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SMART CARD BASED PERSONAL HEALTH RECORDS SYSTEM FOR INTEROPERABILITY

BY

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DECLARATION

This research project is my original work and has not been submitted for any academic award in any other University.

Signature…….. Date……

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This dissertation has been turned in for examination following my consent as the University of Nairobi Supervisor.

Signature…….. Date……

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DEDICATION

I dedicate this dissertation to my pals and all family members for the unconditional support and continued heartening during the course of the academic journey. God bless you all.

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ABSTRACT

Healthcare systems in both developed and the developing nations face numerous challenges such as lack of interoperability and limited personal medical records portability. Lack of conceivable personal health record's portability has resulted to medical data silos. Patients are seeking more control over their personal health records but unfortunately due to medical data silos, they are unable to access and efficiently give out their medical data with healthcare givers across the healthcare space when seeking treatment. The research aimed at demonstrating the capability of a smart card based personal health records intervention using a prototype, guided by: - assessing the use of smart-cards in medical care; finding out ways of enabling patients have more control over their own personal health records; assessing the challenges healthcare workers experience in sharing personal medical data with patients and finally establishing the minimum data set vital for provisioning continuity of medical care. The main limitation of this intervention is the need for multi-stake holder participation and cooperation so as to realize all the benefits of its implementation. The research concluded that: - majority of patients don't have access or power over their individual medical health data; there is little use of smart health cards; medical tests is the most vital information needed for continuity of medical care, and that sharing of personal medical data is majorly manual physical files and word of mouth. Finally, the research concluded that the intervention suggested bridges the medical data silos and gives patients control over their personal health records and advanced sharing capabilities across the healthcare sector. The research recommended that the government through the Ministries of Health in both National and County Governments to actively participate in the implementation of eHealth projects and initiatives. Additionally, healthcare facilities should be more willing to participate in breaking data silos by sharing patient's data through government provided and monitored patient data communication bus. Moreover, the use of smart health cards to share personal health records should be encouraged in the healthcare domain. Finally, the research recommended that patients should be encouraged to participation in their own health by empowering them to access, own and have control over their own personal health records; this involvement will help improve health outcomes through reliable and effective medical data access and sharing.

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ABBREVIATIONS AND ACRONYMS

DHIS2	-	District Health Information System 2
CDR	-	Clinical Data Repository
EMRs	-	Electronic Medical Records
EHRs	-	Electronic Health Records
HIS	-	Health Information System
IoT	-	Internet of Things
IFMIS	-	Integrated Financial Management Information System
KHWIS	-	Kenya Health Workforce Information System
KSI	-	Keyless Signature Infrastructure
LMIC	-	Low and Middle Income Countries
MoH	-	Ministry of Health (*National Government*)
mHealth	-	Mobile-Health
POS	-	Point-of-Service
PHR	-	Personal Health Record
R&D	-	Research & Development
WHO	-	World Health Organization

CHAPTER ONE

1.1 Introduction

The chapter gives the context of the research, the description of the problem, the purpose of the research, the objectives of the research, the research question, the hypothesis, the importance of the research, scope, theoretical framework and the conceptual framework.

1.2 Background

Sound and dependable information is the establishment of making sound decisions in all well-being framework foundational blocks. It is fundamental for health system methodology improvement and use, organization and rule, health research, HR headway, health guidance and instructing, organization transport and financing. The health data structure gives the underpinnings the making of sound decisions and has four key capabilities: (I) formation of data, (ii) aggregation, (iii) examination and blending, and (iv) communication and use. The health information structure accumulates data from health and other relevant divisions, researches the data and ensures their overall quality, criticalness and advantageous quality, and changes over the crude information into processed data for prosperity related choices. (WHO, 2010).

The medical information system is a times compared to reviewing and appraisal yet this is too sophisticated from a different perspective. Despite being basic for reviewing and appraisal, the information system moreover serves increasingly broad objectives, for instance, giving a prepared and early reprimand capacity, supporting patient and the administration of the medicinal services centers, engaging planning, supporting and strengthening investigation, permitting health condition and examples assessments, arranging overall uncovering, and sustaining correspondence of health challenges to special case clients. Information is of minimal worth if it isn't available in bunches that address the issues of different clients, for instance methodology makers, coordinators, executives, restorative administrations providers, systems and individuals. Dispersal and correspondence are along these lines principal attributes of the health information structure (WHO, 2010).

The goal of HIS in the wellbeing domain isn't only the typical assortment of wellbeing administrations information just as the heightening of similar information to the partners, however to help in dynamic procedures that are upheld with proof generally at the phase where the information is gathered. The most basic objective for a HIS's exertion is to improve the wellbeing

status of general society inside a wellbeing framework. The assortment of processed data, understanding and sharing should be organized in a way that completely considers people and the neediest gatherings in the general public. Thusly, the planning of wellbeing should be gotten from such data and henceforth the detailing of techniques that try to determine any type of imbalances distinguished. Also, any HIS should try to energize the fruitful utilization of its data asset through the creation of information that is lined up with the requirements of the clients. Each information output ought to consistently be created with cautiousness that considers the various phases that produce information, how it is shared and utilized (MoH Kenya, 2008).

Regular medical data systems are systems that create information gathered from open and private wellbeing offices and organizations, as well as local medical care centers, at standard time periods in a year at any rate. An enormous amount of data, that give health reports and social insurance associations are put together by healthcare suppliers as they execute their commitments, additionally, other significant commitments originate from the feedback of the normal medical care facilities (MEASURE, 2017).

The wellbeing data framework is a wide-raging and facilitated structure that accumulates, categorizes, researches, surveys, stores, offers, wellbeing and wellbeing related records for proof based decisions as well as planning. Wellbeing information is delivered from various sources, for example, individuals, wellbeing centers, ailment perception areas, the networks and geographical territories. Then, the data is consolidated, inspected and consumed both at the regional and the country levels. Information is commonly shared on from these sources right to the country-level. Customarily, there is the presence of feedback input circles at different phases of the information transmission. Generally in the medical care space, information consumption is either hard-copy documents or in digital format in many areas of the country. Data is collected mainly using hard copies that are re-directed to the district/zones for aggregation and review, from where it’s normally sent to the top country health administration (MoH Kenya, 2008). Regardless, the fact remains that the data amassed from the ground (community level) all the way to the top country health administration for instance in Kenya via the country aggregator DHIS-2, avoids particular patients' own one of a kind clinical records.

1.3 Problem statement

The quality of healthcare relies upon numerous elements, including auspicious accessibility of a patient's personal health records. Customarily in developing nations, patient's health records have broadly been paper based and keep on being restricted to the office that the patient has visited. On account of the nature of the medicinal services framework in these nations, which incorporates essential, auxiliary, and tertiary medical care centers spread crosswise over both government and private sectors, the choices of human healthcare suppliers are by all means interminable (Mane & Kulkarni, 2012). What may have begun as a couple of lines of clinical notes are changed into numerous records spreading over a few hundred pages over a patient's lifetime. From the point of view of the doctor, accessibility of data in an auspicious way would substantially affect the patient's results. Since the invention of the electronic health records (EHR) in first world nations, generous enhancements have been made in the expense and nature of care (Campanella et al., 2016), although the equivalent can't be said in resource-constrained settings. No decisive information with respect to implementation of EHRs in Kenya is accessible.

Globally, there are deliberate efforts aimed at changing access, care conveyance, patient encounters, and healthcare results through electronic health (eHealth). However, in Kenya, eHealth stays at its infancy stage because of social, financial, and technical difficulties. It is vital to mention that a portion of these difficulties incorporate significant cost of eHealth frameworks and developments; low ICT education among users; absence of interoperability of eHealth systems; market disintegration; user resistance to new systems; feeble administrative system; and conceivable infringement of patients' confidentiality and privacy. (Kenya national eHealth policy 2016-2030). This research therefore, specifically focuses on addressing the challenge of lack of portability of personal health records from one healthcare facility to another.

The healthcare framework in Kenya is exceptionally dichotomous in light of the nation's monetary disparities. Although some auxiliary and tertiary healthcare associations have received cutting edge electronic medical data innovations, a greater part still have just essential, legacy information systems in place, if at all they have any (Sood et al., 2008). Majority of health services providers in developing economies still use paper-based documentation or legacy systems. The combination of these factors makes it very difficult for patients' data to be passed electronically from one

physician or health facility to another. Similarly, patients are seeking more dominance over their medical data (Sood et al., 2008).

Given these issues, the circumstance warrants a wellbeing records system that is basic enough for use by patients, primary care physicians and medical centers. Along these lines, the utilization of minimal effort, simple-to-utilize innovations utilizing smart card based PHR is deemed to help bridge some of the gaps in between patient and health care provider interactions.

1.4 The main objective of the research

- The main objective of the research is to introduce a smart card based PHR system for interoperability.

1.4.1 Distinct objectives

- To evaluate the application of mart cards in healthcare.
- To evaluate how we can enable patients' access, control and share their individual medical records.
- To identify the minimum medical data set that can be used to provide continuity of care.
- To design, develop, deploy and test a prototype of an integrated smart card based personal health records system that demonstrates access and sharing of electronic personal health records.

1.5 Research questions

- What are the applications of smart-cards in healthcare?
- How can we enable patients' access, control and share their own personal health records?
- What are the challenges faced by healthcare staff in giving patients electronic access to digital personal medical data?
- What is the minimum health data set that can be used to provide continuity of care?

1.6 Significance

EMRs normally give an abundance of data to doctors and caregivers. It incorporates devices for clinical data and updated patient data to enhance patient care and helps the doctor-patient experience from the first meeting to diagnosis, treatment, and follow-up visits (Dobrow et al., 2019). An appropriately prepared and well-kept medicinal records system plays a significant responsibility in giving the best patient care, issues, for example, doctor's blunders and delayed

remedial choices can likewise be overruled. The findings collected from the research may be useful in the healthcare domain and various stakeholders can use them in suggesting conceivable integrated solutions that help give patients personalized access to personal health records by use of smart cards.

1.7 Justification of the research

Continued access to quality health care is a basic need to every citizen (Sood et al., 2008). However, in our day to day activities we realize that people are very mobile moving from one location to another e.g. long distant traders such as truck drivers on transit or work schedules that require people to move from one regional office to another. All these factors call for a fully integrated and interoperable health systems that give seamless access to personal health records for patients form health facility to another. Unfortunately, the situation is different in most young economies, which is also a challenge even in developed nations. Health management systems in our health ecosystem are highly isolated and barely share data with each other (Sood et al., 2008). A careful review of various factors deemed to hinder full integration and interoperability of health systems in both developed and developing nations is crucial in suggesting a more conceivable solution that would be applicable and deliverable in our local Kenyan context.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This section presents the findings that were gotten from reading through the existing scholarly works concerning portable health records from both the global as well as the local perspective. The research included an evaluation of EMRs/EHRs usage in our health space. Another important aspect of the review included the implementation of integrated PHR systems in the health domain to achieve portability of personal health records. The research also evaluated the PHR evolution and models including sample cases that have successfully implemented integrated health management systems.

2.1 Digital heath data

Digital health data permit storage, recovery and alteration of medicinal records utilizing computerized media rather than paper-based records systems. EMRs incorporate databases of patient statistic information, clinical lab results, radiology pictures and pharmaceutical records, just as patient analysis, treatment, disease progression and endurance information (Sood et al., 2008). By actualizing EMRs, patient information can be tracked over a long durations of time by numerous healthcare professionals. EMRs are intended to assist healthcare facilities with giving proficient and accurate treatment to patients (Kenya National eHealth policy, 2016-2030). Another term that is exchangeable with EMR is the Electronic Health Record (EHR) that are computerized records of wellbeing information that offer a more noteworthy number of limits than EMRs as they base on a patient's general health status not just the standard clinical data. Electronic wellbeing records are proposed to be bestowed to various providers of wellbeing administrations, so endorsed customers may in a brief moment get to a patient's EHR from different medicinal services professionals (Abul & Kenny, 2019).

In Kenya, the National Government's Ministry of Health (MoH), is successfully propelling the use of EMR frameworks with the focal point of improving wellbeing administration services, medicinal services systems organization and patient health results. Both the MoH and the Government are energetic about smoothing out conveyance of information and improving data accessibility (Kenya National eHealth strategy, 2016-2030). In the wellbeing division, DHIS2 is

the fundamental data aggregation national-wide system onto which different, individual systems for example, EMR systems, are supposed to anchor (Josephine et al., 2014). Proof on the reconciliation of existing frameworks with DHIS2 is ambiguous at present: for instance, HIV data frameworks seem to merge well into DHIS2, while this isn't the situation for other platforms handling medicinal data from the other aspects of the healthcare ecosystem. A lot of realistic steps still lay ahead for before effective integration can be accomplished (Muinga et al., 2020).While the implementation of EMRs is achievable at the health facility level, the bigger challenge is the interoperability of these EMRs from one health facility to another and also the integration with the national aggregator, the DHIS2 (Muinga et al., 2020).

2.2 EHR Implementation

The route toward executing EHR frameworks is a big challenge in both little and enormous economic spaces. Open source frameworks may offer little pay giving a chance to diminish the expenses of obtaining frameworks. It can give the implementer access to a comprehensive set of engineers and funders that may broaden economies of scale and steady improvement (Rasmi et al., 2018). Regardless, the troubles present in all EHR execution – for instance, customer buy in, framework multifaceted nature, interoperability and convenience – are consistent with open source adventures as much as they do with business based structures usage. There may exist longer-term impacts on the progress of the Kenya EHR industry if medicinal services habitats lessen their excitement for structures given by private business vendors with inclination for, contributor maintained open source frameworks. Family unit merchants have been regularly profitable in accomplishing usage to present, especially for authoritative and budgetary structures in Kenya's clinical offices. This suggests caution must be observed to choose if these frameworks should be displaced by new national frameworks, or whether the two kinds of frameworks could be facilitated to empower the two methodologies working with one another (Kenya National eHealth policy, 2016-2030).

2.3 PHR evolution

As PHR frameworks become all the more broadly utilized, they will increment in capacity and level of interoperability with other wellbeing data frameworks. There have been recommended a five-phase development prototype for individual medical data frameworks that portrays their advancement from essential wellbeing data to completely interoperability PHRs; Fundamental

PHR – records are now and then hard copy documents, or built physically utilizing normal word-processor or spreadsheets programming; *Independent PHRs* – Personal PC or online programming with formats that manage the manual section of individual wellbeing data; *Benefactor based PHRs* – PHRs accessible via the web frameworks supported by the businesses, suppliers, or guarantors, with some populace of information from support's wellbeing data frameworks; *Online PHRs* – PHR is incorporated with gateway capacities, including wellbeing data access and wellbeing choice guides; *Interoperable PHRs* – interoperable information offering digital wellbeing data. (Roehrs et al., 2017).

HL7 standards characterizes the degree of personal health records usefulness as outlined below: *Basic* – gives innovation establishment to PHR development. Comprises of clients populated wellbeing data. Gives reciprocal choice help devices; *Personalized* – data and choice help custom-made to the extraordinary requirements and inclination of clients. This may incorporate outside information, for example, guarantee inferred information, lab results; *Inter-connected* – bolsters mix with EHR and care the board capacities and stages. Fills in as stage for cutting edge specialized instruments and following. Applies EHR clinical setting and supplier strength principles; *Interoperable* – allows communications across different medial data platforms dependent on healthcare domain norms (Meehan et al., 2016).

2.3.1 The main characteristics of a PHR system

Framework ascribes identify with the qualities of PHR frameworks as detailed in the following section.

2.3.1.1 Contents

Little agreement exists on what data to link to PHRs. Data from specialist sources should utilize straightforward language for laypersons (Flaumenhaft and Ben, 2018). Data entered by patients may not be as enough, precise, and sorted out as information traded between medical services suppliers. Proposals for information to be included in the PHRs is outlined in figure 1 below. (Holmgren, Patel and Adler, 2017) – With additions from different analysts, (Barbarito et al., 2015), certain incessant diseases may require extra data.

Data recommended for inclusion in PHRs

Data	Data sources					
	Patient	Caregiver	PCP	Other physicians	EMR	Insurance claims
Personal information	X	X				
Problem lists	X	X			X	
Procedures, hospitalizations	X			X	X	X
Major illnesses	X	X	X	X	X	X
Provider list	X		X	X	X	
Allergies	X				X	
Home monitor data	X	X				
Family history	X				X	
Social history, lifestyle	X				X	
Preventive health recommendations			X	X		
Immunizations	X				X	
Examinations, diagnoses			X	X	X	
Medications	X				X	X
Laboratory tests, appointments	X				X	X
Notes	X	X	X	X	X	

EMR, electronic medical record system; PCP, primary care physician; PHR, personal health record system.

Figure 1: Data Recommended for Inclusion in PHR

Content must be significant, reasonable, and believable to patients and their guardians, and suitable for web access by understanding approved people (Barbarito et al., 2015). Doctor experience has demonstrated that quiet issue records, clinical notes, prescription and hypersensitivity information, and research center and symptomatic test outcomes can be imparted to patients. An endeavor ought to be made (especially on account of terrible news) to change office work processes so doctors can talk about outcomes with patients before they show up in online records.

2.3.1.2 The sources of data

In an ideal situation, the PHR should join anyway much appropriate data as could sensibly be normal over the individual's lifetime, from various sources, including clinical administrations

workplaces similarly as the individual. The specific data wellspring of everything should be named and observable to the customer. The more intensive the data contained in a PHR are, the more supportive the data will be to patients and medicinal services providers. Information inside PHRs can be emotional or objective as demonstrated as follows.

Objective and Subjective PHR Data Types by Source

	Data Type	
Data Source	**Subjective**	**Objective**
Patient	Manual entry or results of online data capture (e.g., symptoms scores, qualitative descriptions)	Manual entry (e.g., blood pressure, weight)
Home instrumentation	N/A	Automated interfaces (e.g., blood pressure from interfaced home blood pressure monitor)
Clinicians	Automated interface with medical records	Automated interface with medical records
Claims databases	N/A	Automated interfaces

N/A = not applicable.

Figure 2: The categories of PHR data by their Source

In order to be significant to the patient, the PHR must present data and going with contraptions in habits that enable the individual to grasp and to catch up on the information present in the record (Heart, Ben & Shabtai, 2017).

2.3.1.3 Data accessibility

An individually manipulated PHR, coordinated with an essential care EMR, can oversee correspondences for remedies and arrangements at sensible time and cost. Framework interoperability is basic to giving buyers access to wellbeing records in medical clinic, doctor, and research facility frameworks, however this depends on the execution of interoperability principles, for example, HL7 that help record sharing between frameworks. Other related methodologies include centralization of every single patient record at local level, with access through online entries (Barbarito et al., 2015).

2.3.1.4 Security and privacy

Approximately 66% of grown-up purchasers are worried about the protection and security of their wellbeing data (Rozenblum et al., 2015). The individuals who are worried about protection may change their mentalities with proper encircling of contentions preferring record use. The incessantly and intensely sick and the individuals who much of the time use medicinal services administrations will in general be less worried about security than the wellbeing experts. Current security insurance systems should be upgraded for record assurance, however to look after protection, security levels must not turn out to be tight to the point that wellbeing records are unusable. Endeavors have been set up to address security issues with respect to remote transmission of patient clinical information, including the protection, uprightness, and secrecy of the information, and the confirmation and approval of clients (Rozenblum et al., 2015).

2.3.1.5 Functionality

A PHR system functionalities can be named as: (1) data assortment, (2) data sharing and trade, and (3) data self-administration (Barbarito et al., 2015). Review investigations of PHR usage can give information on functionalities. Functionalities incorporate sending and getting electronic messages to and from specialists' workplaces; finishing remedy reestablishment structures, arrangements, and referral approvals; seeing arrangements of current meds and sensitivities; and getting to wellbeing and practice data. Choice help can likewise help patients in overseeing interminable sicknesses, in view of monitoring information (Flaumenhaft & Ben, 2018).

2.3.2 Personal health records, a global perspective.

Generally patients get social insurance administrations from various clinics, and thus their medical services information are scattered over numerous offices' paper and electronic-based record frameworks. This divided arrangement of storage and recovery of basic patient information obstructs continuum care (Holmgren et al., 2017). In New Zealand, Australia and the United Kingdom, the vital objective has been to upgrade digital correspondence joins among essential consideration part and auxiliary well-being organizations (Flaumenhaft & Ben, 2018). In each medical services space, patients are looking for more authority over their own wellbeing data (Rozenblum et al., 2015). So also, numerous nations are concentrating on information interoperability, access, and patient's approval (Sood et al., 2008). The American Academy of

Pediatrics underpins advancement of instructive projects for families and clinicians to advance successful and productive utilization of the individual adaptation of Electronic Health Records, called Personal Health Records as a method of enhancing the nature of human services for youngsters (Evans, 2016). For such reasons, individual medical records are bit by bit getting grounds to the extent that associations like Microsoft have meandered into the universe of individual medical Records and it may have the option to expect PHRs getting fused into clinical practice a tiny bit at a time.

2.3.3 Personal health records portability gap

Applicable patient data isn't constantly accessible to healthcare service experts at the point when it’s needed for of medicinal decision making. This can have significant ramifications for the quality and security of care, especially in connection to recommending where the incident of harm through unfavorable medication reaction has been reported. Electronic health records (EHR) offer extraordinary potential to improve this circumstance by coordinating and availing patient-explicit information from different healthcare settings, despite the fact that there are various technical obstructions to be dealt with in order to accomplish this vision (Cowie et al., 2017). Incorporated individual clinical records offer enormous potential to strengthen disruptive alterations in therapeutic administrations movement and individualized care by healthcare consumers.

While there is a scope of winning PHR models, (autonomous, fastened, coordinated), Cowie et al. (2017) states that its singularly the planned model has confirmed groundbreaking potential to support customers' capacity to deal with their own helpful organizations. Different components impede no matter how you look at it allocation of brought together PHRs: snags in the prosperity organizations framework/culture; issues of buyer conviction and trust; absence of interoperability; lack of normalization; the computer knowledge gap; questionable return on investment (ROI) etc. (Menachemi et al., 2018).

2.3.4 The future outlook of PHRs

Generally, PHRs will be a center point for data concerning patients. They will likewise give patients access to devices for dealing with this data, some of which patients will enter themselves and some of which will originate from their healthcare supplier, drug store, a general wellbeing authority, or different sources. Every last bit of it, including data identified with populace wellbeing and even atmosphere and natural conditions, will be handled and coordinated in such a

way that prompts patients to make suitable moves. The data will be available at whatever point and any place an approved client needs it. Progressed PHRs may normally incorporate capacities, for example, data about a person's wellbeing status, wellbeing practices, and utilization of wellbeing administrations. All the more so they may incorporate patient inclinations for administrations, for example, propelled mandates. Another significant viewpoint is choice rationales from an individual's wellbeing plan that start cautions, alerts, or proposals when clinical discoveries surpass the ideal limits. A person's perceptions about her or his physical and social conditions is likewise another progression to anticipate just as rules with respect to security and access to, and utilization of, data. Different progressions incorporate middleware devices that oversee personality, for example, family relations and name changes; interpretation of data from various PC frameworks into predictable structures; and guaranteeing information uprightness (Heart, Ben & Shabtai, 2017).

2.4 Smart card technology

A smart-card, additionally called chip-card or coordinated circuit-card is a kind of pocket size card with installed incorporated circuits that can process data (Rader, Petersen, Bartholomew, Espin, Cunningham, and MacMillan, 2015). This card can get input which is prepared by method of the ICC applications and conveyed for use. A brilliant card is a plastic card embedded with a PC chip that stores and executes data between customers. Savvy card-improved structures are being utilized today in a couple of key applications, for instance, human administrations, banking, delight and transportation. The card data is executed through a smart-card-reader associated with a computer framework.

2.4.1 Sample smart-card

Figure 3: Sample smart card

2.4.2 Elements of a smart-card

Adopted from the department of Computer Science University Texas at Austin

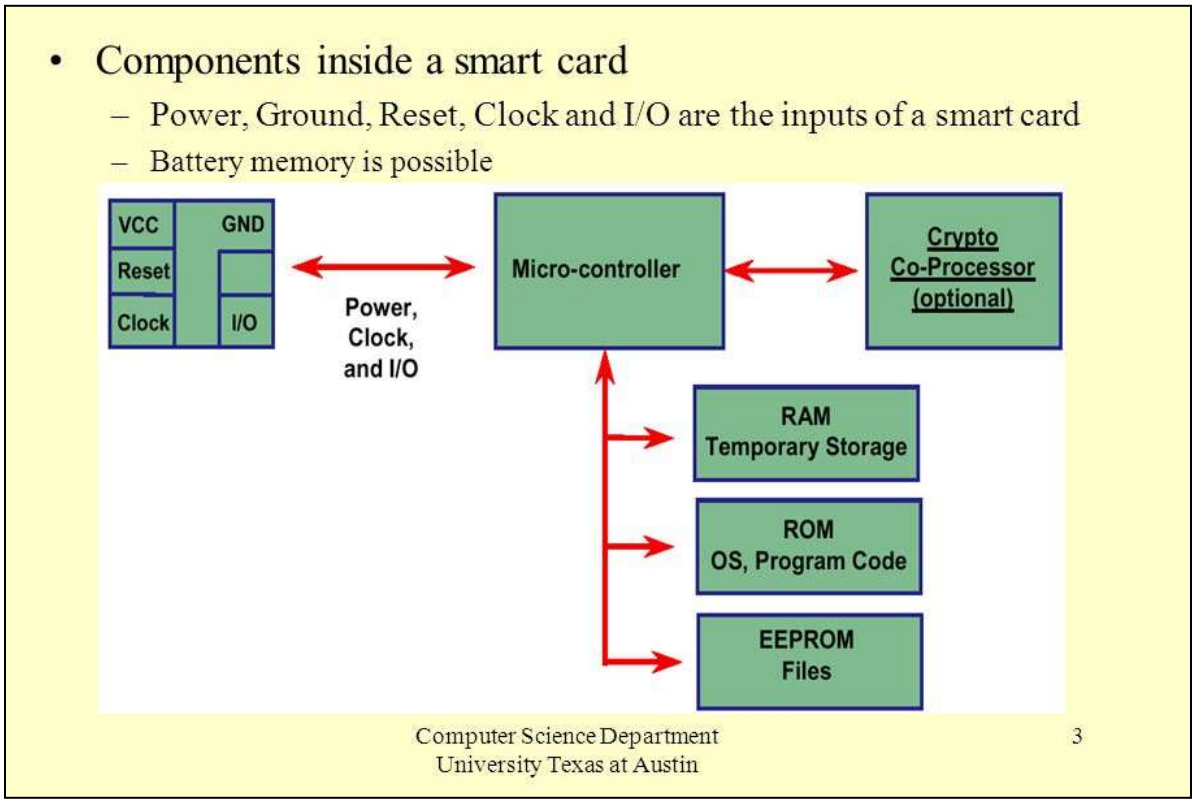


Figure 4: Components of a smart card

2.4.3 Varieties of smart-cards

Proximity smart-card scanners are used as a correspondences medium between the savvy-card and a host, for instance a PC, a retail store terminal, or a mobile phone. Since the chips in the cash related cards are proportional to those used for wireless Subscriber Identity Module (SIM) cards, simply adjusted differently and embedded in another shaped piece of PVC, the chip producers are attempting to the all the more make use of GSM and 3G guidelines. There three primary kinds of shrewd cards specifically: - contact savvy card, Contactless keen card and Cryptographic smart-cards (Rader et al., 2015).

2.4.4 Application of Smart Card Technology in Healthcare – global perspective

As stated by Lerer and Kimberly (2017), the European medical care space has seen significant development in the course of recent years in its utilization (Information Technology) for conveyance of health services administrations and for the administration of the medicinal services

framework. In numerous nations, one noteworthy method of receiving the best in return has end up being the utilization of smart-cards. For the most part, smart-cards in medicinal services are utilized to give quick recognizable proof of patients; improved treatment; a helpful method to convey information between frameworks or medical care centers, and decrease in records handling costs (Keliris, Kolias & Nikita, 2013).

According to Mishra (2016), standardization of information that will be recorded in the wellbeing card is significant particularly with the transcendence of a versatile populace which requests more noteworthy medical services conveyance and enhanced ambulatory care. Wellbeing cards will be gainful and demonstrate significant particularly during mishaps and injury care as they would give indispensable data to specialists and medicinal services work force. Inter-connectivity is one of the most noteworthy necessities for no matter how you look at it use of wellbeing cards. Interoperability between wellbeing card structures is the limit of one wellbeing card system to scrutinize, use and also update the data, on wellbeing cards given by another wellbeing card framework (Keliris, Kolias and Nikita, 2013).

2.5 Integrated health management information systems, global perspective

Sound and reliable information is the foundation of all around educated choices in all prosperity structures, and is basic for prosperity system procedure improvement and utilization, organization and rule, healthcare research, HR headway, medical health guidance just as training, organization transport and financing. The medical health information system gives the underpinnings to dynamic and has four key limits: production of information, investigation, assessment and association, and correspondence and use. The medical health information system assembles data from the medical care division and other relevant parts, assesses the data and ensures their overall quality, congruity and advantageous quality, and changes data into information for medical related choices (WHO, 2010).

2.5.1 An overview of nationwide aggregated healthcare information system in Estonia

Estonia's clinical services framework is characterized by creative e-mediations. Specialists' and patients, additionally clinical offices and medical car facilities, value the significant access and financed ventures that e-medical frameworks have created. Everyone in Estonia with a history of visiting a doctor possesses an online e-Medical data repository. Identified by the digital ID-card, the medicinal records are kept altogether safe and open to selected individuals. Bloack chao=in

technology commonly known as the KSI, is applied in the system for the purposes of security and (Taal, 2018).The e-wellbeing structure in Estonia, called the Estonian countrywide Health Information System (EHIS) has been operational since 2008. The essential accomplishment factors for the e-wellbeing system in Estonia are: - ***clear organization***, ***lawful lucidity***, ***a developed environment***, ***understanding about access rights***, and ***normalization of clinical data*** and ***data sharing guidelines*** (Metsallik et al., 2018). Principle components of the Estonian across the nation Health Information System (EHIS) are illustrated in the outline below.

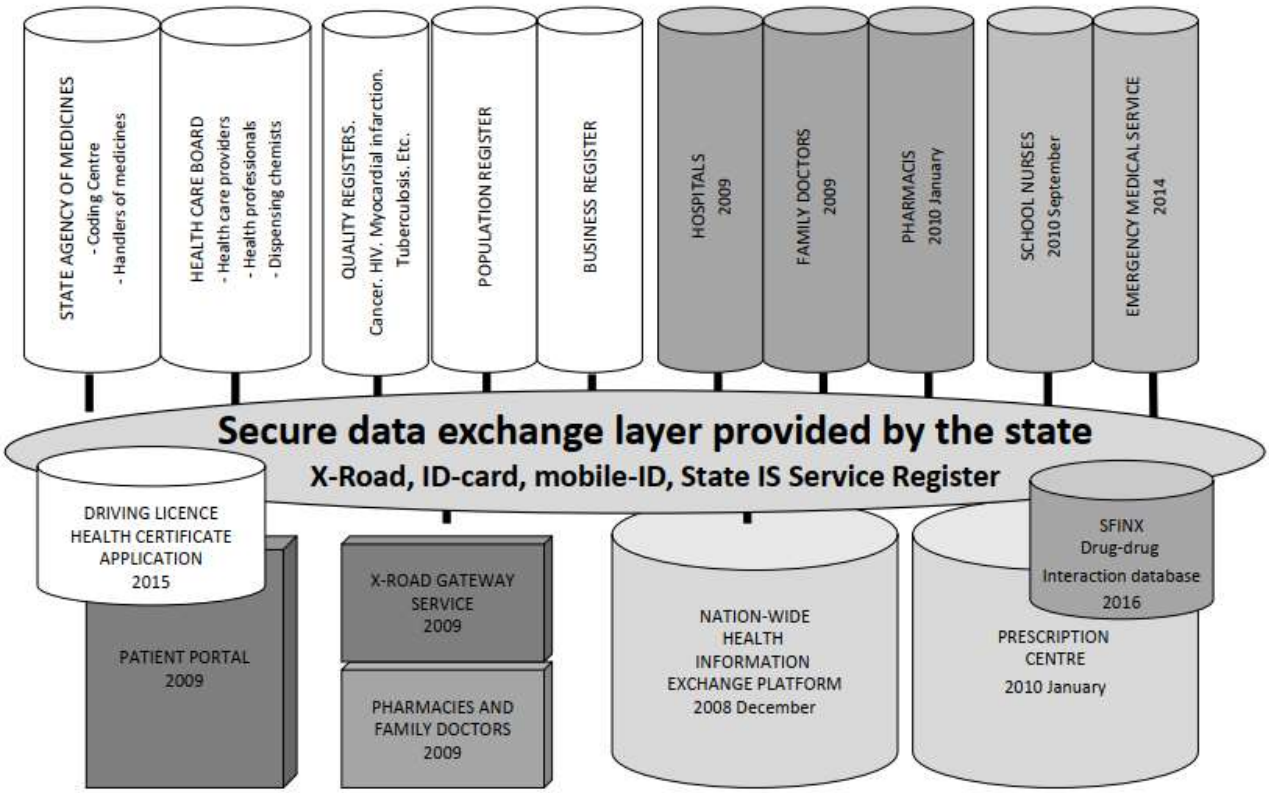


Figure 5: Main elements of the Estonian nationwide Health Information System (EHIS)

2.5.1.1 Government involvement

The dynamic planning of the Estonian e-wellbeing venture by the administration specialists and advocates of e-wellbeing framework occurred somewhere in the range of 2003 and 2005, anyway, some significant occasions occurred before. The Health Services Organization Act, which directs the medical services administration, was stretched out by another chapter for EHIS. The chapter sets out the obligations of patients, wellbeing specialist, and gives necessities to report principles, and so on. All endeavors to see social insurance information in EHIS are observed by the

administration specialists and reported to the patients in the patient's portal. If there should be an occurrence of doubts of unlawful access to the information, important moves are made right away. As indicated by the Act, the moral panel was made to lead the conversations on patients' privileges and to choose the best possible framework for the EHIS. Residents can get to their own information, proclaim expectations and inclinations, and screen logs (Metsallik et al., 2018).

2.5.2 How digital individual health data is accessed by residents in Sweden

The execution of digital health methodologies in Sweden is separated into six activity territories, which are characterized in the National Strategy for eHealth, which was first distributed in 2006. The initial three regions are responsible for setting up better essential conditions for ICT in wellbeing and care for the older citizens. The last three are responsible for the improvement of eHealth arrangements and adjusting these to healthcare consumers' needs. Preceding this National procedure eHealth was managed at a neighborhood or provincial level. The technique is an advancing archive; created through a progression of ordinary status reports. The most recent rendition of the National Strategy for eHealth was settled upon by the Sweden government in June 2010 (Hägglund and Scandurra, 2017).

2.5.2.1 The role of eCards in Sweden

As a major aspect of the distinguishing proof of patients and experts, eCards are utilized in Sweden. Residents and patients can utilize the eCard across the nation since 2005 for various purposes: They can utilize the ID card to speak with social insurance administrations, for example, affirming age and demonstrating identity when gathering professionally prescribed drug at a drug store. Furthermore the eCard can likewise be named to pay in a shop or direct financial business. Alongside the job of giving biometric information, it is intended to insert an electronic circuit in the eCard, which will have the option to convey electronic data – supposed electronic ID administrations (e-ID) – and subsequently distinguish the conveyor electronically. The objective set out by the Sweden government is to accomplish a national, cross-sectoral e-ID arrangement fit for guaranteeing secure electronic distinguishing proof when eServices are utilized (Hägglund and Scandurra, 2017). The eHealth infrastructure in Sweden is depicted in the diagram below.

Adopted from, Sellberg and Eltes, 2017

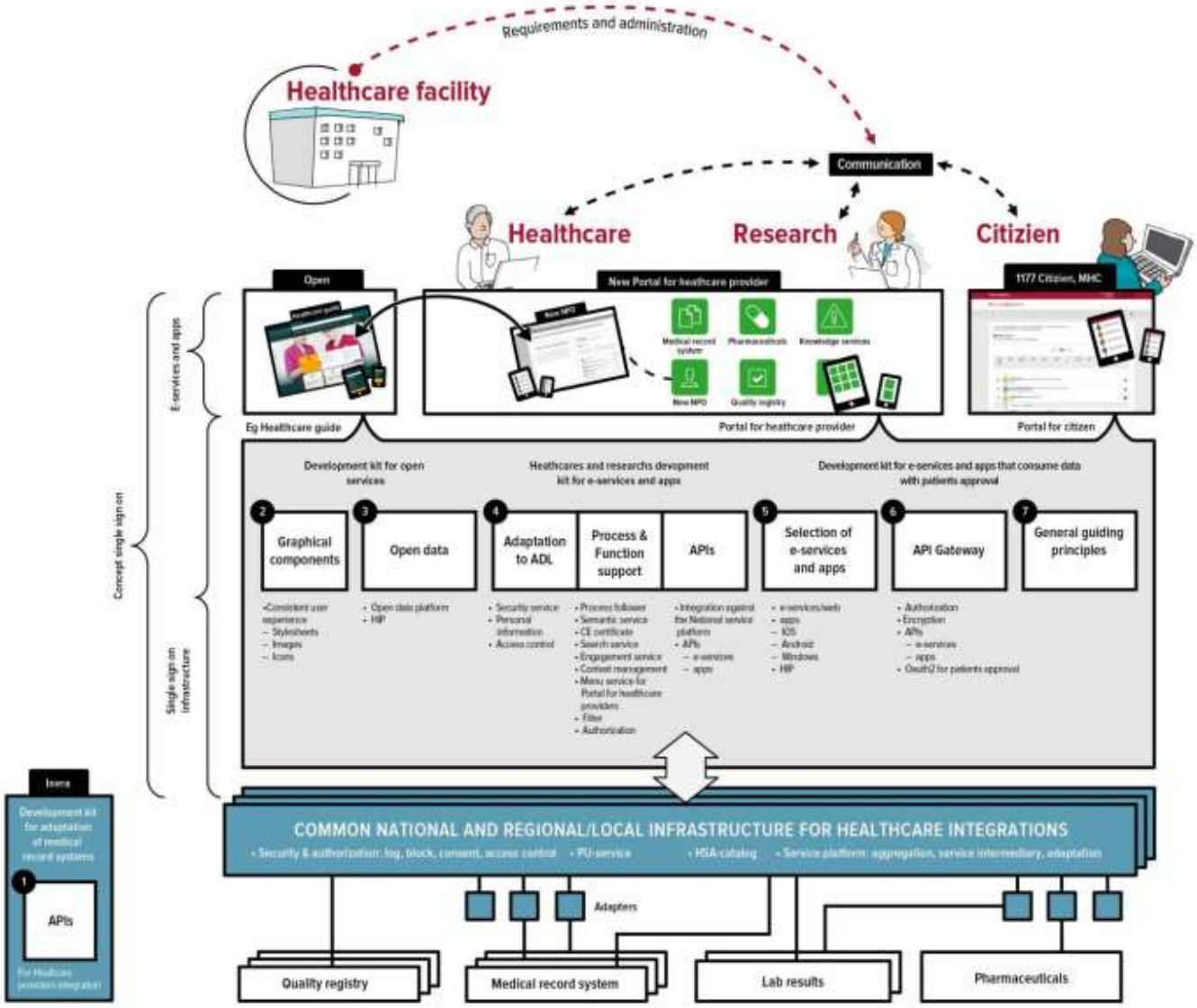


Figure 6: The eHealth infrastructure in Sweden

2.5.2.2 Government involvement

The duty regarding medicinal services arrangement in Sweden is shared between the nationa; government, district committees and regions, with the area chambers the main suppliers. Private medical suppliers likewise work all through Sweden, however they are openly financed and a coordinated piece of the national human services framework. This decentralized association of social insurance additionally implies that every region board (or private medical supplier) has the decision over which EHR framework it employments. This implies all through Sweden, a wide range of EHR frameworks are being used and interoperability between them has customarily been

low. Sweden is giving patients access to all their EHR information through two things to be specific; a national patient gateway and a national wellbeing data transmission system. (Sellberg and Eltes, 2017).

2.6 An overview of the Kenyan eHealth ecosystem

To change the nation into a center level economy, the legislature has started long haul advancement procedures that perceives Science, Technology and Innovation (ST&I) as the drivers to the acknowledgment of Vision 2030 and Sustainable Development Goals (SDGs). Results from a field research in 2016 and meta-examination of articles on eHealth distributed 2017 show that there has been noteworthy increment in take-up of eHealth mediations since the main activity recorded in 2001. Since 2010, we have seen quickened arrangement of eHealth intercessions. This pattern might be credited to the administration's acknowledgment of ICT as a key empowering agent to social, financial, and political turn of events. It is from this drawn out outline that approaches, methodology archives, enactments, and norms should be created and put into use. (Kenya National eHealth Policy (2016-2030).

2.6.1 The need for standardization of health systems in the health-care ecosystem

The operational target of normalization is to give sets of unsurprising points of interest called "models" to be shared by all participants creating comparative things, or giving comparable organizations (Meehan et al., 2016). There are a lot of commonly recognized general models used in therapeutic administrations. These incorporate the Health level 7 norms, OpenEHR, Digital imaging and interchanges in medication (Dicom), CEN/ISO EN13606, International Classification of Disease and so on, enables trade of modernized wellbeing records in a normalized way. As indicated by the Countrywide Digital Health Policy – Kenya (2016-2030), one among many other the difficulties to the joining of eHealth is the absence of norms and rules that are confined to the setting of utilization. This has constrained most eHealth item and specialist co-ops to choose restrictive guidelines from first world nations that may not materialize when applied in Kenya.

2.6.2 Legitimate and moral prerequisites

Absence of a far reaching legitimate structure on usage and utilization of eHealth frameworks and administrations may uncover patients and social insurance suppliers to unlawful and exploitative practices. Thus, the arrival of principles and rules for the Electronic Medical Records (EMR) in 2010, eHealth Strategic Plan (2011-2017), ICT strategy (2006), and Kenya Communications Act

(2012) denoted a significant achievement towards making an administrative structure favorable for the usage and use of eHealth in Kenya. Nonetheless, the administration is as yet confronted with legitimate difficulties in directing eHealth frameworks because of absence of eHealth enactments. This arrangement thusly perceives the requirement for a far reaching lawful structure that controls execution and utilization of eHealth frameworks and administrations in Kenya (Kenya National eHealth Policy 2016-2030).

2.6.3 e-Health obstacles

A few difficulties ruin effective execution of most eHealth frameworks in Kenya. A portion of the constraints include: - helpless framework; low education; absence of normalization; insufficient specialized ability; nonappearance of strategies administering interoperability and clinical information sharing; inconsistent force gracefully in underestimated regions; restricted financing and absence of government contribution in most eHealth ventures. Consequently, to quicken consistent mix of eHealth into customary medical services frameworks, WHO/ITU's Global Observatory Survey report (2014) focuses to the requirement for creating nations to figure eHealth techniques for conquering these difficulties. A portion of the methodologies and mediations being applied incorporate broadband network, strategy detailing, setting eHealth guidelines, making private-open organization, and limit building (Kenya National e-Health Policy 2016-2030)

2.6.4 The need for core infrastructure for health systems integration

The government has pledged to providing infrastructure as one of the pillars towards achieving a digital economy. Digital framework overrides the ordinary framework in that it has Information Technology abilities implanted inside it in this manner delivering it to have brilliant and increasingly responsive capacities sensors to make them keen and progressively responsive. The sagacity empowers the framework to be savvy enough to interconnect to different gadgets for example Brilliant vehicles, Speed sensors, savvy wellbeing, Traffic lights, Drones, Smart metering gadgets among different machines to electronically gather, process, investigate, store, remember and communicate information (Kenya Digital Economy Blueprint, 2019).

2.7 Theoretical framework

The research has been guided by a review of various architectural designs that have been implemented in other parts of the world where integrated eHealth initiatives have successfully

been implemented or are being implemented such as Estonia and Sweden. Transforming a health ecosystem into adopting technological advancement is not just a matter availing the technologies or the systems but a collective responsibility of all the stakeholders and users in general. From the reviewed cases, there are various building blocks that have been identified that are deemed to be the foundation of a successful implementation of an eHealth initiative. They include: - *technology/infrastructure, legal frameworks, policies, standardization, government involvement, user willingness, and health facility participation.*

2.8 General overview of the integration architecture proposed for Kenyan context

Adopted from Estonia's & Sweden's integrated health information systems

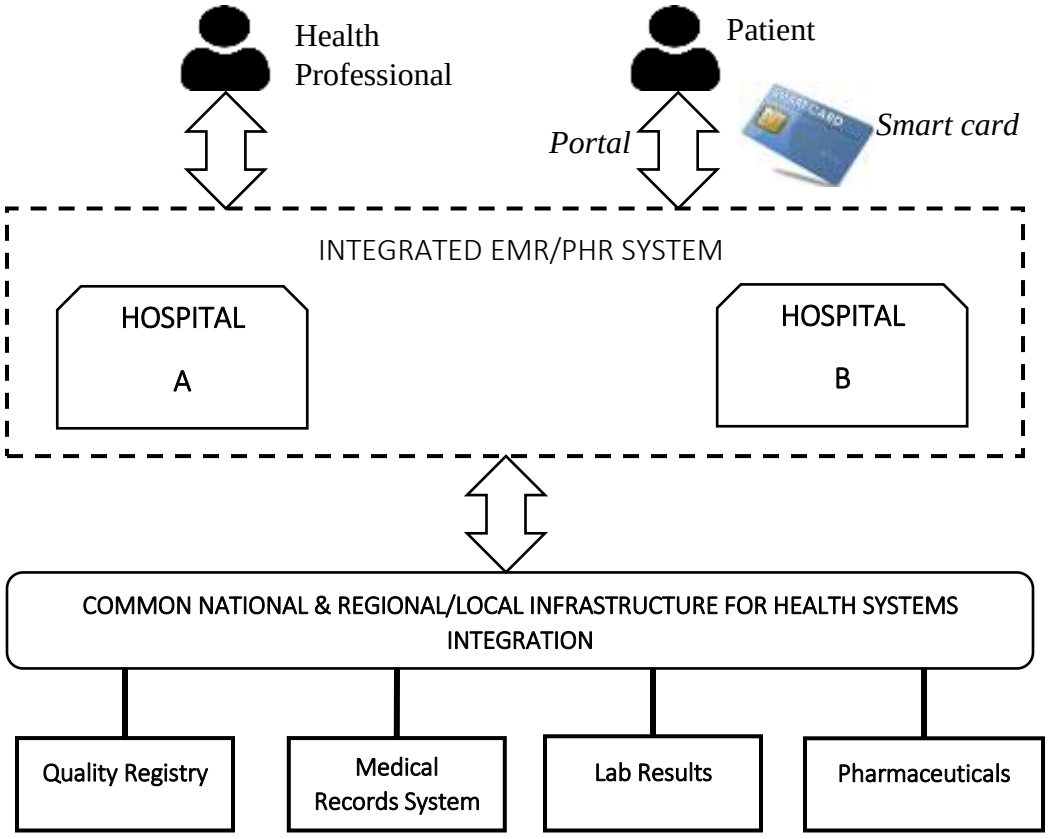


Figure 7: General overview of the integration architecture proposed for Kenyan context

2.8.1 Administrative and usage levels of the proposed architecture

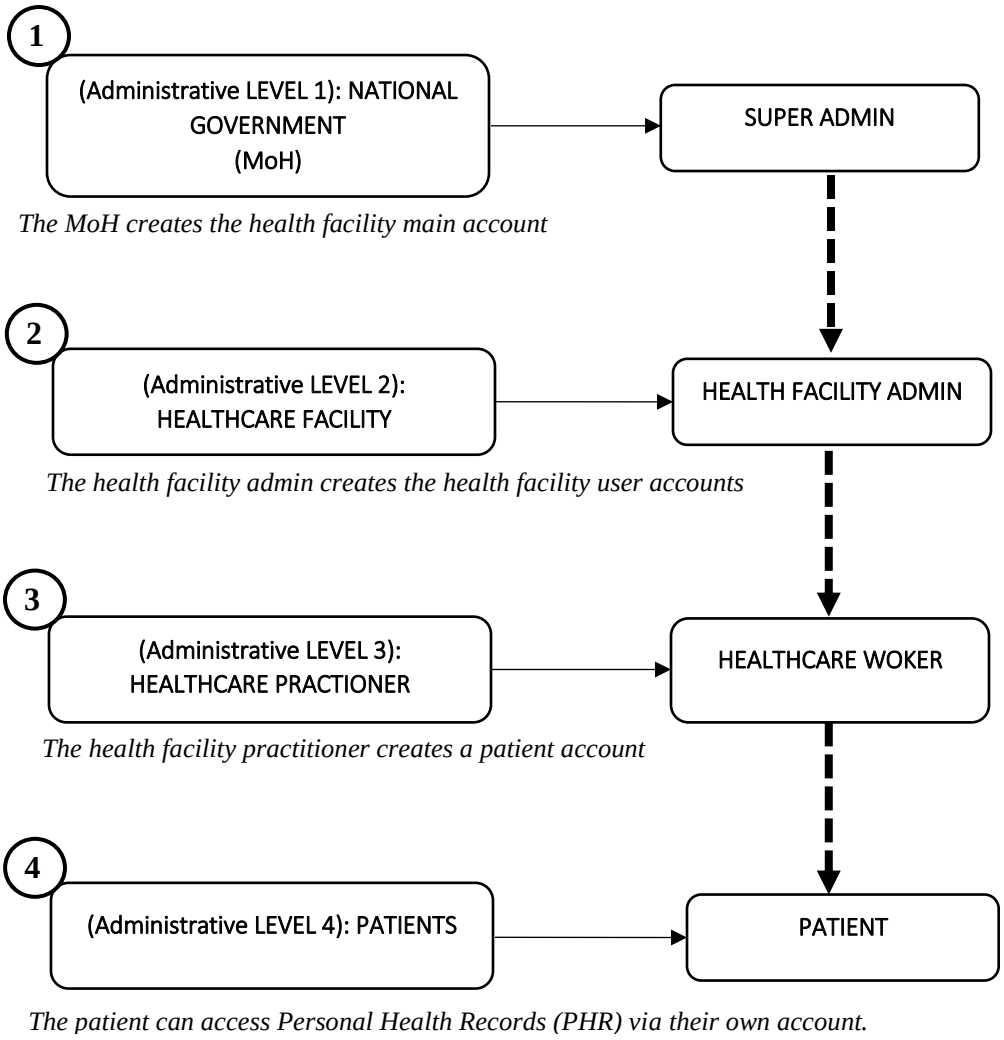


Figure 8: Administrative and usage levels of the proposed architecture

2.8.2 Security aspects of the proposed architecture

Savvy card-based e-wellbeing framework is novel as it is relied upon to coordinate characterized well-being services information of all medical suppliers and gives an outline of the wellbeing state of each patient as far as treatment history and other related information (Keliris, Kolias and Nikita, 2013). Such a thorough information framework requires a strong security framework. Thusly, the security of the proposed e-wellbeing framework will be guaranteed by the accompanying six characteristics:

- A secure validation and approval of all clients with ID card or savvy ID;
- Digital marking (by people) or computerized stamping (by foundations) of every single clinical record;
- Accountability and straightforwardness given by a carefully designed and un-removable secure log (review trail) containing all activities;
- Coding of individual information guarantees partition of individual information from clinical information;
- Encrypted database records permit a negligible classification risk from the specialized heads of the framework;
- Monitoring of all activities along with the relating countermeasures (both hierarchical and specialized) permits distinguishing proof of extortion and abuse rapidly and unquestionably

2.9 The architectural framework

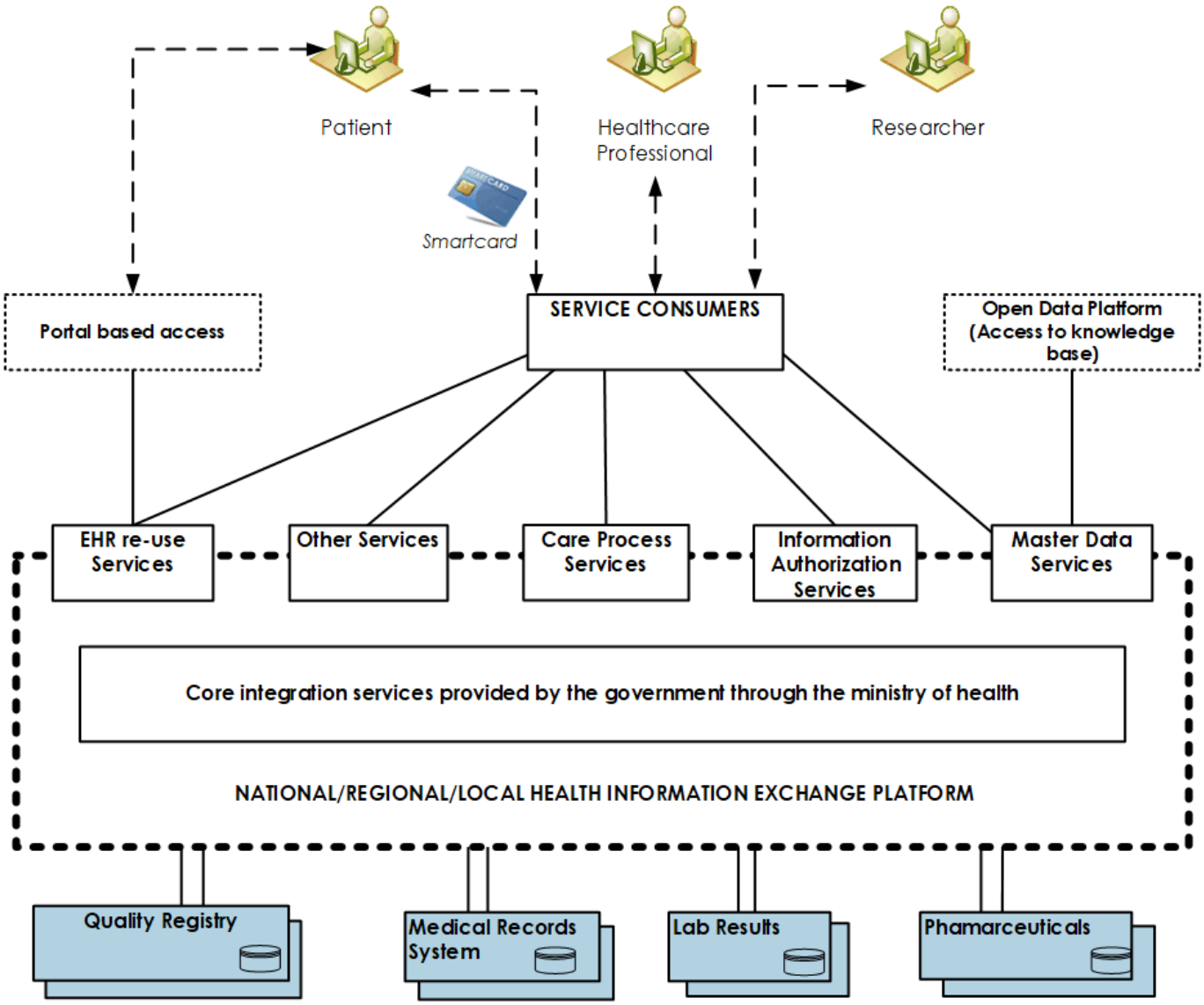


Figure 9: The architectural framework

2.9.1 Data table for the architectural framework

The table below explains the various data elements used in the architectural framework.

Table 2.1 Data table for the architectural framework

Data Element	**Attributes**
Portal based access	Access to personal health records by patients
EHR re-use services	Encounters, clinical notes, diagnosis, medications, , vaccinations, referrals, lab outcomes, allergies, insurance, next of kin details, Hospital appointments
Open data platform (Knowledge base)	Terminologies, quality reporting master data, quality reports
Service consumers	Patients, healthcare professionals, researchers. (*Interaction is through: - Applications, EMR, E-services, and quality services*).
Care process services	Encounter management, referral process, ePrescribing, lab order process, agency reporting, medical certificate exchange.
Information authorization services	Consent, restriction, EHR, access log, patient relationship.
Master data services	Healthcare professionals, citizens, quality reporting definitions, care services offerings, terminologies.
Quality registry	For collecting, analyzing and reporting health-related information
Medical records system	Integrated repository for patient's medical records
Laboratory results	Integrated repository for lab results
Pharmaceuticals	Integrated repository for pharmaceutical records (*drug catalogue and patient prescriptions*)
Patient	Healthcare services consumer (personal health records owner)
Healthcare professional	Healthcare services giver (e.g. to the patient)
Researcher	Healthcare knowledge contributor (individual or agency)
Core health information exchange bus	Given and monitored by the legislature through the ministry of wellbeing (MoH-Kenya).

CHAPTER THREE

THE METHODOLOGY OF THE RESEARCH

3.0 Introduction

The section portrays the reasoning behind the research, research structures adopted and utilized during the research, basis of the philosophy, depiction of the research zone, target populace, testing strategies, information assortment technique, materials and techniques, measurable information treatment lastly information investigation techniques utilized.

3.1 Requirements analysis

The research focused on devising a conceivable solution for the Kenyan context that would enable interoperability of personal medical data via the introduction of smart card based PHR systems. Thus, the research involved knowledge development, knowledge utilization, design and development. The key data required for this research included understanding the applications of smart cards in healthcare; personal health records access, storage and sharing; and understanding the minimum health data set that can be used to provide continuity of care. Questionnaires were utilized as the primary tool for data gathering from randomly sampled patients and health care workers from various healthcare facilities within the country as detailed in the sections below. Online survey developed using Google Forms, were sent out to different respondents in various locations in the country. The data accumulated from this process contributed to answering the research questions.

3.2 Research design

The research utilized an illustrative research strategy in investigating the different components of research that were recognized. An research strategy is the method the scientist utilizes for responding to the questions of the research which sets up the structure for the research or the outline of the analyst (Creswell and Creswell, 2017). Study research is portrayed as a technique for gathering data by talking or regulating polls to an research test. Surveys are good for obtaining information from enormous instances of the masses and are exhaustive in the sorts and number of variables that may be thought of, require immaterial theory to make and direct, and are tolerably straightforward for making theories. The survey method was utilized due to its engaging nature so as to help the specialist in gathering information from respondents to gauge the populace

boundaries. Studies may likewise evoke information about viewpoints that are regardless difficult to measure using observational methodology (Ponto, 2015).

The segment beneath delineates the examination procedure and techniques used to accomplish the different research goals by addressing the different research questions as outlined in the following table.

Table 3.2 Questions of the research and the methods of research utilized

Question	**Research method**
• What are the uses of smart-cards in the wellbeing framework?	Reading through the existing literature Questionnaires
• How can we can enable suffers monitor, control and share their individual medical records?	Reviewing of existing literature Questionnaires
• What are the challenges faced by healthcare staff in enabling sufferers possess their electronic personal medical records?	Reviewing of existing literature Questionnaires
• What is the minimum health data set that can be used to provide continuity of care?	Reviewing of existing literature Structured questions

3.3 The aimed populace

The targeted populace size used in the research was suggested to be 110 persons composed of randomly sampled patients and various healthcare workers drawn from various primary healthcare facilities in various counties within the county. Otzen & Manterola (2017), portrays an objective populace as any gathering of foundations, individuals or items that have basic attributes. The healthcare workers participants were drawn from various departments such as laboratory, pharmacy, Nursing, Clinical, Dental and Radiology. For the patients' participants, they were randomly picked from the general public population.

3.4 Sample size

Through the guide from the table formulated by Kerjcie and Morgan (1970), the research proposed a sample-size of 86 participants drawn from a target populace size of 110 persons composed of

patients and healthcare workers. A populace representation size is described as a unit of a subject of the full populace utilized to show the overall interpretations of the aimed representative populace. A representative size is useful to a researcher when it brings out a reliable representation of the population for generalization (Taherdoost, 2016).

3.5 Research instruments

The research embraced surveys as the essential information assortment instrument. Polls were created in accordance with the research goals. The polls focusing on patients and human services workers were created utilizing Google forms and were regulated on the web. As indicated by Goertzen (2017), surveys give for the most part unassuming, smart and capable technique for getting a ton of information from a gigantic case of people. Data can be accumulated reasonably quickly in light of the fact that the researcher shouldn't be accessible when the surveys were done. This is important for tremendous peoples when gatherings would be ridiculous. To guarantee the legitimacy of the research, the information is gathered from the genuine settings. The inquiries for the poll were framed dependent on the research goals, investigated scholarly works, together with the input of different specialists.

3.6 Ethical issues

The researcher sought approval from the university, to perform the research and was issued with a letter to take to the target primary health care facilities. Before the information assortment instrument was sent out to the respondents, express assent was looked for from them. Before this, preparation meetings were held with the respondents to give them affirmation that the examination and the information gathered was for scholarly purposes just and hence their security, protection, obscurity and privacy all through the research procedure, was ensured. Because of the susceptibility of patient's clinical records, the information assortment associated with this examination concentrated on the procedure and not the real patient's clinical information.

3.7 Analysis of data

While conducting the research, all the information was investigated for exactness and consistency. The examination was brought out through literary arrangements with the assistance of tables. The examination concentrated on building up a model and exhibiting its contribution on the compactness of individual wellbeing records and quantitative information investigation techniques were embraced. Findings from the questionnaires administered to various participants are analyzed

quantitatively using SPSS software. The discoveries from the information examination were then outlined as per the research goals.

3.8 Prototype design and analysis

The system consists of three layers namely: -

- The user interface, which is a web-based Graphical User Interface for system administrators, healthcare professionals and patients to interact with the system.
- Input and output processing layer – Used stored procedures for fast processing of inputs and outputs
- Database layer which is where patient personal health records are stored.

3.8.1 Overall database architecture

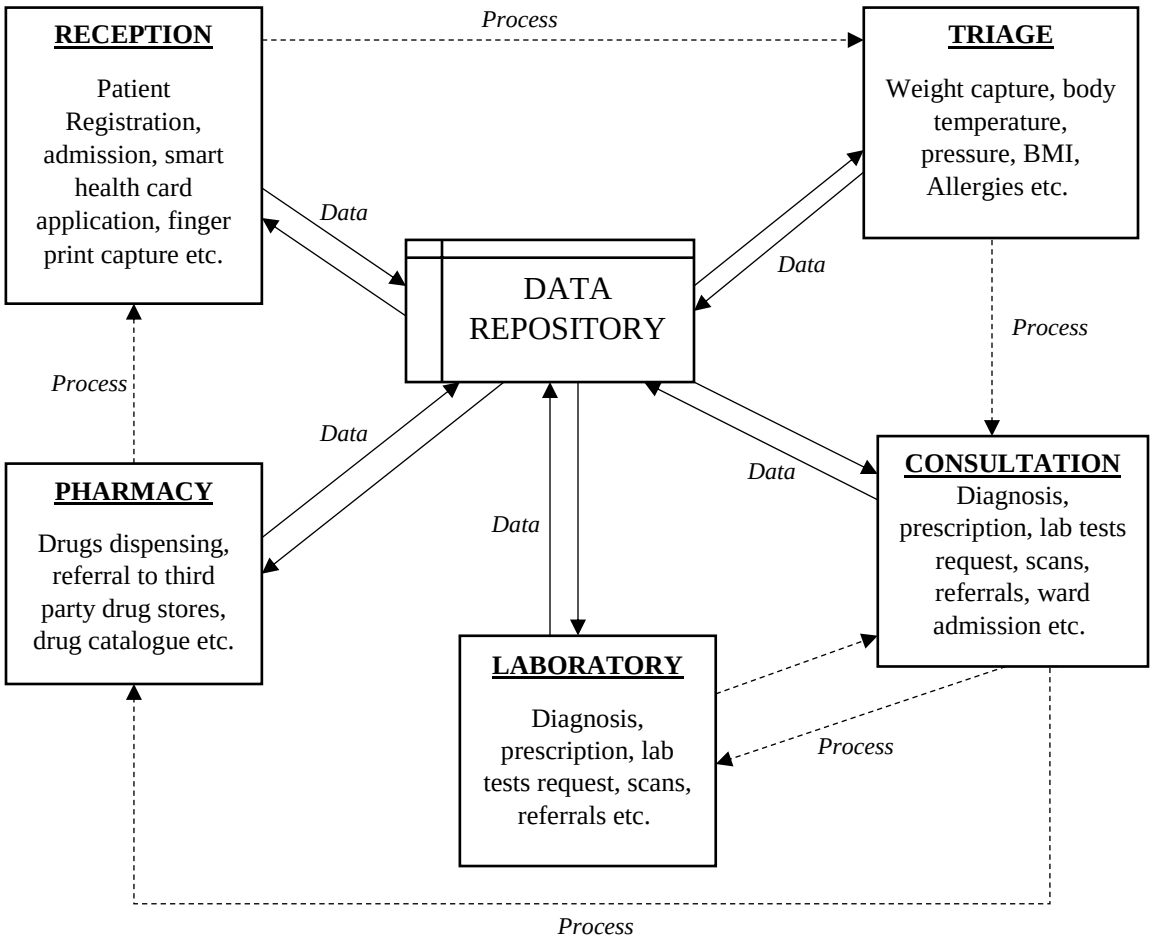


Figure 10: Overall database architecture

3.8.2 Use case – Reception

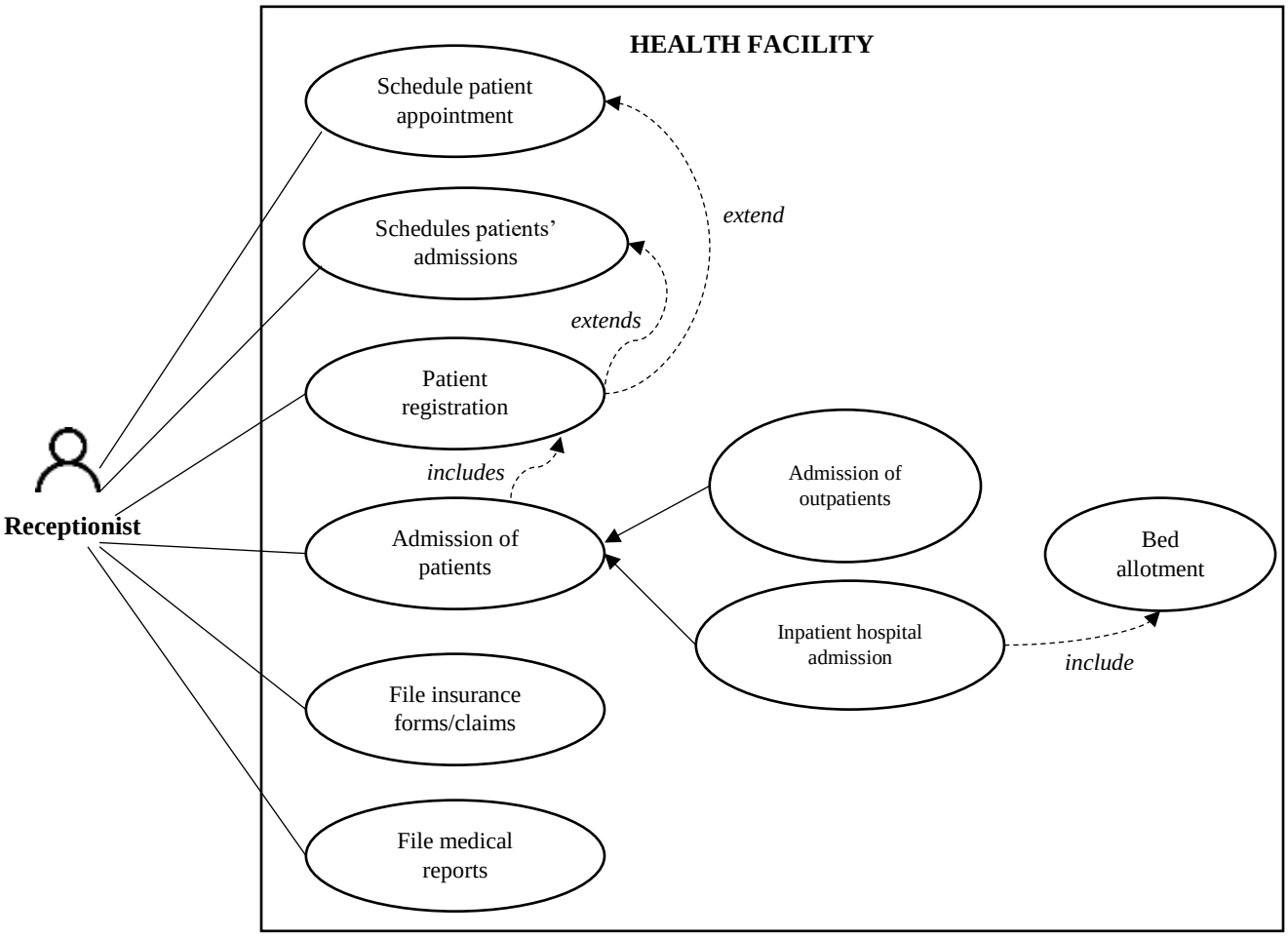


Figure 11: Use case – Reception

3.8.3 Use case – Ministry of Health super admin

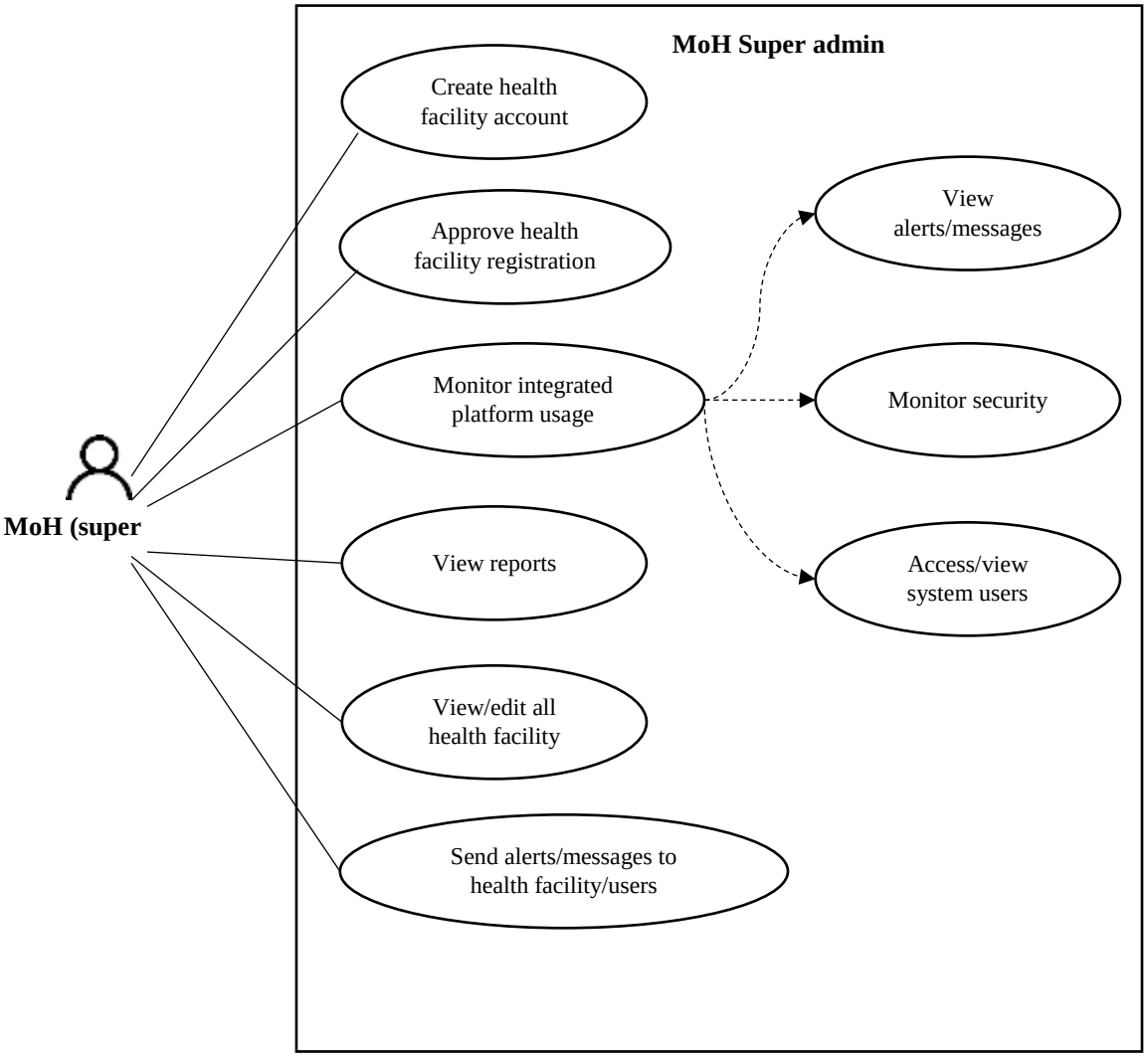


Figure 12: Use case – Ministry of Health super admin

3.8.4 Use case – Patient

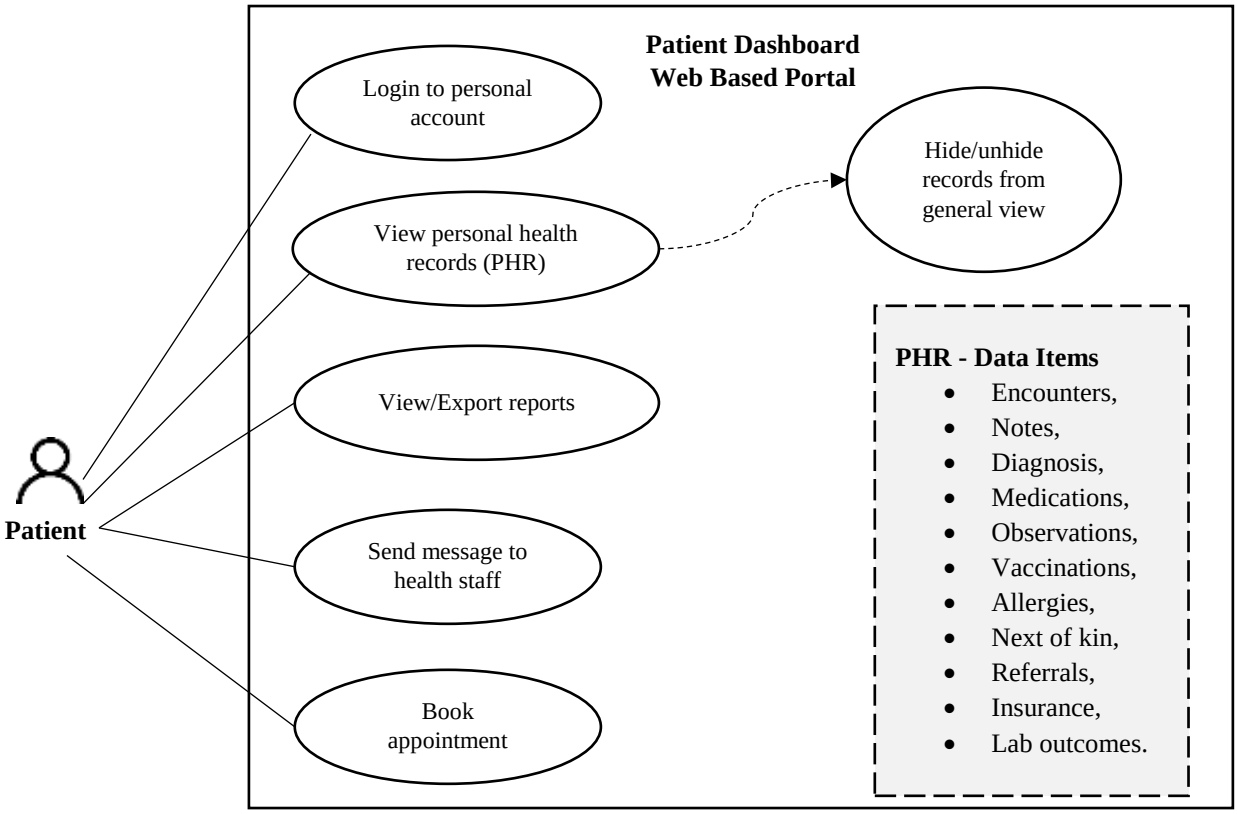


Figure 13: Use case – Patient

3.8.5 Use case – Healthcare facility admin

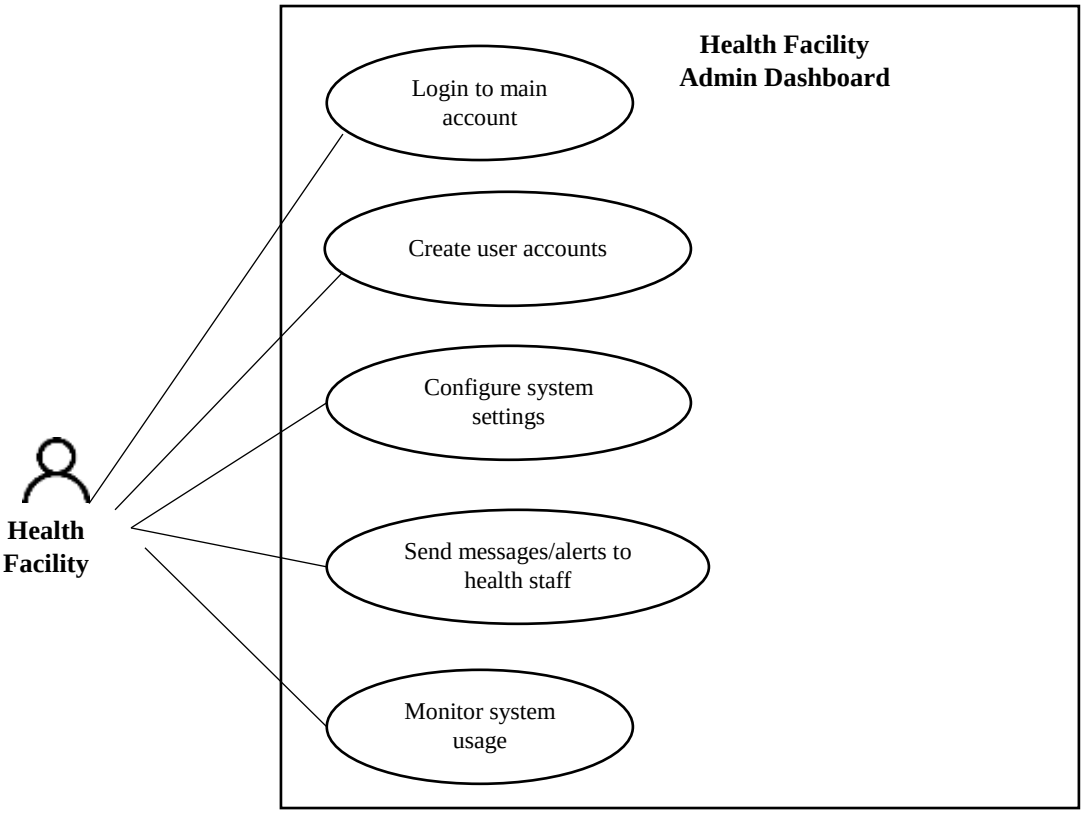


Figure 14: Use case – Healthcare facility admin

3.8.6 Overall patient's journey

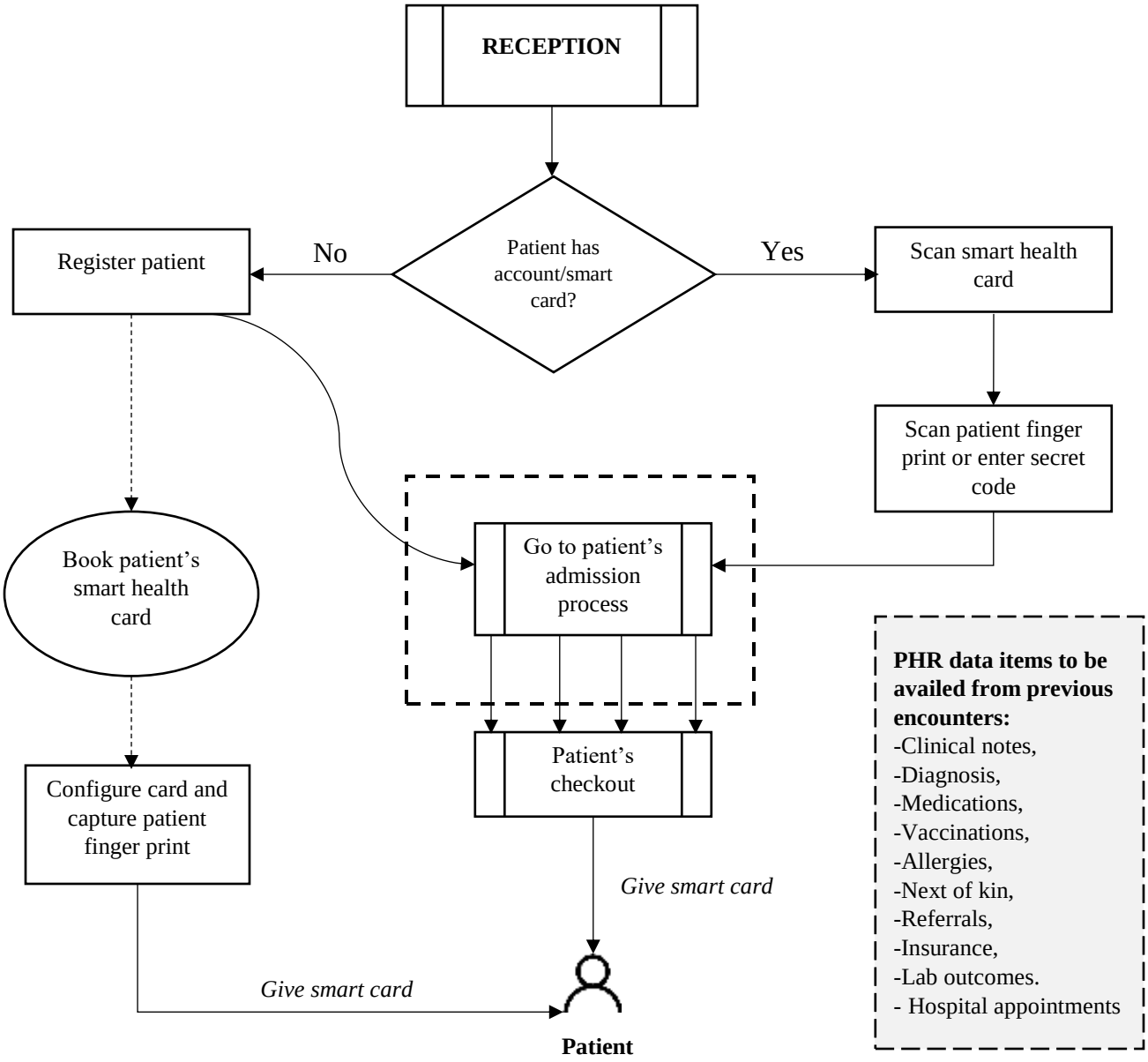


Figure 15: Overall patient's journey

3.8.7 System administrative and user levels

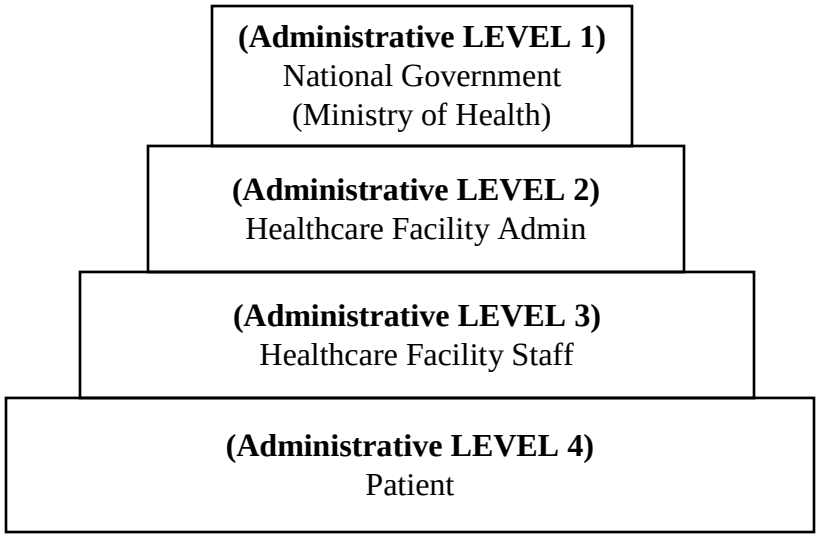
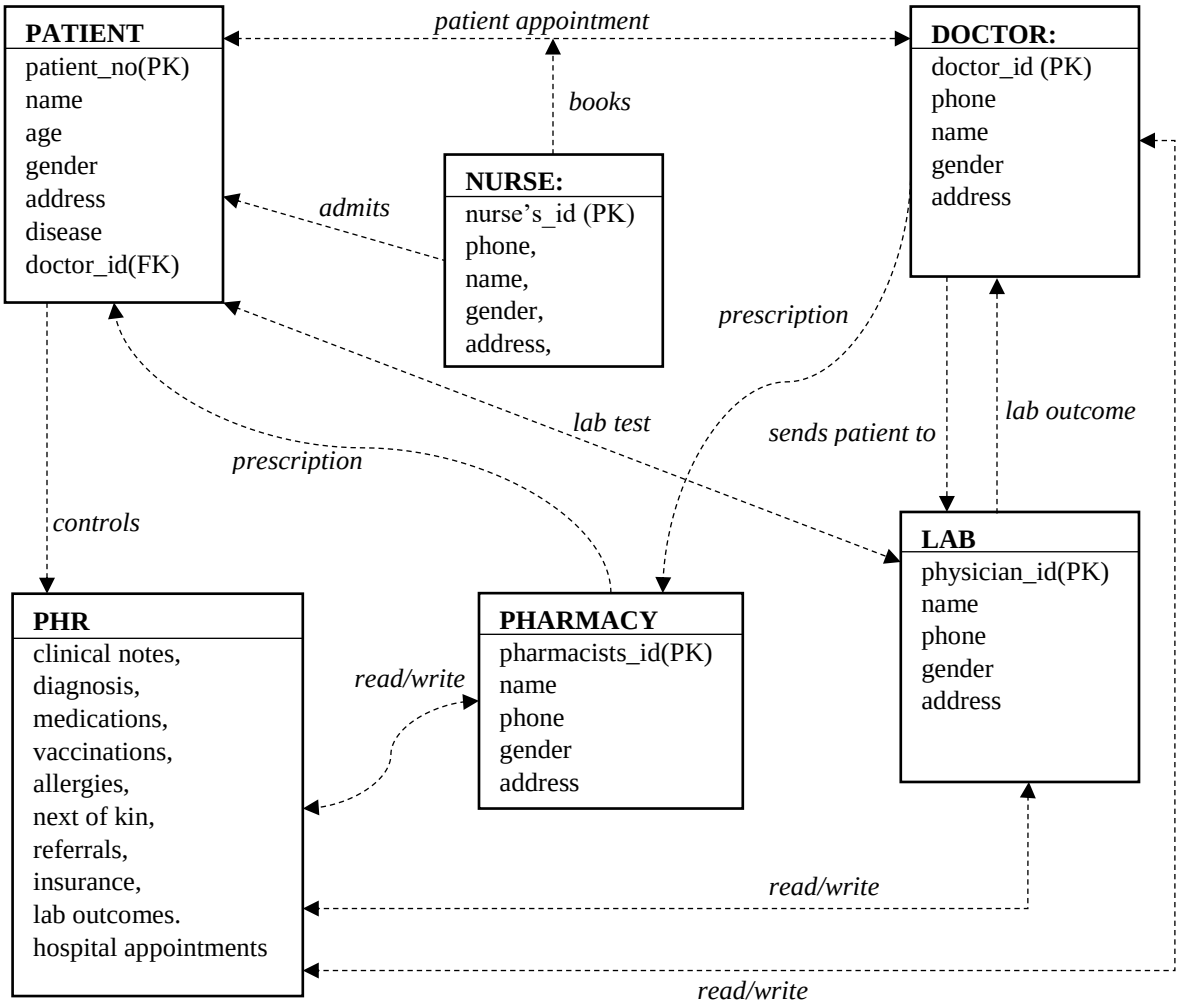
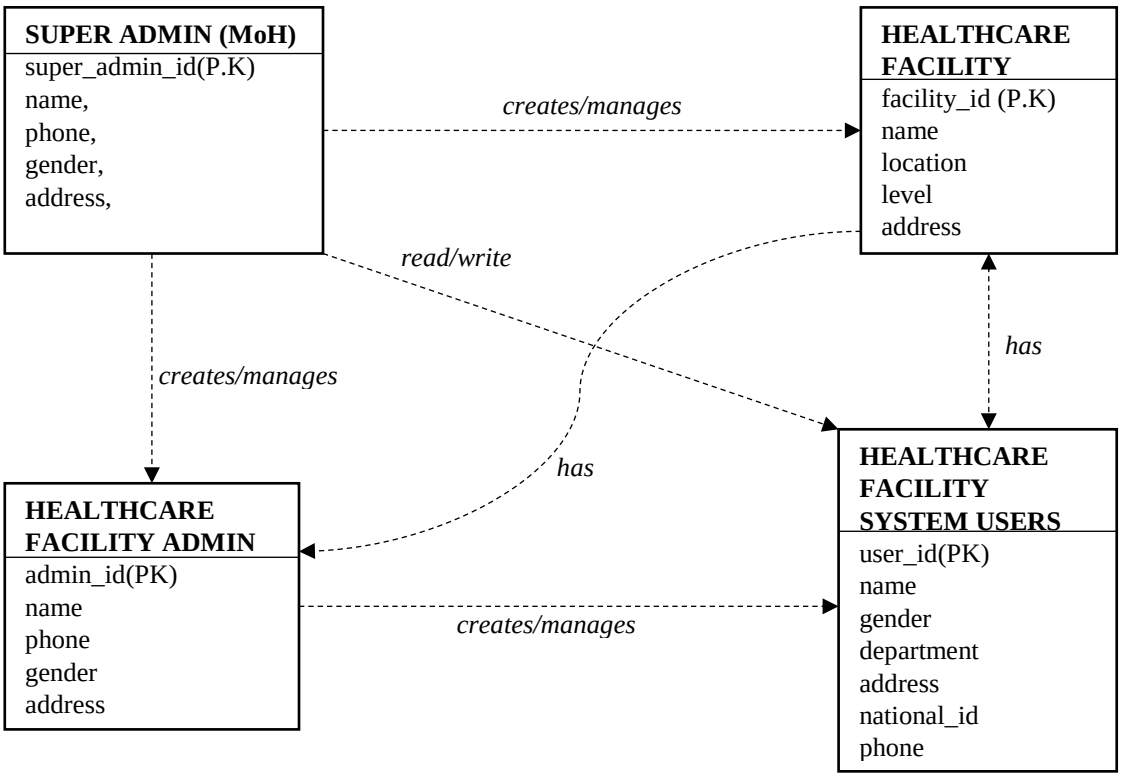


Figure 16: System administrative and user levels

3.8.8 Entity Relationship (ER) Diagram – Users experience



3.8.9 Entity Relationship (ER) Diagram – System administration



CHAPTER FOUR

PROTOTYPE IMPLEMENTATION, DATA INSPECTION AND EXPLANATION

4.1 Introduction

The section outlines the prototype implementation, the outcomes of the research as well as the detailed discussions. All the data is outlined in table formats. The findings of research are explained according to the themes according to the research objectives.

4.2 Prototype implementation and testing

The section expounds the prototype design, implementation and testing. Technologies that were used include MySQL for the database, PHP programming language for the user interface using Laravel Framework and GitHub was used for hosting, code versioning and collaboration.

4.2.1 System Login Screen

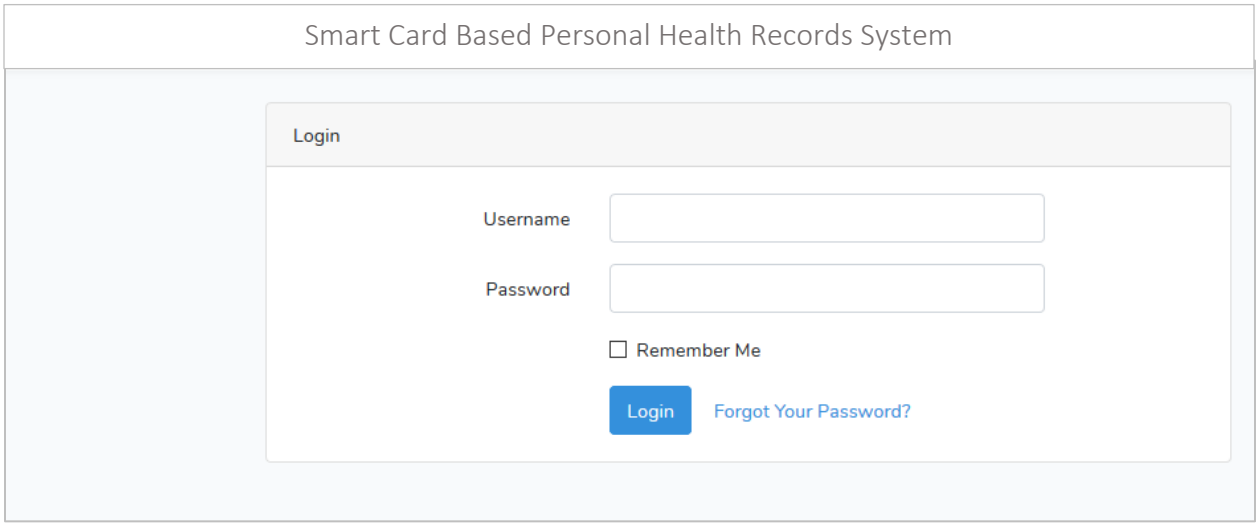


Figure 17: System login screen

4.2.2 Super administrator (Ministry of Health) dashboard

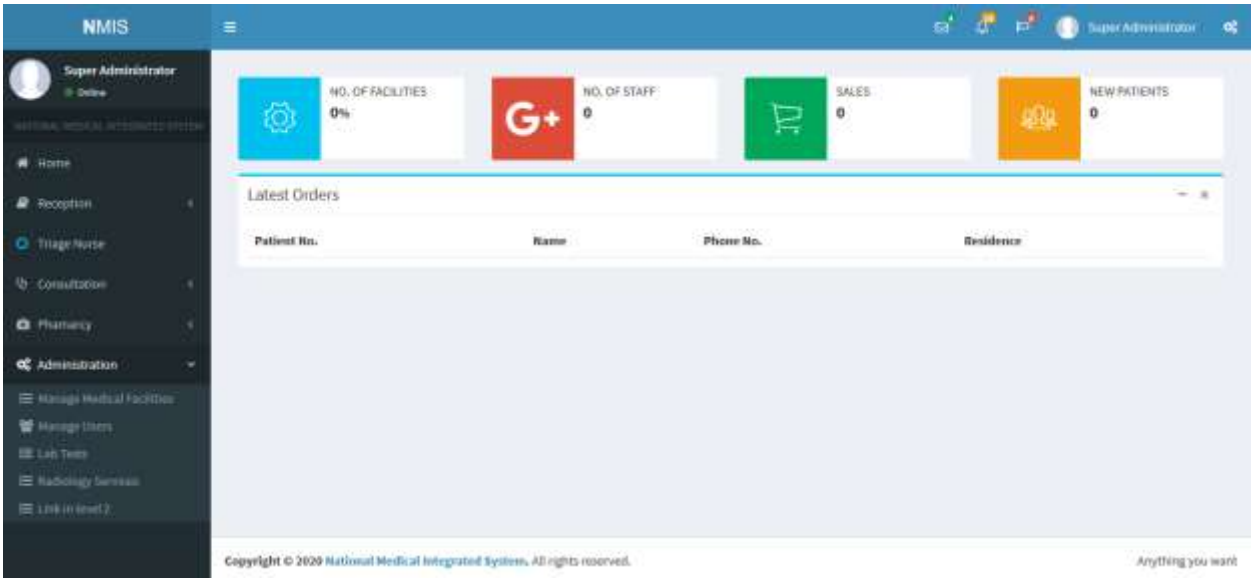


Figure 18: Super administrator (Ministry of Health) dashboard

4.2.2.1 Super admin adding healthcare facilities

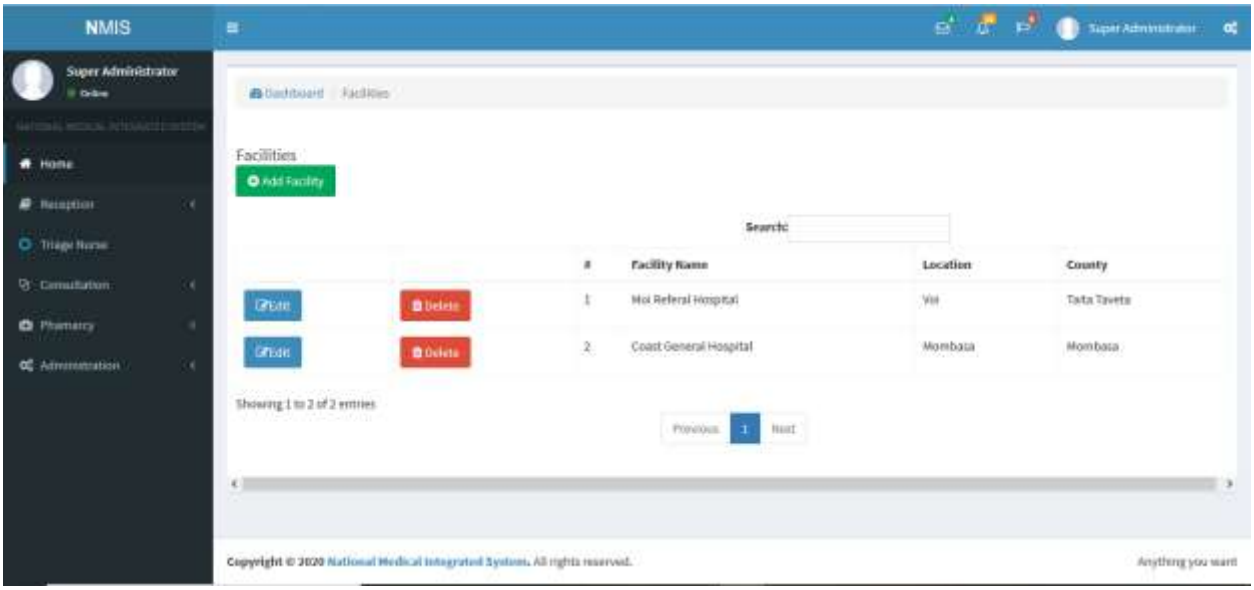


Figure 19: Super admin adding healthcare facilities

4.2.2.2 Super admin adding healthcare facility admins

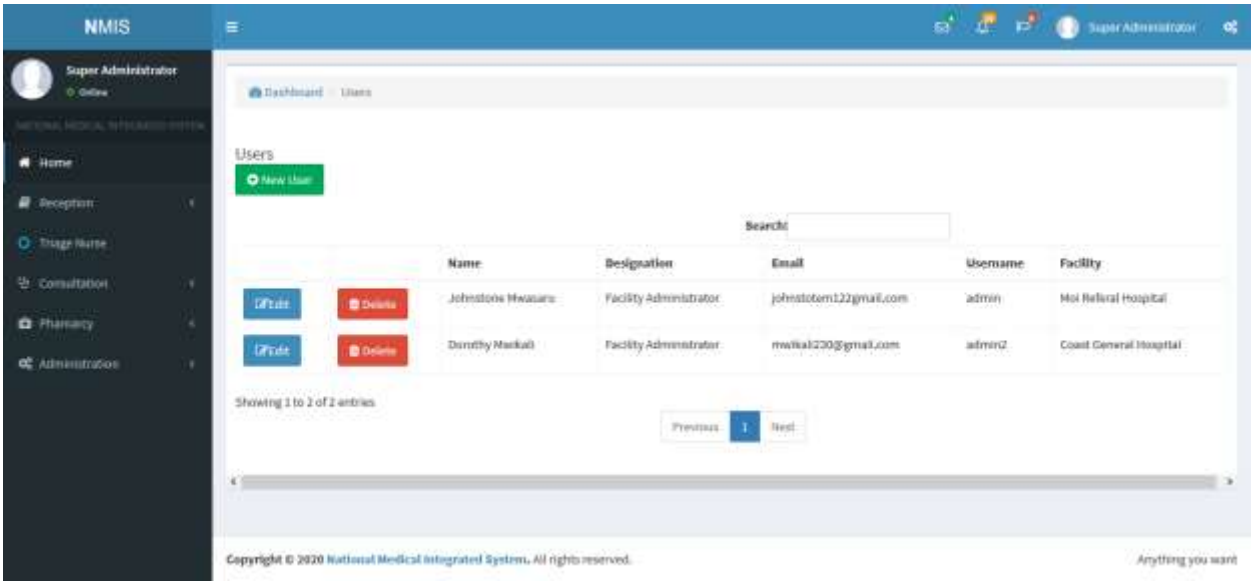


Figure 20: Super admin adding healthcare facility admins

4.2.3 Healthcare facility main admin dashboard

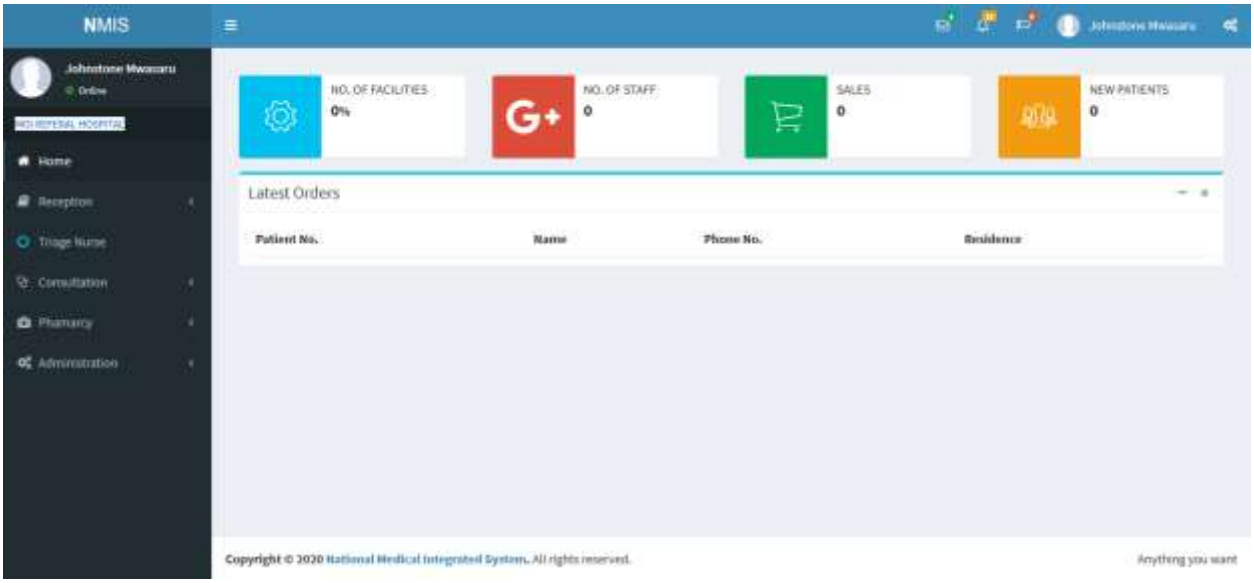


Figure 21: Healthcare facility main admin dashboard

4.2.3.1 Healthcare facility admin creates staff/other facility user account accounts

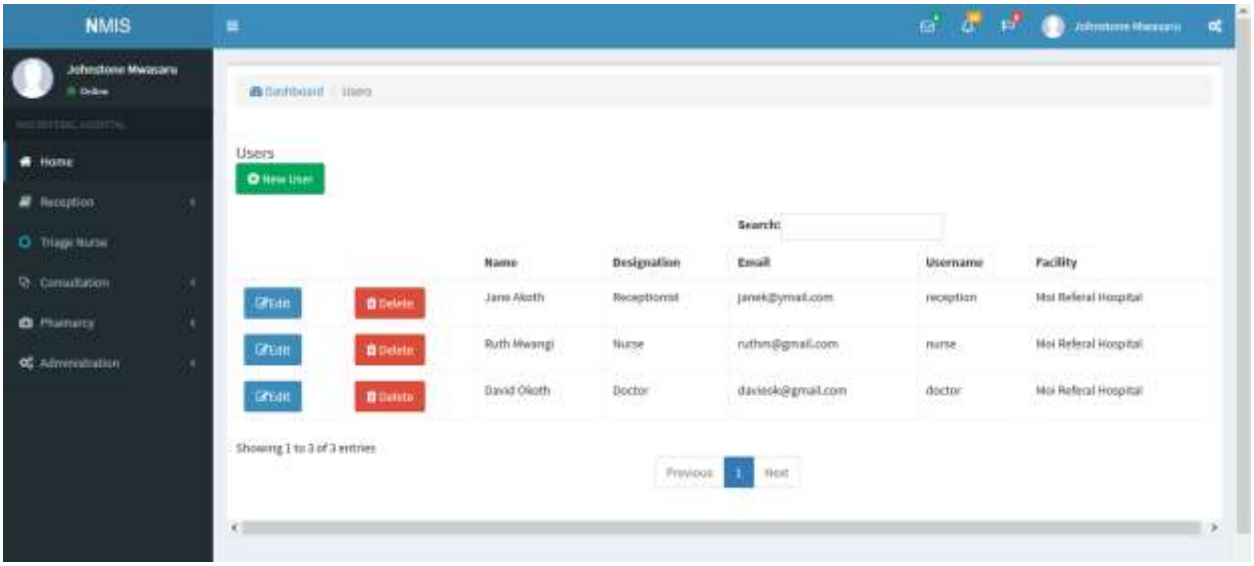


Figure 22: Healthcare facility admin creates staff/other facility user account accounts

4.2.3.2 Healthcare facility admin configures other system settings

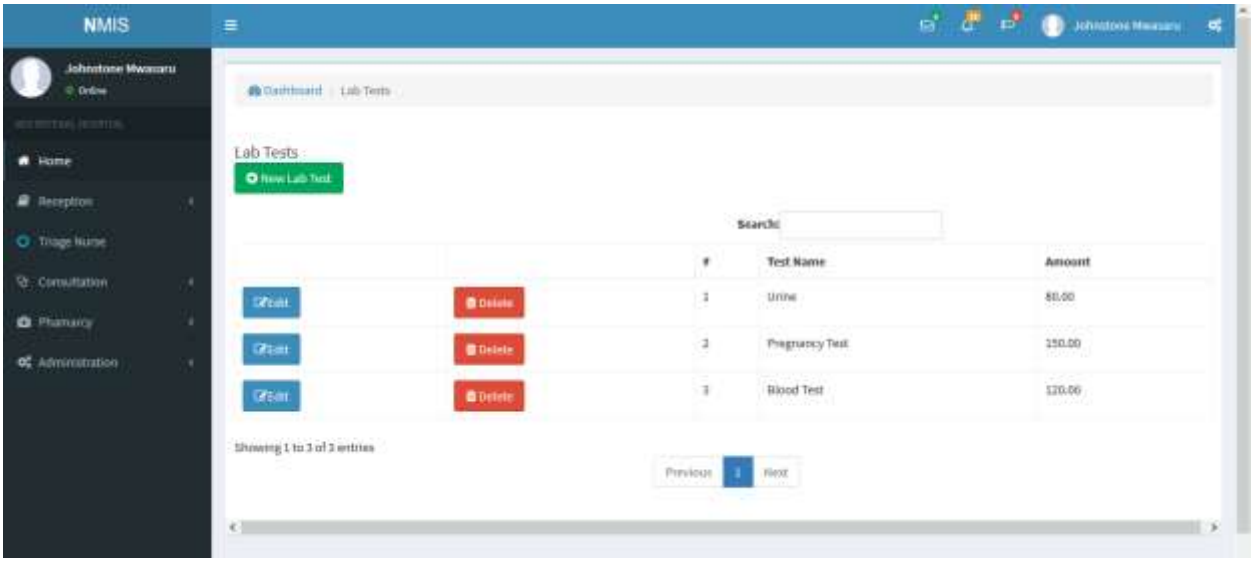


Figure 23: Healthcare facility admin configures other system settings

4.2.4 Healthcare facility staff dashboard

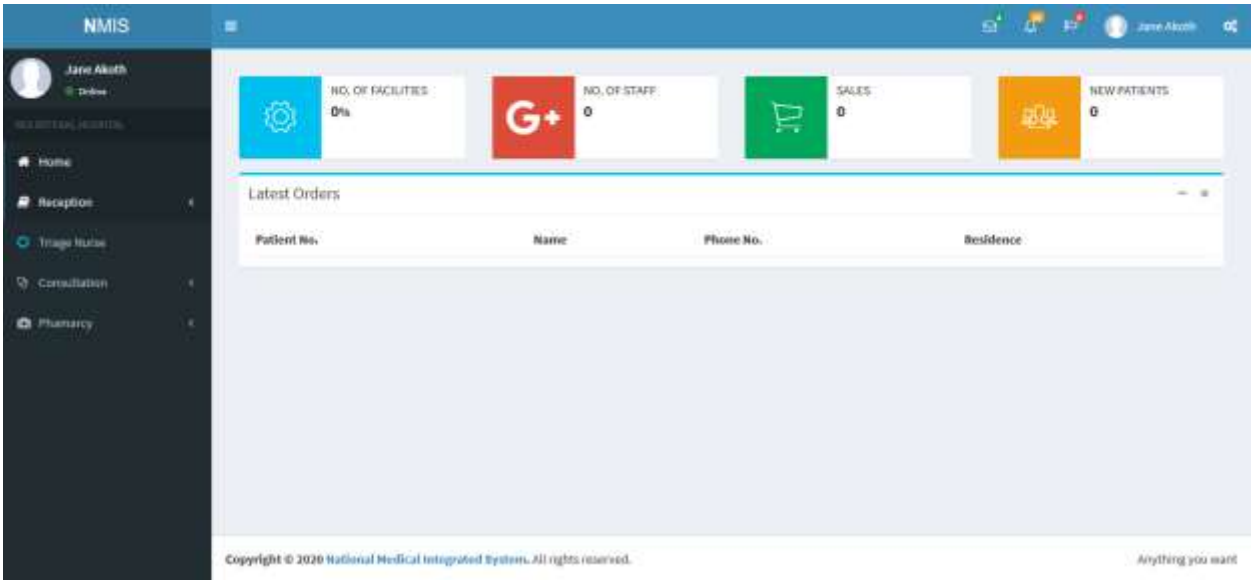


Figure 24: Healthcare facility staff dashboard

4.2.4.1 Healthcare facility staff managing patients

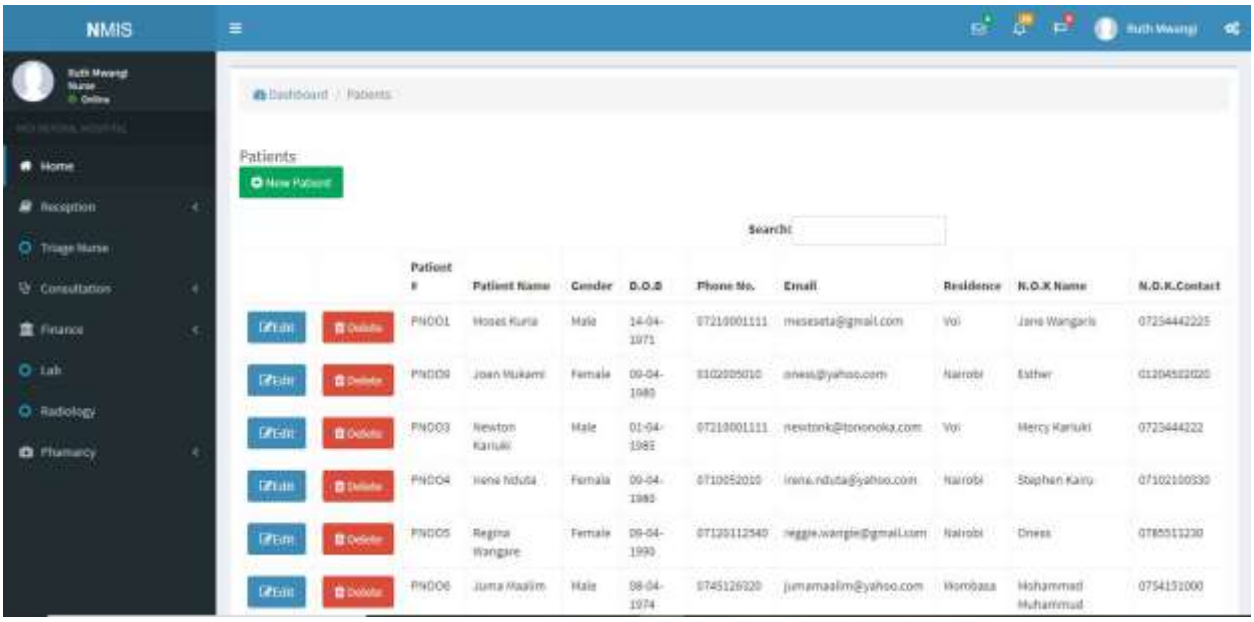


Figure 25: Healthcare facility staff managing patients

4.2.4.2 Patient dashboard –management of medical data visibility

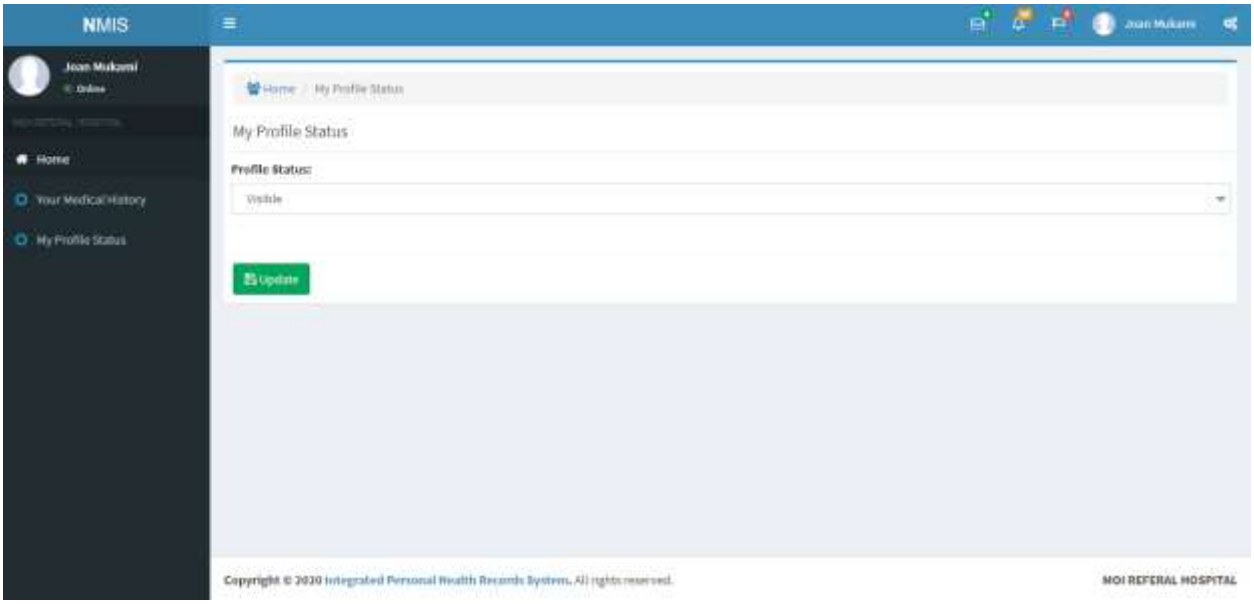


Figure 26: Patient dashboard –management of medical data visibility

4.2.5 Testing of the system and the outcome

Table 4.0 Test cases and outcomes

Test-ID	Test Description	Expected Results	Observed Results
One	A user logging in with incorrect username and or password	Login attempt should fail and error message sent displayed to user	Login was unsuccessful and message echoed onscreen "The login details entered are not correct"
Two	Super admin (MoH) can create facilities and facility admin	The system should allow super-admin to capture healthcare facilities as well admins for those	The super admin was able to create healthcare facility accounts, as well as admins.
Three	A user in a healthcare facility has access to personalized dashboard that is not shared by the other facilities.	When a user belonging to a specific healthcare facility logs in, they should access the dashboard for that facility only	A user with an account belonging to a specific facility was able to access personalized dashboard for that facility but could not access dashboard for another facility.
Four	Only patient data is shared across the various healthcare facilities.	A patient profile that is open for viewing should be available across different healthcare facilities	Different users, logged into two different facility accounts and they were able to view the same patients' profiles shared across board

Five	A patient logged into the system can grant or deny physicians access to personal health records by putting the profile into hidden mode.	When denied access, the health workers should be unable to trace the patient's records in the patients register or any other data related to the patient.	Different user roles logged into the system and searched the record of the patient and they were nowhere to be found until the when the patient granted access.
Six	Personalized dashboards are private to each healthcare facility apart from the shared patient's data.	A physician logged into the system cannot be able to access other healthcare facility's information such as employee details, departmental details etc. apart from shared patients records	A physician logged into one of the healthcare facility's account and could not access information belonging to other healthcare facilities such as employee data. The only information accessible across board was the shared patient's data.
Seven	An admin is able to create logging credentials for other system other users and patients	An admin should be able to create physicians' accounts as well as those of patients and issue login credentials	A healthcare facility admin was able to login and create various user roles for a particular healthcare facility and was also able to create patients accounts and issued login credentials
Eight	An admin is able to issue and print a smart card to a patient	A healthcare facility admin should be able to issue and print smart cards for a patient	A healthcare facility admin was able to issue and print a smart card for a patient.
Nine	A physician is able to search for patients data using the smart card's unique QR code	A physician should be able to scan the QR-code on the smart-card of the patient retrieving the record of the patient.	A physician was able to scan the patient's smart card using an external QR code reader integrated in a smart phone and managed to view the records of the patient.
Ten	A physician is enabled to create a profile for a patient or edit an existing one	A physician attending to a patient should either be able to modify the records of the patient or create new.	A user with the role of a nurse logged into the system and was able to create new patient profile as well as updating existing.

4.3 Questionnaire response rate

The research grouped the respondents into two distinctive groups; and different sets of questionnaires were administered. One set targeted the patients and the other set targeted the healthcare workers. The research aimed at a population size of 86 respondents from which 72 questionnaires (36 patients – personal health records owners – from 12 Counties and 36 healthcare

workers from 10 Counties) were answered and given back giving a response-rate of 83.7%. Mugenda (2008) states that a response with the rate of 50% is enough for a research, 60% is fulfilling and 70% or more is excellent. Therefore, a response that was at 83.7% was suitable and could fully be relied upon for this research.

Table 4.1 Questionnaire response rate

	Administered questionnaires	**Returned and Filled Questionnaires**	**Percentage**
Respondents	86	72	83.7

4.4 Respondents demographic attributes.

The research sought to establish the demographical characteristics of the participants. This aimed finding out their gender, county and level of education of both PHR users (patients) and healthcare workers who participated in the survey. This is further discussed below as per the themes in the questionnaire.

4.4.1 Tabulation of participants by gender

The research sought to find the number of male and female participants and therefore they were asked to state their gender in the questionnaire. Table 4.2 and 4.3 below indicate the results of gender distribution for PHR users and healthcare workers respectively.

Table 4.2 Distribution of respondents by gender - PHR users (patients)

Gender	**Frequency**	**Percentage**
Female	23	63.9
Male	13	36.1
Total	**36**	**100.0**

Table 4.2 above illustrates that 23 (63.9%) of the participants were female while 13 (36.1%) were male. This is an indication that data was collected from various PHR users irrespective of their gender and the research did not suffer from gender bias.

Table 4.3 Tabulation of participants by gender - Healthcare workers

Gender	Frequency	Percentage
Female	17	47.2
Male	19	52.8
Total	**36**	**100.0**

The results presented in the table above indicates that 17 (47.2%) of the participants were female while 19 (52.8%) were male. Similarly, this is an indication that data was collected from all genders without bias.

4.4.2 Tabulation of participants by county

The research also sought to establish the distribution of respondents by County of residence for both patients and healthcare workers. The findings of the research are presented in Table 4.4 below.

Table 4.4 Tabulation of participants by County - PHR users

County	Frequency	Percentage
Nairobi	18	50
Mombasa	4	11.1
Embu	2	5.6
Kiambu	2	5.6
Trans Nzoia	2	5.6
Laikipia	2	5.6
Kilifi	1	2.8
Kitui	1	2.8
Makueni	1	2.8
Nakuru	1	2.8
Kakamega	1	2.8
Kisii	1	2.8
Total	**36**	**100.0**

The results presented in Table 4.4 illustrate that majority of the respondents 18 (50%) were from Nairobi, 4 (11.1%) of the respondents were from Mombasa. The results further indicate that Embu,

Kiambu, Trans Nzoia and Laikipia had the same frequency of respondents, which is 2 (5.6%) each. Additionally, the results illustrate that Kilifi, Kitui, Makueni, Nakuru, Kakamega and Kisii had the same frequency of respondents which is 1 (2.8%) each. The findings from results above illustrate that the respondents were distributed across 12 different Counties and this is an indication that there was a fair regional balance of the respondents therefore improving the quality of research response and variance.

Table 4.5 Distribution of respondents by County - Healthcare workers

County	Frequency	Percentage
Nairobi	14	38.9
Mombasa	6	16.7
Uasin Gishu	5	13.9
West Pokot	4	11.1
Kakamega	2	5.6
Wajir	1	2.8
Machakos	1	2.8
Murang'a	1	2.8
Vihiga	1	2.8
Kisumu	1	2.8
Total	**36**	**100.0**

The results in Table (4.5) above indicates that a greater number of participants 14 (38.9%) were from Nairobi, 6 (16.7%) of the participants were from Mombasa, 5 (13.9%) of the participants were from Uasin Gishu, 4(11.1%) of the participants were from West Pokot, 2 (5.6%) of the participants were from Kakamega. The findings further shows that, Wajir, Machakos, Murang'a, Vihiga and Kisumu had the same frequency of respondents which is 1 (2.8%) each. The findings from results above shows that the respondents were distributed across 10 different Counties, an indication that there was a fair regional balance of the respondents therefore improving the quality of research response and variance.

4.4.3 Tabulation of participants by academic level

The research sought to find out the education level of the participants and because it is related to the respondent's individual ability to interpreted various subjects. Therefore, all respondents both PHR users (patients) and healthcare workers were prompted to state their top most academic level. The results are presented in Table 4.6 below.

Table 4.6 Tabulation of participants by academic level - PHR users

Level of education	Frequency	Percentage
First degree	16	44.4
Diploma	9	25
Master's degree	7	19.4
Certificate	4	11.2
Total	**36**	**100.0**

The outcome shown in the table above shows that 16 (44.4%) of the participants have attained first degree, 9 (25%) of the respondents have attained a Diploma, 7 (19.4%) have attained a second degree (masters), 4 (11.2%) have attained a certificate. The results above shows that the respondents had the capacity to interpret and respond to the questions correctly.

Table 4.7 Tabulation of participants by academic level - Healthcare workers

Education level	Frequency	Percentage
Diploma	16	44.4
First degree	12	33.3
Higher Diploma	6	16.7
Certificate	2	5.6
Total	**36**	**100.0**

Table 4.7 above illustrates that majority of the participants 16 (44.4%) of the respondents have attained Diploma qualification, 12 (33.3%) of the respondents have attained first degree, 6 (16.7%) of the respondents have attained higher diploma and 2 (5.6%) of the respondents have attained a certificate. The results above indicate that, the respondents had attained formal qualifications and were in a position to interpret the questions and respond correctly.

4.5 Patient's ability to access and own personal health records

The research sought to establish whether the respondents have a collection of their own personal health records. The outcomes are shown in Table-4.8 below.

Table 4.8 Patient's access and ownership of personal health records

Opinion	Frequency	Percentage
No	28	77.8
Yes	8	22.2
Total	**36**	**100.0**

The findings in Table 4.8 above, illustrate that a greater number of the participants 28 (77.8%) don't own personal health records while 8 (22.2%) of the respondents indicated that they have access to their individual medical data. This shows that many of the patients are unable to access their own personal health records, which is in line with the problem statement of the research.

4.5.1 The format in which personal health records are accessed

The research also wanted to find out the format in which the participants were able to access their own medical care data. The outcomes are presented in the following table.

Table-4.9 Format in which personal health records are accessed

Records Format	Frequency	Percentage
Physical file	5	62.5
Electronically	2	25
Both	1	12.5
Total	**8**	**100.0**

The results in Table 4.9 above illustrate that a greater number of the respondents 5 (62.5%) could access their own personal health information through physical files, 2 (25%) of the respondents could access their own personal health information electronically and 1 (12.5%) of the respondents could access personal health information both electronically and through physical files. This is an indication that from the respondents who have access their individual personal medical information, the access is majorly though physical paper files.

4.5.2 Inability to access and own personal medical records

The research sought to establish the reason why the respondents dint have access and ownership of their personal health information. The results are illustrated in Table-4.10 below.

Table-4.10 Inability accessing and owning personal health records

Reason	Frequency	Percentage
I don't have the means to access my personal health records	15	55.6
I have never thought of obtaining my personal health records	8	29.6
I had the records but they got lost	4	14.8
Composite mean	**9**	

The outcome in Table 4.10 above, a greater number of the participants 15 (55.6%) shows that they lack the means to access their own personal health records, 8 (29.6%) of the respondents indicated that they have never considered obtaining their personal health records while 4 (14.8%) indicated that they had the records but they got lost. The findings illustrate that at the moment patients are lacking the means of accessing, controlling and sharing their individual medical data electronically.

4.6 Electronic access to specific personal health records data items

The research sought to establish whether respondents were able to electronically access specific data items from the whole set of personal health information and to what extent. The outcome is shown in the table below (Table 4.11).

Table 4.11 Electronic access to specific personal health records data items

Data item	Frequency	Percentage
Not able to access	13	36.1
Personal details	11	30.6
Insurance details	11	30.6
Next of kin details	9	25
Healthcare center appointments	6	16.7
Drug prescriptions	5	13.9
Lab outcomes	5	13.9
Allergy to drugs	3	8.3
Clinical notes	2	5.6
Diagnosis	2	5.6
Vaccinations	1	2.8
Composite mean	**6.2**	

According to table 4.11, the findings indicate that 13 (36.1%) of the respondents are not able to electronic access any of the personal health information data items, 11 (30.6%) of the respondents could access personal details, 11 (30.6%) of the respondents could access insurance details, 9 (25%) of the respondents could access next of kin details, 6 (16.7%) of the respondents could access healthcare center appointments, 5 (13.9%) of the respondents could access drug prescriptions, 5 (13.9%) of the respondents could access lab outcomes, 3 (8.3%) of the respondents could access information about allergy to drugs, 2 (5.6%) of the respondents could access clinical notes, 2 (5.6%) of the respondents could access diagnosis information while 1 (2.8%) of the respondents could access vaccinations information. This implies that majority of the patients are unable to access their individual medical data electronically.

4.7 Receiving copies of medical prescriptions when seeking medication

The research wanted to establish whether the participants received medical prescriptions when seeking medication or not. The outcome is outlined in Table-4.12 below.

Table 4.12 Receiving copies of medical prescriptions when seeking medication

Opinion	Frequency	Percentage
Yes	27	75
No	9	25
Total	**36**	**100.0**

Table 4.12 illustrates that 27 (75%) of the respondents receive copies of their medical prescriptions when seeking medical treatment while 9 (25%) indicated that they normally don't receive copies of their medical prescriptions when seeking medical treatment. The results imply that majority of patients get access to copies of their medical prescriptions while seeking treatment.

4.7.1 The medium through which the recipients receive medical prescriptions

Additionally, the research sought to find the medium though which the respondents received their medical prescriptions. The outcome is presented in Table-4.13 above.

Table 4.13 Method of receiving medical prescriptions

Method	Frequency	Percentage
Physical file	23	88.5
Word of mouth	3	11.5
Either via Email, WhatsApp, fax or SMS	2	7.7
Through a patient's portal	1	3.8
Medical mobile App	0	0.0
USB drive or optical disks (CD drives)	0	0.0
Composite mean	**4.8**	

According to the results shown in Table 4.13 above, 23 (88.5%) of the respondents indicated that they received copies of their medical prescriptions in form a physical paper file, 3 (11.5%) of the respondents received copies of prescriptions through the word of mouth, 2 (7.7%) of the respondents received copies of prescriptions either via email, WhatsApp, fax or SMS, 1 (3.8%) of the respondents received their copies of prescriptions through the a patients portal. The findings depict that the main mode of sharing the copies of medical prescriptions with patients is through physical paper files while none of them received prescriptions through mobiles apps, USB or CD drives.

4.8 Transmission of vital individual medical data by patients

The research sought to establish how the patients shared personal health information vital for continuity of medical care with the healthcare workers when seeking treatment. The outcome is tabulated in table 4.14 as follows.

Table 4.14 Sharing of vital personal health information with healthcare workers

Method of sharing	Frequency	Percentage
Word of mouth	34	94.4
Physical file records	6	16.7
Either via Email, SMS, Fax or WhatsApp	0	0.0
Using a smart medical card	0	0.0
Composite mean	**10**	

Table 4.24 illustrates that 34 (94%) share their vital information through the word of mouth, 6 (16.7%) share their vital information via physical paper files. The results further indicate that no respondent share vital information via Either via Email, SMS, Fax or WhatsApp as well as smart medical cards. The findings indicate patients majorly share their vital personal health information through the word of mouth and none of them used email, SMS, Fax, WhatsApp or smart card.

4.9 Inter-healthcare facility transfer

The research also wanted to establish whether the respondents had encountered a referral from one healthcare facility to another. The outcome is presented in table 4.15 below.

Table 4.15 Inter-healthcare facility transfer

Opinion	Frequency	Percentage
No	27	75
Yes	9	25
Total	**36**	**100.0**

The results presented in the table above depict that 27 (75%) of the participants have not encountered an inter-healthcare facility transfer while 9 (25%) of the respondents agreed to have heard an inter-health facility transfer. This implies that majority of the patients have been treatment in one facility at a time.

4.9.1 Method of sharing referral clinical notes with the healthcare workers

The research wanted to establish the mode in which participants shared their medical transfer information with the healthcare workers attending to them in the healthcare facility they were referred to. The findings are given in Table 4.16 below.

Table 4.16 Method used in sharing referral clinical notes with the healthcare workers

Method	Frequency	Percentage
Physical file	6	60
Word of mouth	3	30
Accompanied by healthcare worker	1	10
Either via Email, SMS, Fax or WhatsApp	1	10
Smart health card	0	0.0
USB thumb drive or optical disks (CD drives)	0	0.0
Composite mean	**1.9**	

The results in Table 4.16 above shows that 6 (60%) of the participants shared inter-healthcare facility transfer information through a physical paper file, 3 (30%) of the respondents the referral details though a word of mouth, 1 (10%) of the respondents were accompanied by a healthcare worker to the healthcare facility the respondent was transferred to, 1(10%) shared the referral details either through email, SMS, Fax or WhatsApp. The findings indicate that the method used to share referral clinical notes was majorly manual using physical paper files while none of them used either a smart card, USB or optical drives.

4.10 Use of patient's portal

One of the components in the suggested prototype was the patient's portal and the research wanted to establish whether the respondents use a patient's portal. The outcomes are given in Table 4.17 below.

Table 4.17 Use of patient's portal

Opinion	Frequency	Percentage
No	28	77.8
Yes	8	22.2
Total	**36**	**100.0**

The results in Table 4.17 above illustrates that a greater number of the participants 28 (77.8%) don't use a patient's portal while 8 (22.2%) indicate that they use patient's portal. The findings indicate that, the use of patient's portal is not common among the respondents.

4.10.1 Activities in the patient portal applied

The research wanted to find out the kind of activities the participants carried out using the patient's portal. The results are tabulated in Table 4.18 below.

Table 4.18 Activities in the patient portal

Activity	Frequency	Percentage
To book doctor's appointment for myself	4	44.4
To do a treatment follow up	3	33.3
To book doctor's appointment for someone close to me	1	11.1
To access drug prescriptions	1	11.1
To access lab results	1	11.1
To check my insurance status	1	11.1
To access previous medical diagnosis	0	0.0
Composite mean	**1.6**	

As shown by the results in Table 4.18 above, 4 (44.4%) of the respondents have used the patients portal to book doctors' appointments, 3 (33.3%) used the portal to do treatment follow ups, 1 (11.1%) used the portal to book treatment appoint for people close to them, 1 (11.1%) used the portal to access drug prescriptions, 1 (11.1%) used the portal to access lab results while 1 (11.1%) used the portal to check their insurance status. The findings shows that that most of the participants used the patient's portal to book doctor's appointment while none of them used the portal to access previous medical diagnosis.

4.11 Use of electronic (smart) medical card

One of the aims of this research was to evaluate the usage of smart cards in healthcare sector and this section sought to find out whether the respondents make use of smart health cards when seeking medication. The outcome is shown in Table 4.19 below.

Table 4.19 Use of electronic (smart) medical card

Opinion	Frequency	Percentage
No	22	61.1
Yes	14	38.9
Total	**36**	**100.0**

Table 4.19 above illustrates that 22 (61.1%) of the respondents don't use smart health cards while seeking medication while 14 (38.9%) of the participants indicated that they make use of smart health cards. The findings imply that smart health cards are not being utilized by majority of patients.

4.11.1 Applications of the smart health card

The research also sought to establish how the smart health card are being applied in the healthcare sector. The participants were prompted to indicate what they utilize the health medical card for. The research found out the following as shown in the following table (4.20).

Table 4.20 Applications of the smart health card

Activity	Frequency	Percentage
For insurance cover purposes	13	86.7
For personal authentication when I visit a healthcare center	4	26.7
To store and share my personal information	3	20
For purchasing prescribed drugs from pharmaceutical outlets	2	13.3
To store my next of kin details	1	6.7
To store and share my clinical tests and medical prescriptions	0	0
Composite mean	**3.8**	

Table 4.20 illustrates that 13 (86.7%) of the respondents use smart health cards to access for insurance purposes, 4 (26.7%) of the respondents user the smart card for authentication when they visit a healthcare center, 3 (20%) of the respondents use the smart cards to transmit their individual

medical information, 2 (13.3%) of the participants use the smart cards to for purchasing prescribed drugs from pharmaceutical outlets, 1 (6.7%) of the participants use the smart to store next of kin details while none of the respondents used the smart card to share clinical test and medical prescriptions information. The findings indicate that smart health cards are not fully being used to share personal health information when seeking medication.

4.12 Sharing of previous personal clinical outcomes when seeking treatment

The research wanted to establish the ability of the participants to share their previous personal clinical outcomes when seeking treatment from a healthcare center. The outcome is analyzed in the following table.

Table 4.21 Sharing of previous personal clinical outcomes when seeking treatment

Opinion	Frequency	Percentage
No	23	63.9
Yes	13	36.1
Total	**36**	**100.0**

The outcome presented in Table 4.21 above illustrates that 23 (63.9%) of the participants are not able to share their previous health information when seeking treatment while 13 (36.1%) of the respondents indicated that they are able to share their previous health information when seeking treatment in a healthcare facility. The findings indicate that majority of patients lack the means to share their previous medical history with healthcare workers when seeking treatment.

4.13.1 Method of sharing previous clinical outcomes

The research sought to establish the method or format through which the respondents were able to share their historical medical information. The outcome is shown in Table 4.23 below.

Table 4.22 Method of sharing previous clinical outcomes

Method	Frequency	Percentage
Word of mouth	11	78.6
Physical paper file	5	35.7
Either via email, WhatsApp, SMS or Fax	1	7.1
Using a smart health card	0	0.0
USB drive or optical disks (CD drives)	0	0.0
Composite mean	**3.4**	

Table 4.23 above illustrates that 11 (78.6%) of the respondents shared their historical medical information through the word of mouth, 5 (35.7%) of the respondents shared their historical medical information in form of a physical paper file, 1 (7.1%) of the respondents share their previous medical information either through email, WhatsApp, SMS or Fax while none of the respondents used either a smart card, USB or Optical disks to share their historical medical information. The findings above show that, sharing of personal historical medical records is majorly not done using electronic means.

4.14 Distribution of healthcare workers respondents by healthcare facility

The research wanted to find out the distribution of the respondents by the healthcare facility. The participants were therefore asked to indicate the healthcare facility they work in. The findings indicate that the respondents were distributed across 24 different healthcare facilities both public and private.

4.14.1 Distribution of healthcare workers by department

The research wanted to find out the various departments that the healthcare workers operated in within the healthcare facilities. The results are tabulated in Table 4.24 below.

Table 4.23 Distribution of healthcare workers by department

Department	Frequency	Percentage
Pharmacy	6	16.7
Nursing	6	16.7
Clinical	6	16.7
Radiology	5	13.9
Lab	4	11.1
Front Office	3	8.3
Dental	2	5.6
Sales of human drugs	2	5.6
Physiotherapy	1	2.8
Medical representative	1	2.8
Total	**36**	**100.0**

The findings in Table 4.24 illustrates that 6 (16.7%) of the respondents are pharmacists, 6 (16.7%) of the respondents are nurses, 6 (16.7%) of the respondents are clinicians, 5 (13.9%) of the respondents are radiologists, 4 (11.1%) of the respondents work in the laboratory, 3 (8.3%) of the respondents are in the front office, 2 (5.6%) of the respondents are dentists, 2 (5.6%) of the respondents are in sales of human drugs, 1 (2.8%) of the respondents are physiotherapists, and 1 (2.8%) of the respondents are medical representatives. The findings indicate the respondents were fairly distributed across all departments of healthcare facilities and data was collected from without bias.

4.15 The process of registering a new patient within the facility

The research sought to find out the process involved in registering a new a patients in a health facility and the participants were prompted to state how the process of registering a new patient is handled in the healthcare facility. The outcome is outlined in Table 4.25 below.

Table 4.24 The process of registering a new patient within the facility

Process	Frequency	Percentage
Electronically	19	52.8
Both	11	30.6
Manually	6	16.7
Total	**36**	**100.0**

From the results presented in Table 4.25 above, 19 (52%) of the respondents indicated that the process of registering a new patient in the facility is conducted electronically, 11 (30.6%) of the respondents indicated that registering a new patients is done both manually and electronically while 6 (16.7%) of the respondents indicated that the process of is conducted manually. The findings imply that, majority of the healthcare facilities have some form of an electronic system they use to register patients in the facility.

4.16 Presence of software application in the facility

The research wanted to establish the availability of application software systems in the healthcare facility used to manage the operations of the facility. Therefore the participants were prompted to state whether they use any software systems in the facility. The results are tabulated in Table 4.26 below.

Table 4.25 Presence of software application in the facility

Opinion	Frequency	Percentage
Yes	28	77.8
No	8	22.2
Total	**36**	**100.0**

Table 4.26 illustrates that 28 (77.8%) of the respondents indicated that they use a software system to manage the operations in the facility while 8 (22.2%) of the respondents indicated not using any software application system in the facility. The findings imply that majority of the healthcare facilities have some form of a software system they use to manage operations.

4.17 Type of system used in the healthcare center

The research wanted to establish the kind of application software system used in the healthcare facilities i.e. one integrated system or different systems. The findings are outlined in table 4.27 below.

Table 4.26 Type of system used in the facility

System type	Frequency	Percentage
One system	24	66.7
Different systems	12	33.3
Total	**36**	**100.0**

The results in 4.27 above shows that 24 (66.7%) of the respondents use one integrated system within the facility while 12 (33.3%) of the respondents use different system within facility. The findings indicate that majority of healthcare facilities use integrated systems which is in line with main goal if this research, of using smart cards to access and share personal health records in integrated healthcare environments.

4.17.1 Sharing of patient information among departments when using different systems

The research sought to find out how patient information is shared from one department to another within the healthcare facility where they use more than one system. The findings are presented in table 4.28 below.

Table 4.27 Sharing of patient information

Method	Frequency	Percentage
Hard copy documents (patient files)	6	50
Cloud based shared drives such as google drive, drop box etc.	3	25
Via email	2	16.7
USB drives or Optical drives (CD disks)	1	8.3
Word of mouth	0	0.0
Total	**12**	**100.0**

Table 4.28 illustrates that 6 (50%) of the respondents share patient records from one department to another through physical files, 3 (25%) of the respondents share patients records using cloud

based drives, 2 (16.7%) of the respondents utilize emails to share patient records, 1 (8.3%) of the respondents use USB or optical based drives, however the results shows that nobody passed the patient records across departments through the word of mouth. The results indicate in environments without an integrated system, manual records sharing is most prevalent.

4.18 Obtaining of personal health information from patient

The research sought to establish how respondents obtained personal medical information from patients when giving medical treatment. The findings are tabulated in Table 4.29 below.

Table 4.28 Method of obtaining of personal health records from patient

Method	Frequency	Percentage
Physical paper file	17	47.2
Referral letter (either from internal, external referral or treatment follow up)	12	33.3
Word of mouth	6	16.7
Electronically either via email, WhatsApp, Fax or SMS	5	13.9
Electronically via Smart Card	5	13.9
USB drives or Optical drives (CD disks)	2	5.6
Phone call	2	5.6
From system for returning patients	1	2.8
Composite mean	**6.3**	

Table 4.29 illustrates that 17 (47.2%) of the participants obtained patients' personal medical information though physical paper files, 12 (33.3%) obtained the information from the transfer letter where a patient had an inter-healthcare facility referral, 6 (16.7%) received the information through the word of mouth, 5 (13.9%) obtained it via either email, WhatsApp, Fax or SMS, 5 (13.9%) indicated to have obtained it via smart cards, 2 (5.6%) received the information from optical or USB drives, 2 (5.6%) obtained the information via a phone call while 1 (2.8%) obtained the records from the system for returning patients. The results imply that, patient's personal medical information is majorly obtained manually when a patient visits a healthcare facility to seek treatment.

4.19 Minimum health data set that can be used to provide continuity of care

One of the research objectives was to determine the minimum and the most vital information that is needed by healthcare workers in order to provide a continuity of medical care to a patient. The respondents were therefore asked to indicate the minimum data set that is required for continuity of medical care to a patient. The outcome of the research is outlined as shown by the following Table (4.29).

Table 4.29 Minimum health data set that can be used to provide continuity of care

Data set	Frequency	Percentage
Clinical tests done	30	83.3
Transfer letter from previous healthcare facility if it's a referral	27	75
Any previous drug prescriptions for the same sickness	26	72.2
Allergy to drugs	24	66.7
Name of patient	23	63.9
Age of patient	21	58.3
Location (patient residence)	14	38.9
Insurance details if any	12	33.3
Next of kin details	10	27.8
Family medical history	1	2.8
Composite mean	**18.8**	

The findings in Table 4.30 illustrate that clinical test with a frequency 30 (83%) is the most vital information needed for the provision of continuity of care to a patient, followed by referral letter 27 (75%) in cases of inter-healthcare facility transfer, closely followed information about previous drug prescriptions for the same sickness with 26 (72.2%), information about allergy to drugs follows suit with 24 (66.7%), then the name of the patient with 23 (63.9%) and the age of the patient with 21 (58.3%), the residence of the patient came next with 14 (38.9%), insurance details followed suit with 12 (33.3%), next of kin details followed with 10 (27.8%) and coming last was family medical history with 1 (2.8%). The findings imply that the most critical information vital for continuity of care is clinical outcomes rather than personal information.

4.20 Sharing of medical information with patients

The research also wanted to establish how the respondent's enabled patients to access their personal medical records during and after treatment. The findings are outlined in Table 4.31 below.

Table 4.30 Sharing of personal medical information with patients

Method	Frequency	Percentage
Physical paper files	23	63.9
Word of mouth	9	25
Patients portal	6	16.7
Either via Email, Fax, Telegram or SMS	4	11.1
Using a smart health card	1	2.8
USB drives or optical disks (CD drives)	1	2.8
Composite mean	**7.3**	

Table 4.31 indicates 23 (63.9%) of the respondents gave patients access to their own records using physical files, 9 (25%) passed the information though the word of mouth, 6 (16.7%) made the information available through a patient portal, 4 (11.1%) used either email, WhatsApp, Telegram or SMS, 1 (2.8%) made the information accessible via a smart card, 1 (2.8%) used USB or optical drives to share the information while none of the respondents that did not share any information with the patients. The findings indicate that, personal medical information is always shared with the patients however it is majorly manually through physical paper files.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 Introduction

The chapter outlines the summary of the research findings, recommendations and conclusions. The results are aggregated in line with the goals of the research. The conclusions identified from the findings as well as the recommendations made all focus on addressing the objectives of the research.

5.2 Summary of findings

Coming up next is the outline of the results of the research on interoperability of individual wellbeing records through the utilization of a smart-card based coordinated individual wellbeing records framework.

5.2.1 Patient's ability to access, own and share personal health records

One of the aims of this research was to find out the patient's ability to access and share personal health records and how to enhance their capability to own and control their personal medical information. The findings of the research reveal that majority of patients (77.8%) are not able to access to and own their personal health records, while only a small group (22.2%) had access to their personal medical information. The findings concur with problem statement of the research and in agreement with the findings of Sood et al. (2008) that states that patients are seeking more access and control over their personal health information.

In relation to the format through which patients are able to access their personal medical information in, the findings indicate that the main access is through physical paper files represented by (62.5%) followed by a smaller number (25%) who have electronic access. Additionally, the findings indicate that a vast majority of patients (88.5%) received medical prescriptions through a physical paper file. In terms of how the patients share their own personal medical information when seeking medication, the findings shows that (94.4%) shared the information by word of mouth followed by physical paper files (16.7%). The results concur with Sood et al., (2008) stating that, majority of healthcare service providers in developing economies still use paper-based documentation or legacy systems. The combination of these factors makes it very difficult for patients' data to be passed electronically from one physician or health facility to another.

5.2.2 Application of smart cards in healthcare

Another aim of this research was to assess the usage of smart cards in healthcare sector. The findings further indicate that majority of patients (61.1%) don't use smart medical cards and even then, the population that uses the smart cards it's majorly for insurance purposes (86.7%) followed by authentication when seeking medication (26.7%) and storage of personal information (20%). The trend in the results indicate that smart cards aren't mainly being applied in sharing personal medical records when seeking treatment. The findings illustrate that an efficient way of access and sharing personal medical records such as the use of smart cards such as the one suggested in this research is still needed in order to improve health outcomes. This is in agreement to the recommendations of Kolias, Keliris & Nikita (2013) who states that, for the most part, smart-cards in medical services are utilized to give quick distinguishing proof of patients; improved treatment; an advantageous method to convey information between frameworks or social insurance arrangement locales, and decrease of records support costs.

5.2.3 Minimum health data set that can be used to provide continuity of care

The other research objective was to find out the minimum data set that can be used by healthcare workers to provide continuity of care to a patient. The findings indicate that the most vital data set that is needed to provide continuity of care to a patient is majorly clinical test with a rating of (83.3%), followed by any information with regard to prior treatment in case of referral with a rate (75%), previous drug prescriptions for the same sickness with a rate of (72.2%), information about allergy to drugs with a rate of (66.7%) followed by name of patient with a rate of (63.9%) the age of the patient with a rate of (58.3%) while personal information getting low rating of less than forty percent. The findings illustrate that medical details specific to a particular case are the most important details needed for continuity of care as compared to personal information. Other results obtained in this research have shown that majority of patients (77.8%) are not able to access and share their most vital medical data set when seeking medication. One of the deliverables of this research was providing patients with an intervention that allows them to access, control and share vital personal medical information when seeking treatment and improve both the decision-making capabilities of the healthcare workers as well as improving the health outcome of the patients. This

is in agreement with WHO (2010) which expresses that, sound and solid data is the establishment of dynamic over all wellbeing framework building blocks.

5.2.4 Smart card based integrated personal health records system prototype

The last aim of this research was to design and come up with a prototype of an integrated smart card based personal health records system that demonstrates the ability to access, control and sharing of electronic personal health records from one healthcare facility to another by the patients. The research found out that, while a majority (66.7%) of healthcare facilities use an integrated system, the personal medical records are still in silos (within the facilities) and sharing the information externally with the patient is majorly done through physical files (63.9%) and word of mouth (25%). The findings imply that the developed prototype which is able to demonstrate access, control and sharing of patients' personal health records is an intervention that enables patients to own and have control over their own personal health records and also bridges the gap existing among healthcare facilities and enables seamlessly sharing of individual health data from among different healthcare centers. Additionally, this intervention improves the quality of health by ensuring reliable access to patients' personal health records. This is in line with Mane and Kulkarni (2012), who states that the quality of healthcare relies upon numerous elements, including auspicious accessibility of a patient's personal health records.

5.3 Conclusions of the research

From the results gathered, the research conclusion was that a greater number of patients don't have access to their own personal records and hence they are not able to share the same information with the healthcare workers when seeking medication. Additionally, a lot of medical information exchange between patients and healthcare workers is done through physical paper files and work of mouth. Moreover, in as much as majority of the healthcare centers have health information management systems, the healthcare workers still luck the means to effectively share the electronic personal health records with the patients.

The research also concluded that application of smart health cards in the health sector is still in its infancy stage in our healthcare domain. Majority of patients don't have smart health cards and even where the cards are applied, they are majorly used for transmitting other information other than the patients' personal medical information.

The research further concluded that when a patient is seeking medication from any healthcare center, the most vital information that is needed in order to provide continuity of care is medical details such as clinical tests done or any previous medication relating to the condition under investigation.

Finally, the research concludes that the capabilities demonstrated by the prototype imply that the intervention provided by this research gives patients access, ownership, control and advanced capabilities of sharing personal health records with healthcare workers from one healthcare facility to another through the use of smart cards. Moreover, the intervention gives patients control and advanced capabilities where they can decide whether they want their personal medical information to be accessed and viewed or not.

5.4 Recommendations

The research made the following recommendations;

1. The research recommends that the government through the Ministry of Health should be at the forefront in implementing eHealth projects targeted on interoperability of health records and breaking data silos, by providing key integration and communication infrastructure as well as implementing policies and guidelines for the implementation and adoption of health informatics.
2. A successful realization of the benefits of interoperability of health systems calls for multi-stakeholder involvement and proper sensitization should be done to both healthcare facility owners and patients. More specifically, healthcare facilities should be more willing to participate in breaking data silos and sharing patient's data through a government provided and monitored data communication bus.
3. The use of smart health cards in the healthcare sector should be encouraged, more importantly is using the smart cards to share personal health records from one healthcare facility to another. Therefore, there should be a close corporation between the government, healthcare facilities and the patients.
4. Patients ought to be urged to cooperation in their own wellbeing by enabling them to get to, claim and have power over their very own wellbeing records. This involvement will help improve health outcomes through reliable and effective medical data access and sharing.

5.5 Suggestions for further research

The present research concentrated on showing the ability of a smart-card based coordinated individual wellbeing records framework. The research, hence, advocates the following areas for further future research;

1. The use of virtual cards in the place of physical smart cards that can be used in the integrated personal health records system.
2. Assessing the factors affecting the adoption of eHealth interventions in our healthcare sector.
3. Investigating the sustainability of multi-tenancy personal health records systems in our healthcare domain since eHealth is still at its infancy stage.

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APPENDICES

Appendix 1: Personal health records (PHR) questionnaire for the patients

This questionnaire is part of my masters research on interoperability of personal health records and how to give patients access and control over their own personal health records as well as advanced capabilities of electronically sharing that information from one healthcare center to another while seeking medication.

The questionnaire is targeting PHR users and it takes approximately 5 to 10 minutes to complete.

For each section, please respond to all items by selecting the correct answer. Kindly answer as truthfully as possible.

1 Gender:

[ ] Male [ ] Female

2 County: ……

3 Indicate your highest academic level

[ ] Certificate. [ ] Diploma. [ ] First degree.
[ ] Master's degree. [ ] PhD. [ ] others (specify)…….....

4 (a) Do you have a collection of all your personal health records that can give a detailed view of your previous medical treatments and medications??

[ ] Yes [ ] No

4 (b) If the answer is yes in (a) above, in what form are they? Select the one(s) that apply.

[ ] Electronically
[ ] Physical file
[ ] Both

4 (c) If the answer is no in (a) above, kindly give the reason(s) why. Select the one(s) that apply to your case.

[ ] I have not been able to access my personal health records

[ ] I had the records but they got lost

[ ] I have never thought of obtaining my personal health records

[ ] Other (specify)…….

5. Which of the following personal health records data items are you able to access electronically? Select the one(s) that apply in your case.

[ ] Clinical notes

[ ] Diagnosis

[ ] Drug prescriptions

[ ] Vaccinations

[ ] Allergy to drugs

[ ] Next of kin details

[ ] Inter-hospital referrals

[ ] Insurance details

[ ] Lab outcomes

[ ] Healthcare center appointments

[ ] Personal information

[ ] None

[ ] Other (specify) ……

6 (a) Do you receive copies of your medical prescriptions when seeking medication?

[ ] Yes [ ] No

6 (b) If the answer is yes in (a) above, how do you receive the information??

[ ] Through a patients portal

[ ] Either via Email, WhatsApp, Telegram or SMS

[ ] Physical file

[ ] Medical mobile App

[ ] Word of mouth

[ ] USB drive or optical disks (CD drives)

[ ] Other (specify) ……

7. As a patient when you visit a healthcare center, how do you share your vital personal medical records such as allergies to drugs and or any other vital personal information?

[ ] Word of mouth
[ ] Either via Email, SMS, Telegram or WhatsApp
[ ] Using a smart medical card
[ ] A physical file record
[ ] USB drive or optical disks (CD drives)
[ ] Other (specify) ……

8 (a) Have you ever had an inter-hospital referral?

[ ] Yes [ ] No

8 (b) If the answer is yes in (a) above, how did you access and share the referral clinical notes with the healthcare workers?

[ ] Either via Email, SMS, Telegram or WhatsApp
[ ] Physical file
[ ] Word of mouth
[ ] Smart health card
[ ] USB thumb drive or optical disks (CD drives)
[ ] Other (specify) ……

9 (a) Do you use a patient's portal?

[ ] Yes [ ] No

9 (b) If the answer is yes in (a) above, what have you used it for? Select the one(s) that apply.

[ ] To book doctor's appointment for myself
[ ] To book doctor's appointment for someone close to me
[ ] To access previous medical diagnosis

[ ] To access drug prescriptions

[ ] To access lab results

[ ] To do a treatment follow up

[ ] Other (specify) ……

10 (a) Do you have an electronic (smart) medical card?

[ ] Yes [ ] No

10 (b) If yes in (a) above, what do you use it for? Choose the most suitable option(s) below that best describes your usage of the smart card.

[ ] To store my next of kin details

[ ] To store and share my personal information

[ ] To store and share my clinical tests and medical prescriptions

[ ] For my insurance cover purposes

[ ] For purchasing prescribed drugs from pharmaceutical outlets

[ ] For personal authentication when I visit a healthcare center

[ ] Other (specify) ……

11(a) When seeking treatment in a healthcare center, are you able to present to the medical personnel a collection of all your personal clinical outcomes obtained from previous medical treatments?

[ ] Yes [ ] No

11 (b) If the answer is yes in (a) above, how do you share the records?

[ ] Either via email, WhatsApp, SMS or Telegram

[ ] Using a smart health card

[ ] Physical paper file

[ ] Word of mouth

[ ] USB drive or optical disks (CD drives)

[ ] Other (specify) ……

12. What is your perception on utilizing digital platforms to enhance accessibility and sharing of personal medical records in the healthcare sector?

……
……
……
……

Thank you for your participation

Appendix 2: Personal health records (PHR) questionnaire for the healthcare workers

This questionnaire is part of a research on interoperability of personal health records and how we can give patients access and control over their own personal health records as well as advanced capabilities of electronically sharing that information from one healthcare center to another while obtaining medication.

INSTRUCTIONS: Please do not put your name on the questionnaire. In every part, select the or fill in the blanks with the correct answers. Kindly answer as truthfully as possible

1. Gender:

   [ ] Male [ ] Female

2. Which county do you come from.....?

3. Indicate your highest academic level.

   [ ] Certificate. [ ] First degree. [ ] Diploma.

   [ ] PhD. [ ] Master's degree. [ ] others (specify)…….....

4 (a) Name of facility

[ ] Specify…….

4 (b) Which department/unit are you in within the health facility?

[ ] Lab [ ] Pharmacy [ ] Nursing

[ ] Dental [ ] Radiology [ ] Front Office

[ ] Clinical [ ] other (specify)……...

5 How is the process of registering a new patient conducted within the facility?

[ ] Electronically

[ ] Manually

[ ] Both

6 (a) Do you have any software application that you use to manage the operations such as patient registration, record keeping etc, within the facility?

[ ] Yes [ ] No

6 (b) If the answer is yes in (a) above, what is the name of the application software (system) being used?

[ ] Specify…….

7 (a) If the facility is using any software application to manage its operations, is it a one whole inter-connected information system or there are different systems for each department/unit??

[ ] One system

[ ] Different systems

7 (b) If the answer in (a) above is "different systems", how is patient information shared among different departments/units?

[ ] Hard copy documents (patient files)

[ ] USB drives or Optical drives (CD disks)

[ ] Via email

[ ] Cloud based shared drives such as google drive, drop box etc.

[ ] Word of mouth

[ ] Other (specify)…….

8. When attending to a patient how do you normally obtain their previous personal health records vital for continuity of treatment?

[ ] Electronically either via email, WhatsApp, Telegram or SMS

[ ] Physical paper file

[ ] Electronically via Smart Card

[ ] Word of mouth

[ ] USB drives or Optical drives (CD disks)

[ ] Referral letter (either from internal, external referral or treatment follow up)

[ ] Phone call

[ ] Other (specify)…….

9. What is the most important information that is required in order to give continuity of healthcare to a patient? Please select all that apply.

[ ] Transfer letter from previous healthcare facility if it's a referral

[ ] Clinical tests done

[ ] Any previous drug prescriptions for the same sickness

[ ] Allergy to drugs

[ ] Next of kin details

[ ] Insurance details if any

[ ] Age of patient

[ ] Name of patient

[ ] Location (patient residence)

[ ] Gender of patient

[ ] Other (specify)…….

10. After attending to a patient, how do you share their personal medical data with them?

[ ] Either via Email, WhatsApp, Telegram or SMS

[ ] Using a smart health card

[ ] USB drives or optical disks (CDdrives)

[ ] Physical paper files

[ ] Patients portal

[ ] Word of mouth

[ ] None

[ ] Other (specify)…….

Thank you for your participation

Appendix 3: Guideline for identifying the size of a sample for a certain populace.

Table for Determining Sample Size for a Given Population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size
"S" is sample size.

Source: Krejcie & Morgan, 1970

Figure 27: Table for guiding the sample-size for a certain populace..

Appendix 4: Sample back end database outlook

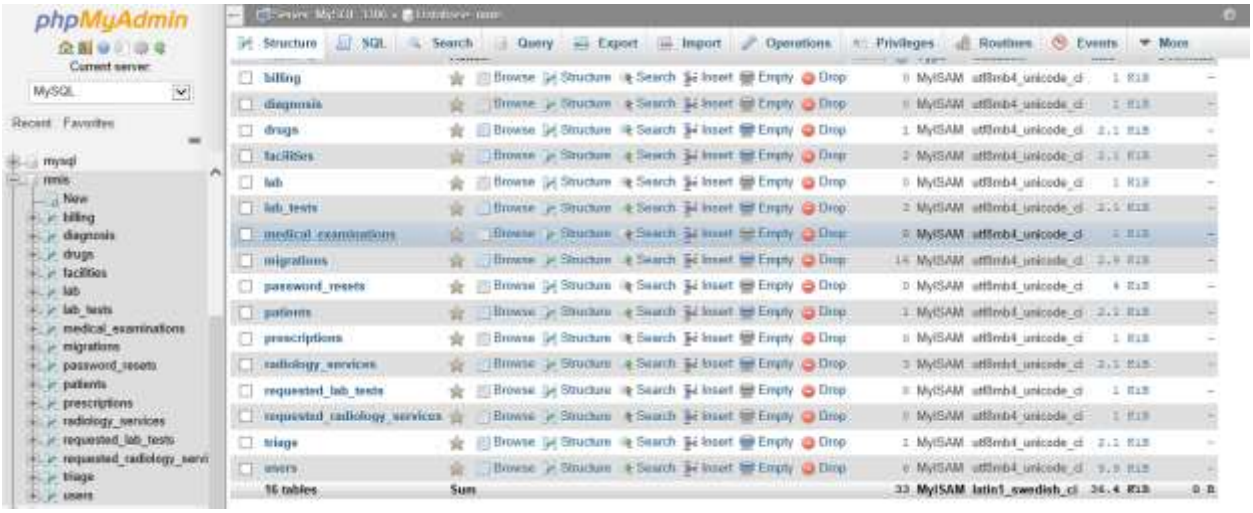

Figure 28: Sample back end database outlook

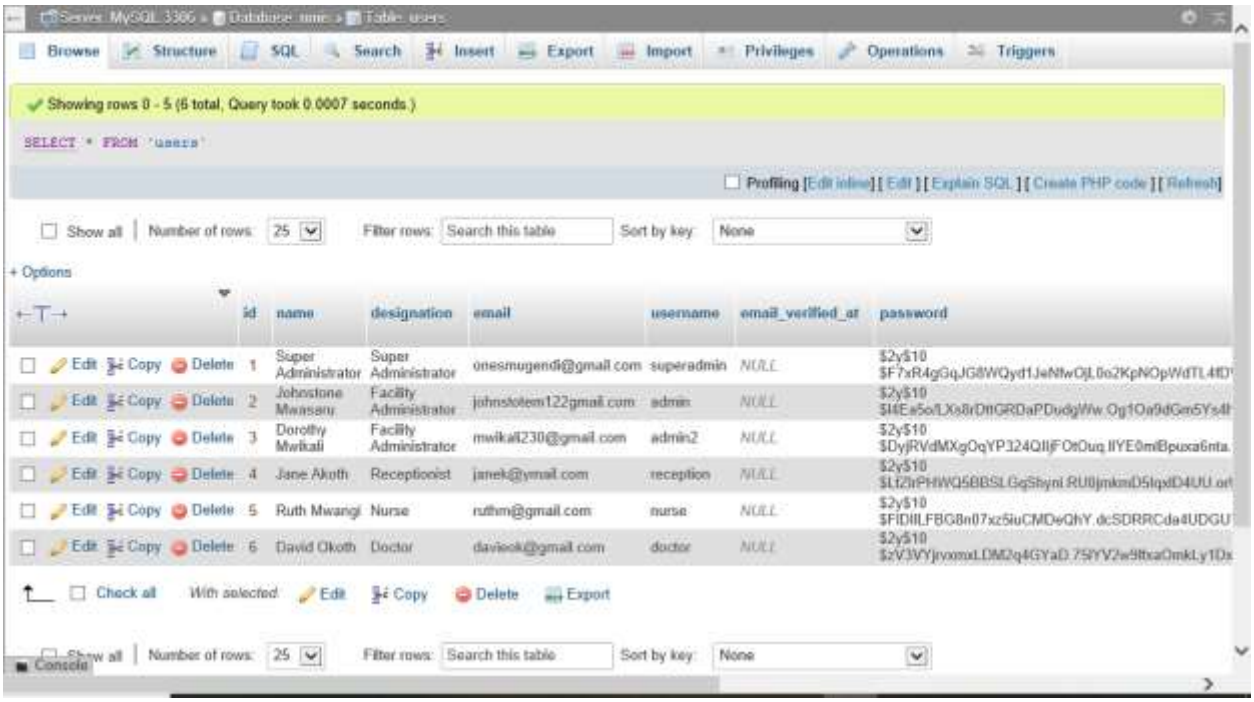

Figure 29: Sample back end system user data

Appendix 5: Sample code

Users Controller

```
<?php

namespace App\Http\Controllers;

useIlluminate \Http\Request;
useIlluminate \Support\Facades\Hash;
useApp \User;
useApp \Facility;

class Users Controller extends Controller
{
    /**
     * Display-a-listing-of-the-resource.
     *
     * @return \Illuminate \Http \Response
     */
    publicfunction index()
    {
        if(\Auth::user() ->user_type=='superadmin'){
            $users=User::where('user_type','facilityadmin')->get();
        }else{
            $facility_id = \Auth: :user () ->facility_id;
            $users= User::where ('user_type','medicalstaff') ->where
('facility_id', $facility_id) ->get();
        }

        return view('users.index')->withUsers($users);
    }

    /**
     * Show the form for creating a new resource.
     *
     * @return \Illuminate\Http\Response
     */
    public function create()
    {
        $facilities=Facility::all();

        return view('users.create')->withFacilities($facilities);
    }

    /**
```

```
     * Store a newly created resource in storage.
     *
     * @param  \Illuminate\Http\Request  $request
     * @return \Illuminate\Http\Response
     */
    public function store(Request $request)
    {
        $this->validate($request,[
            'full_name'=>'required',
            'email'=>'required',
            'username'=>'required',
            'password'=>'required',
            'designation'=>'required'
        ],
        [
            'full_name.required'=> 'Name is required!',
            'email.required'=> 'Email is required!',
            'username.required'=> 'Username is required!',
            'password.required'=> 'Password is required!',
            'designation.required'=> 'Designation is required!'
        ]);

        $full_name=$request->input ('full_name');
        $email=$request->input ('email');
        $username=$request->input ('username');
        $password=Hash::make ($request->input('password'));
        $designation=$request->input ('designation');

        if(\Auth::user()->user_type=='superadmin'){
            $facility=$request->input('facility');
        }else{
            $facility=\Auth::user()->facility_id;
        }

        //Determine User type of the user being added
        If (\Auth: :user ()-> user_type=='superadmin'){
            $user_type= 'facilityadmin';
        }else{
            $user_type= 'medicalstaff';
        }

        $user = User:: create([
            "name"=> $full_name,
            "designation"=> $designation,
            "email"=> $email,
```

```
            "username"=>$username,
            "password"=>$password,
            "user_type"=>$user_type,
            "facility_id"=>$facility
        ]);

        If ($user){
            returnredirect ('/users') ->with
('success','User added successfully');
        } else {
            return redirect () ->back () ->withInput () ->with ('save-error','
An error occurred, user was not added!');
        }
    }

    /**
     * Display-the-specified-resource.
     *
     * @param-int-$id
     * @return \Illuminate \Http \Response
     */
    Public-function show ($id)
    {
        //
    }

    /**
     * Show-the-form-for-editing-the-specified-resource.
     *
     * @param  int  $id
     * @return \Illuminate \Http \Response
     */
    public function edit($id)
    {
        $user= User::find ($id);
        $facilities= Facility::all ();

        return view ('users.edit')-> with ('user',$user)-> withFacilities
($facilities);
    }

    /**
     * Update-the-specified-resource-in-storage.
     *
     * @param  \Illuminate \Http \Request  $request
```

```
     * @param-int  $id
     * @return \Illuminate \Http\Response
     */
    public function update (Request $request, $id)
    {
        $this-> validate ($request,[
            'full_name'=> 'required',
            'email'=> 'required',
            'username'=> 'required',
            'designation'=> 'required'
        ],
        [
            'full_name.required'=> 'Name is required!',
            'email.required'=> 'Email is required!',
            'username.required'=> 'Username is required!',
            'designation.required'=> 'Designation is required!'
        ]);

        $full_name=$request-> input('full_name');
        $email=$request-> input('email');
        $username=$request-> input('username');
        $password=Hash::make($request-> input('password'));
        $designation=$request-> input('designation');

        if(\Auth::user()->user_type=='superadmin'){
            $facility=$request->input('facility');
        }else{
            $facility=\Auth::user()->facility_id;
        }

        $user= User::find($id);
        $user-> name=$full_name;
        $user-> designation=$designation;
        $user-> email=$email;
        $user-> username=$username;
        $user-> password=$password;
        $user-> facility_id=$facility;
        $user-> save();

        if($user){
            returnredirect ('/users') ->with
('success','User updated successfully');
        } else {
            returnredirect ()->back () ->withInput ()->with('save-
error','An error occurred,user was not updated!');
```

```
        }
    }

    /**
     * Remove-the-specified-resource-from-storage.
     *
     * @param-int  $id
     * @return \Illuminate \Http \Response
     */
    public function destroy ($id)
    {
        $user= User::find ($id);
        $user-> delete ();

        if($user){
            return; redirect ('/users')->with
('success','User deleted successfully');
        } else {
            return redirect ()->back () ->withInput ()->with ('save-
error','An error occurred,user was not deleted!');
        }
    }

    /*
    * Get-facility-name
    */
    Public-static function getFacilityName ($facility_id)
    {
        $facility= Facility::find ($facility_id);

        If(!empty($facility-> facility_name)){
            $facility_name= $facility->facility_name;
        }else{
            $facility_name =null;
        }


        return $facility_name;

    }
}
```