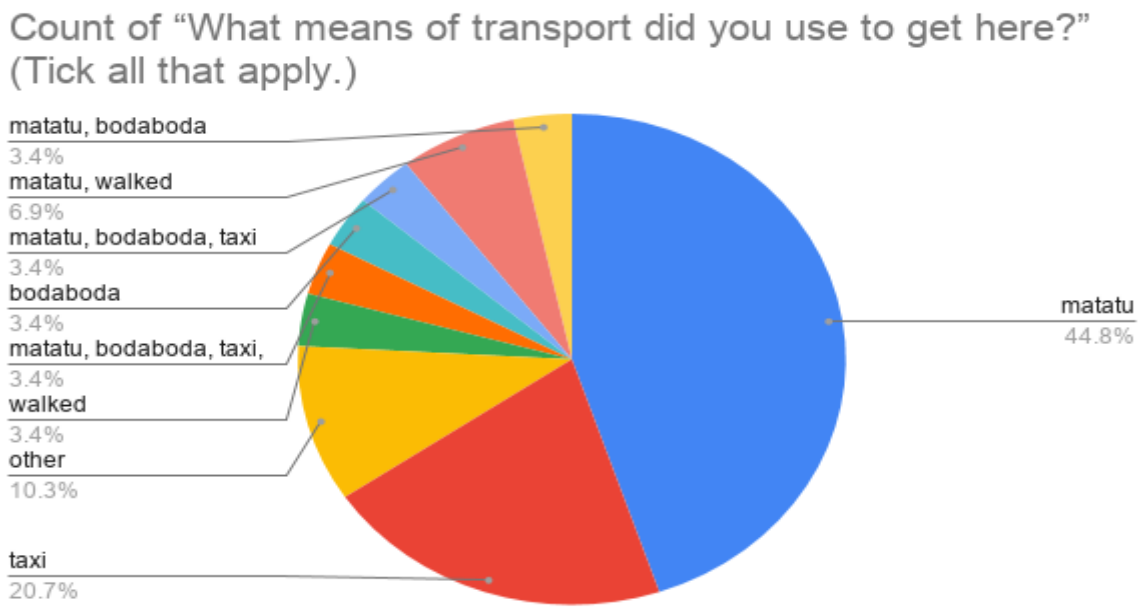


Fig 28: Geographical access

Capacity of health care workers

The study wanted to establish whether health facilities had skilled work force and their degree of expertise Some referral facilities utilized the services of interns and less experienced personnel for minor procedures citing the high cost of hiring experienced specialists.

The findings of the study revealed that a majority 75% of the workforce were not skilled on referral guidelines, while the remaining 25% had some clue on the referral procedures.

Therefore, it can be concluded that a majority of the respondents were not trained on referral guidelines. The researcher wanted to establish whether the health facilities had adequate human capacity to address referral cases

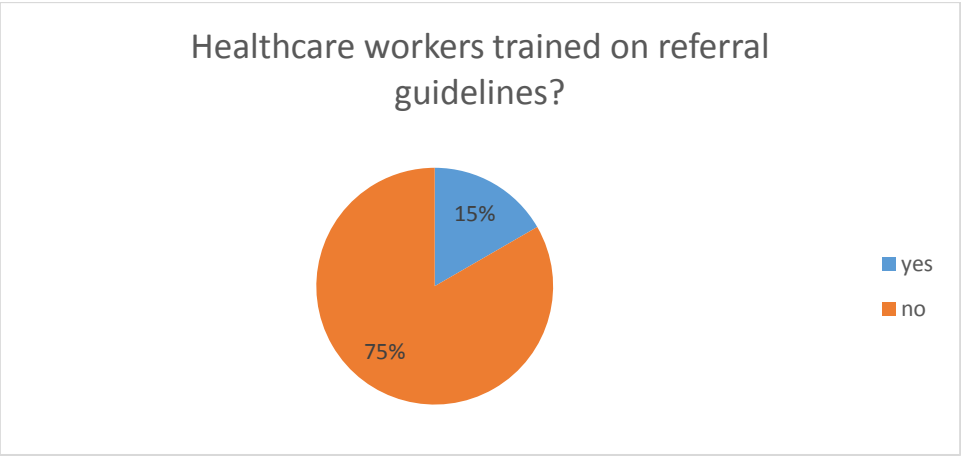


Fig 29: Capacity of health care workers

eReferral Information systems

The researcher wanted to investigate whether these health facilities had any eReferral management system and whether these systems were linked to other facilities to enable feedback transmission to the referring health facility. Also of importance was issue of referral slips. These slip documents served as reference for diagnosis and evidence of refer.

A majority of the respondents, 70% indicated the health facilities did not have standard referral documents while the remaining 30% indicated they issued referral slips.

The findings of the study deduced that most health facilities had no standardized referral documents for referrals.

There was a big % of self-referral cases 40% which contributed greatly to the lack of the referral slips. Some of the reasons given for self-referral was closeness of these healthcare facilities, availability of specialized personnel and equipment.

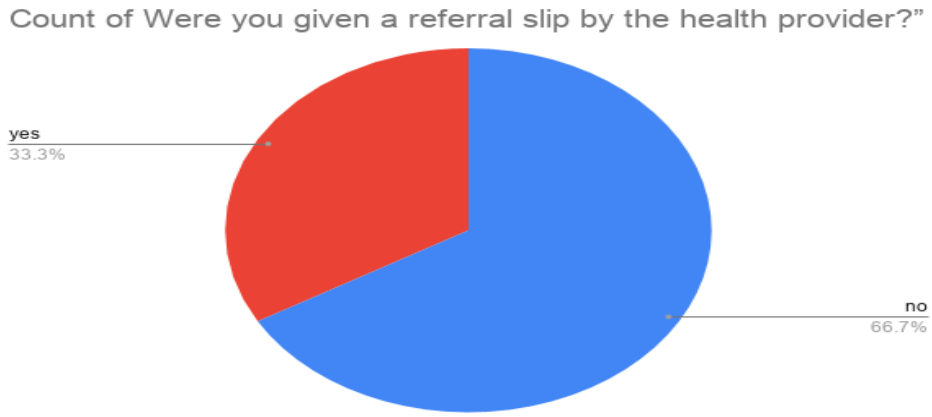


Fig 30: eReferral IS

Financial Resources

The researcher wanted to find out whether the health facilities had budgetary allocation for referrals. Based on the study findings, a majority (80%) indicated majority of health facilities in Kiambu County had no allocated funds, while the remaining (20%) had some budgetary allocations. The study concludes that a majority of the health facilities had no budgetary allocation for referrals and there was a need to increase funding for these health facilities and adequately equipping them to cope with the increasing cases.

The researcher also sort to find out which mode of transport was most commonly used and Matatu was most popular at 44.8 % followed by tax at 20.7%, other modes at 10.3% and Bodaboda at 3.4%. This proves that most people don't or could not afford private means to go to the hospital.

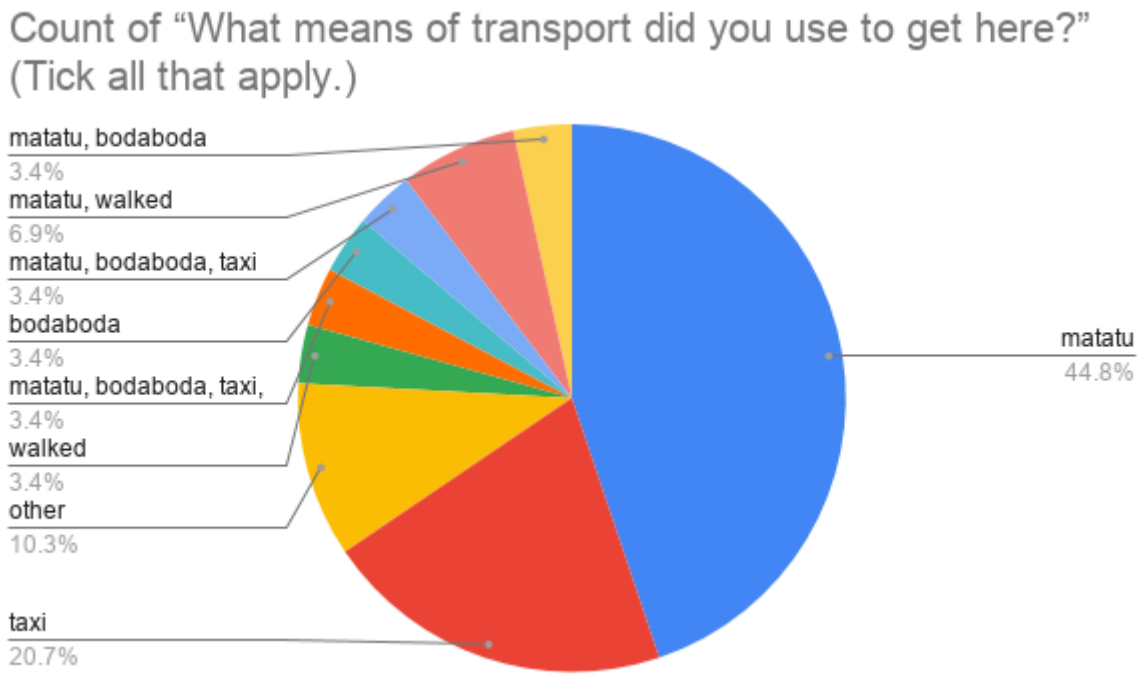


Fig 31: Financial Resources

Conclusion

A majority of the respondents unanimously agreed that the use of eReferral system would improve access to referral facilities. Cost of making an appointment came up: the high costs incurred in travelling, accommodation and time wastage being incurred in the manual process. Thus from this findings its evident that use of the proposed eReferral this costs will be slashed enormously.

CHAPTER FIVE: CONCLUSION AND RECOMMENDATIONS

5.1: Conclusions

The future is very promising in the case of Natural Language Processing (NLP) and with advancement of machine learning the use of DSS and BOTs is inevitable. Bots enable a seamless business operation 247 since there is no much human intervention unlike in a human operated call centre agent process. DSS enables clinicians to make informed decisions thereby reducing the error rate.

The main objectives of this research project was to access the extent of adoption of referral systems in Kenya and it's on this context that a framework was developed to accelerate the adoption of this technology. Data was collected to gather views from the respondents and factors that hinder the adoption of eReferral system were noted and recommendations have been made on how to handle these challenges.

Based on the collected data, a comprehensive analysis was done using SPSS Software and recommendations made in regards to the same. The proposed framework was statistically tested using the sample data and the results provided a strong need to use eReferral as follow: Usability, Efficiency, Effectiveness, Reliability, Cost and Satisfaction. The results showed that recognizing both technological and personality traits determined to a great length the adoption of eReferral systems.

From the analysed data, nearly all the respondents believed that by use of eReferral systems there would make the referral process more efficient and effective since they would be able to save on costs such as transport and time taken to travel physically to the healthcare facility to make an appointment. This would be cost efficient and making a follow-up made easy. Facilitating factors such as ease of use of the system, availability of cheap internet services and availability of smartphones was also a determining factor in adoption of the eReferral system. Organizational and technical infrastructure supporting the use of eReferral and the ability to get reliable health information through their mobile phone whenever was also a motivating factor to adopt use of eReferral system.

5.2 Major Contribution of the Research:

The theoretical model was able to demonstrate that the majority of the respondents (90%) were for the adoption of the eReferral system has it was of great benefit to the health system.

As a theoretical contribution this research was able to draw a strong relationship between the facilitating conditions and behavioral intentions of the Kenyan population and their intention to adopt eReferral. Therefore, from a theoretical perspective, the inclusion of facilitating

conditions enabled understanding of the roles of technological and personality traits in eReferral adoption in healthcare industry.

5.3 Recommendations

Below are some of the recommendations for future research work:

- To scale up this research to many hospitals in order to get bigger pool of data.
- To conduct the study in different counties to measure the degree of acceptability by other respondents in rural areas.
- More hospitals can be added to the google maps API to facilitate effective hospital mapping.
- Use of CHATBOTs and having additional intents to the bot to cover more context.
- List more hospitals in the google API so as to make the DSS more efficient.
- The use of a bot to list all possible services offered in the healthcare facility for the user incase they are not aware of what specific issue they what addressed.

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25.

APPENDICES:

Questionnaire

Questionnaire 1 Surveyor no……

Caretaker / Patient Interview Guide Today's date: ……

1 Age ☐ **0-5** ☐ **6-10** ☐ **11-20** ☐ **21-30** ☐ **41-50** ☐ **above 50**

Sex ☐ male ☐ female

Referred from Type of facility: ☐ Health Provider ☐ Health Center ☐ Hospital

Patient's presenting complaint: **(Tick appropriately.)**

- ☐ Diarrhea/dehydration
- ☐ Bloody stool
- ☐ Fever/malaria
- ☐ Convulsions
- ☐ Difficult breathing/cough/pneumonia
- ☐ Lethargy
- ☐ Not eating/drinking anything
- ☐ Vomiting
- ☐ Vomiting everything
- ☐ Anemia/malnutrition
- ☐ Measles
- ☐ Ear problem
- ☐ Diabetics
- ☐ Other, specify: _____

2. Is the patient hospitalized? ☐ Yes. How many days?_____ ☐ Not hospitalized

2.1 "Have you sought help from **somewhere else** for the current problem?"

☐ Yes ☐ No **(IF "NO"—GO TO 3)**

2.2 If "Yes," Where was the patient seen? ☐ Hospital ☐ Govt Health Center ☐ Private HCF

2.3 "Did **any** provider tell you to bring the Patient here to this facility?"

☐ Yes. Which provider? …….. ☐ No **(IF "NO"—GO TO 3)**

2.4 Were you given a referral slip by the health provider?"

☐ Yes ☐ No **(IF "NO"—GO TO 3)**

3. "What means of transport did you use to get here?" **(Tick all that apply.)**

- ☐ Matatu (Bus/minibus)
- ☐ Ambulance/facility vehicle
- ☐ Taxi / Uber
- ☐ Private car
- ☐ Bodaboda (Motorbike)
- ☐ Walked
- ☐ Animal/cart(donkey)
- ☐ Boat
- ☐ Bicycle
- ☐ Other, specify: _____

4 "How long did it take you to get here from your home?" Minutes _____

5. "How much money will you have spent to come here and return to your home on:

a. Transportation _____

b. Lodging/food _____

c. Medical services (consultation, admission, drugs, etc.)?" _____

TOTAL: _____

7. "Why did you choose to come to **this** facility at this time?"

(Circle all that apply. PROBE: Is there is another reason?)

- ☐ Convenience
- ☐ Trust
- ☐ Doctor's Availability
- ☐ Referred by a HC Practitioner

- ☐ Cost
- ☐ Better care
- ☐ Always come here
- ☐ Closest facility
- ☐ Child did not improve
- ☐ Availability of Drugs
- ☐ better equipment
- ☐ Other, specify: _____

8. "Are there other health providers/facilities that you could use that are **closer** to your home?"

☐ Yes ☐ No **(IF "NO"—GO TO 9)** ☐ Don't know

8.1 "What type of providers are closer to your community?" (**Tick all that apply. PROBE :)**

- ☐ Hospital
- ☐ MOH Health center
- ☐ NGO facility
- ☐ Private practitioner
- ☐ Community health worker
- ☐ Traditional healer
- ☐ Drug seller/pharmacy
- ☐ Religious leader
- ☐ Other specify: _____

9.1 "What was the diagnosis?" **(Circle all that apply.)**

- ☐ Diarrhea/dehydration
- ☐ Vomiting
- ☐ Fever/malaria
- ☐ Pneumonia
- ☐ Convulsions
- ☐ Diabetics
- ☐ Blood Pressure
- ☐ HIV
- ☐ Anemia/malnutrition
- ☐ TB
- ☐ ENT
- ☐ Other, specify: _____
- ☐ Wasn't told diagnosis
- ☐ Can't remember

9.2 "Where were you referred?"

- ☐ Health center
- ☐ District hospital
- ☐ Regional hospital
- ☐ Private clinic
- ☐ Teaching hospital
- ☐ Other, specify: _____

9.3 "Will going to the referral site be: **(Prompt the caretaker.)**

- ☐ Easy
- ☐ Possible
- ☐ Difficult
- ☐ Impossible

9.4 "Do you think referral is necessary?" ☐ Yes ☐ No ☐ Don't know

9.5 "Will you be able to take the patient to the referral site today?"

☐ Yes **(IF "YES"—GO TO 11)** ☐ No ☐ Don't know

9.5.1 "What prevents you from taking the Patient to the hospital today?"

- ☐ Lack of medical cover (NHIF)
- ☐ Transport costs / Distance
- ☐ Long waiting times
- ☐ Lack of Transport Means
- ☐ Weather
- ☐ No drugs at referral site
- ☐ Bad experience there before
- ☐ Other, specify: _____

10. "How do you feel about the care/treatment received today?"

- ☐ Satisfied
- ☐ Some How Satisfied
- ☐ Not satisfied at all
- ☐ No opinion

11. "What improvements would you like to see in future to offer better experience?"

……

12. Is there an online referral system? ☐ Yes ☐ No

13. Would an online referral system help to speed up the process? ☐ Yes ☐ No

Questionnaire 2 Surveyor no……

Health Provider Interview (Outpatient–Referring Facility) Today's date: …….

1. Name of facility: ……..…… County: ……

Sub-County: …… Ward: ……

Type of facility: ☐ Health Center ☐ Hospital ☐ Teaching hospital

2. Respondent designation

☐ Medical Doctor ☐ Professional nurse

☐ Administrative Officer ☐ Clinical Officer

☐ Community health officer ☐ Other specify: …….

3. Are you trained in emergency care response? ☐ Yes ☐ No

4. How long have you worked in this profession?

Less than 5yrs ☐ 5-10yrs ☐ above 10-20yrs ☐ over 20yrs

5. How many patients have been referred to this health facility from elsewhere? …….

6. How many patients have been referred to other health facilities elsewhere? …….

7. How many of the Patients were referred by:

- Hospital: ……..… CHW: ……..…….
- MOH Health Center: …….. Drug Seller/Pharmacy: ……..
- NGO Facility: ……. Religious Leader: ……..
- Private Practitioner: …… Other, Specify: _____

8. How many of the referred cases were brought with a referral slip? ……..

9. How many of the referred cases were eventually admitted here? …….

10.What are the reasons why referred cases sometimes do not make it to this facility?

☐ Cost of transport ☐ Weather

☐ Cost of medical care ☐ Other children to take care of

☐ Perceived poor care ☐ No opinion

☐ Problems with transportation ☐ Fear of the hospital

☐ Poor treatment by health workers ☐ Other, specify: _____

11. "Do you usually fill out counter-referral/feedback slips for patients that are referred to you?

☐ Yes ☐ No

12. "To your knowledge, are referral cases from healthcare facilities given priority in the OPD?

☐ Yes ☐ No ☐ Don't know

13. "Are there referral cases that you think don't need to be referred and could be treated locally?" ☐ Yes. examples…….…….. ☐ No ☐ Don't know

14. "In your opinion what needs to be done to improve referral system?"

……

15. Is there an online referral system? ☐ Yes ☐ No

16 Would an online referral system help to speed up the process? ☐ Yes ☐ No

17. Would an online referral system reduce the cost involved in the referral process?

☐ Yes ☐ No

18. Is your health facility adequately equipped and funded to cater for referrals? ☐ Yes ☐ No

19 Is there an ambulance vehicle in your health care facility? ☐ Yes ☐ No

Questionnaire 3 Surveyor no……
Focus Group Discussion Interview Guide Today's date: …….

1. What are the common illnesses that are referred to this facility? That affect children (under 5 years) and the elderly (over 55 years) in this community?
Which are the most dangerous for these two vulnerable groups?

2. How do you determine that the patient (and especially patients that are under 5 years and over 55 years) are seriously ill? What symptoms do you look for?

3. What do you do when the patient is seriously ill? Where is the initial facility that you would seek medical attention first?

4. What happens if the patient does not get better after the first treatment?

5. If your sick child is referred by a health worker to another facility, where would this normally be (name the facility)? What are your experiences at this facility?

6. "What would deter you from taking a patient to the hospital?
   1. Staff behavior (give examples and scenario)
   2. Quality of facility (long lines, availability of drugs, etc.)
   3. Distance (time, availability of transport)
   4. Cost of treatment
   5. Cost of transport
   6. Influence of spouse, family members, friends
   7. Beliefs

7. If you need to take a patient to the hospital**,** what could be done to make this easier for you?

8. Is there a budgetary allocation to referral hospitals to cater for better facilities and hiring specialist?
9. Do health facilities have ambulances to enable in patient, specimen and specialist movement?

Research Budget

	Item description	Unit cost	Amount (ksh)
1	Transport		4000
2	Printing		3000
3	Research allowances		2000
4	Subsidence (food and drinks)		2000
5	Miscellaneous		1000
6			
7			
		Total	**12,000**

Table 10: budget

Project schedule

Description								
Project idea generation								
Chapter 1								
Chapter 2								
Chapter 3								
Chapter 4								
Chapter 5								
Design								
Coding								
Documentation								
Support								

Table 11: project schedule

Sample Referral Form

Name of facility:	**Referral Form**						**original / copy**
Referred by:	Name:		Position:				
Initiating Facility Name and Address:				Date of referral:			
Telephone arrangements made:	YES	NO	Facility Tel No.	Fax No.			
Referred to Facility Name and Address:							
Client Name							
Identity Number				Age:	Sex:	M	F
Client address							
Clinical history							
Findings							
Treatment given							
Reason for referral							
Documents accompanying referral							
Print name, sign & date	Name:		Signature:	Date:			
Note to receiving facility: On completion of client management please fill in and detach the referral back slip below and send with patient or send by fax or mail.							

---------✂----------receiving facility - tear off when making **back referral**----------✂---------

Back referral from Facility Name		Tel No.	Fax No.
Reply from	Name:		Date:
(person completing form)	Position:	Specialty:	
To Initiating Facility: *(enter name and address)*			
Client Name			
Identity Number		Age:	Sex: M F
Client address			
This client was seen by: *(give name and specialty)*			on date:
Patient history			
Special investigations and findings			
Diagnosis			
Treatment / operation			
Medication prescribed			
Please continue with: *(meds, Rx, follow-up, care)*			
Refer back to:			on date:
Print name, sign & date	Name:	Signature:	Date:

Register of Referrals OUT

Date referral made	**Client Name (M or F)**	**Identity No.**	**Referred to** ***(name of facility / specialty)***	**Referred for**	**Date Back referral received**	Follow-up required YES / NO	Follow-up completed YES / NO	**Appropriate referral YES / NO**

Table 12: Register of Referrals OUT

Register of Referrals IN

Date referral received	**Client Name (M or F)**	**Identity No.**	**Referred from** ***(name of facility / specialty)***	**Referred for**	**Appropriate referral YES / NO**	**Summary of treatment provided**	**Date Back referral sent**

Table 13: Register of Referrals IN

List of private hospitals in Nairobi

Private Hospitals In Nairobi			
1	Nairobi South Hospital	28	Jacaranda Healthcare
2	Bristol Park Hospital	29	The German Medical Center
3	Ladnan Hospital	30	Mediheal Hospital
4	Acacia Medical Center	31	Care Hospital
5	Aga Khan University Hospital Nairobi	32	Kasarani Maternity and Nursing Home
6	Meridian Medical Center	33	Menelik Hospital
7	Meridian Equator Hospital Limited	34	St. Scholastica Uzima Hospital
8	Savannah Healthcare Services	35	Marura Nursing Home
9	Avenue Healthcare	36	Maria Immaculata Hospital
10	Getrude Gardens Children Hospital	37	Radiant Hospital
11	Nairobi Women's Hospital	38	Family Health Options Kenya
12	The Mater Hospital	39	Garden Specialist Hospital
13	Guru Nanak Ramgarhia Sikh Hospital	40	Apples + Sense
14	Karen Hospital	41	Penda Health
15	Mariakani Cottage Hospital	42	The Lifeline Group of Hospitals – Wendani
16	Coptic Mission Hospital	43	Westlands Medical Centre
17	Nairobi West Hospital	44	Oasis Healthcare Group
18	St. Mary's Hospital Langata	45	Livewell Health Clinic
19	Mp Shah Hospital	46	Komarock Modern Healthcare
20	Masaba Hospital	47	St Patrick Healthcare Centre
21	Nairobi East Hospital	48	Reinha Rosary Hospital
22	Langata Hospital	49	Ruai Family Hospital
23	Ruaraka Uhai Neema Hospital	50	Midhill Hospital
24	Medanta Africare	51	Wema Hospital
25	Melchizedek Hospital	52	AAR Healthcare
26	Jamaa Mission Hospital	53	Jamia MedClinics
27	St. Francis Community Hospital	54	Scion Hospital

Table 14: list of private hospitals

List of public hospitals in Nairobi

Public Hospitals & Health Centers In Nairobi			
Hospitals		WESTLANDS	
1	Mama Lucy Kibaki District Hospital	1	Westlands H/C
2	Mbagathi District Hospital	2	Kangemi H/C
3	Pumwani Maternity Hospital	3	Highridge H/C
Health centres		4	Karura H/C
KAMUKUNJI		5	Lady Northey H/C
1	Eastleigh H/C	6	State House. Clinic
2	Pumwani Majengo H/C	7	Kabete Approved Sch. H/C
	Bahati H/C	8	State Hse. Dispensary
STAREHE		9	Lower Kabete H/C
1	Ngaira H/C: Off Hailesellasie	10	MjiwaHuruma Disp.
2	STC Casino H/C	11	KARI 9Muguga) h/C
3	Huruma Lions H/C	12	Waithaka H/C
4	Lagos Rd. Disp.	13	Riruta H/C
5	Mathare Police Post	14	Ngong Rd H/C
KASARANI			
1	Mathare North H/C	15	Dagoreti Approved Sch. h/C
2	Kariobangi North H/C	16	Langata H/C
3	Kasarani H/C	17	Karen H/C
4	Kahawa West H/C	18	Kibera DO H/C
5	Babadogo H/C	19	Langata Women Prison H/C
6	NYS H/C	20	Nairobi West Prison H/C
7	GSU Hq H/C	21	Uhuru camp H/C
8	Kamiti Prison H/C	22	Kibera DO H/C
9	.Ruiru PSTC Location: Ruiru prison	23	KiberaAmref H/C
10	CID Hq's Disp.	24	GSU Kibera H/C
11	GSU Ruiru Disp.		

Table 15: list of public hospitals

Public Hospitals & Health Centers In Nairobi			
EMBAKASI		**NJIRU**	
1	Kayole 1 H/C	1	Dandora 1 H/C
2	Kayole II H/C	2	Dandora 11 H/C
3	Umoja H/C	3	Njiru H/C
4	Embakasi H/C	4	Kariobangi South Disp.
5	GSU Embakasi H/C		
6	APTC Embakasi H/C		
MAKADARA			
1	Makadara H/C	8	Mbotela H/C
2	Jericho H/C	9	Hono Clinic
3	Loco H/C	10	MOW Dispensary
4	Kaloleni Dispensary	11	Police Band Dispensary South C
5	Railway training Institute (South B) Dispensary	12	RTI South B Clinic
6	Nairobi remand Home H/C		
7	LungaLunga H/C		
New Facilities			
1	Dagoreti – uthiruMutuini		
2	Kasarani – marurui and Korogocho		
3	Embakasi – mukuru– kwa – Njenga H/C		

Table 15: list of public hospitals continued

Sample code

PHP

```
<?php
   include("includes/header.php");
 ?>
<!DOCTYPE html>
<html>
<head>
          <title>Booking</title>
   <script src="https://www.gstatic.com/dialogflow-
console/fast/messenger/bootstrap.js?v=1"></script>
<df-messenger
 intent="WELCOME"
 chat-title="docPatientChat"
 agent-id="29766bdc-0b03-44d1-a6dc-c5b6fd4a12f7"
 language-code="en"
></df-messenger>
 <link rel="stylesheet" href="camera.js">
 <link rel="stylesheet" href="camera.css">
<script type="text/javascript">
     /* NOTE : Use web server to view HTML files as real-time update will not work if you directly
open the HTML file in the browser. */
     (function(d, m){
       var kommunicateSettings =
{"appId":"1a966694dc4dd1b992c7bf433e60dbd57","popupWidget":true,"automaticChatOpenOnNavi
gation":true};
       var s = document.createElement("script"); s.type = "text/javascript"; s.async = true;
       s.src = "https://widget.kommunicate.io/v2/kommunicate.app";
       var h = document.getElementsByTagName("head")[0]; h.appendChild(s);
       window.kommunicate = m; m._globals = kommunicateSettings;
     })(document, window.kommunicate || {});
 </script>
 </head>
<body BGCOLOR="LIGHTGREY", style="background-image: url(img.jpg)">

   <br>   <br>   <br>   <br>
```

```
<h2><a href="https://bot.dialogflow.com/29766bdc-0b03-44d1-a6dc-c5b6fd4a12f7">click here</a>
</h2>

<iframe width="350" height="430" allow="microphone;" src="https://console.dialogflow.com/api-
client/demo/embedded/29766bdc-0b03-44d1-a6dc-c5b6fd4a12f7"></iframe>

<script type="text/javascript">
    /* NOTE : Use web server to view HTML files as real-time update will not work if you directly
open the HTML file in the browser. */
    (function(d, m){
      var kommunicateSettings =
{"appId":"1a966694dc4dd1b992c7bf433e60dbd57","popupWidget":true,"automaticChatOpenOnNavi
gation":true};
      var s = document.createElement("script"); s.type = "text/javascript"; s.async = true;
      s.src = "https://widget.kommunicate.io/v2/kommunicate.app";
      var h = document.getElementsByTagName("head")[0]; h.appendChild(s);
      window.kommunicate = m; m._globals = kommunicateSettings;
    })(document, window.kommunicate || {});

</script>
 <div id="container">
          <video autoplay="true" id="videoElement">
                  </video>
</div>
<script>
var video = document.querySelector("#videoElement");

if (navigator.mediaDevices.getUserMedia) {
 navigator.mediaDevices.getUserMedia({ video: true })
   .then(function (stream) {
     video.srcObject = stream;
   })
   .catch(function (err0r) {
     console.log("Something went wrong!");
   });
}
</script> </body> </html>
```