

A web-based medical records keeping system for all healthcare providers and institutions in Kenya.

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Group: A

An Information Systems Project Proposal Submitted to the Faculty of Information Technology in partial fulfillment of the requirements for the award of a Degree in Business Information Technology

Date of Submission: January 2021

DECLARATION

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

Student Signature:

A handwritten signature in black ink, consisting of several overlapping loops and a horizontal line crossing through the middle.

Sign:

Date: 27th January, 2021

ABSTRACT

Record keeping in healthcare facilities has for many years been done manually and this made the whole process repetitive and inefficient. Over the years and with advancements in technology, more and more hospitals have switched to electronic record keeping methods.

Without a system that allows this and hence record sharing for all healthcare providers, the burden usually falls on patients and their loved ones to find ways to access the information they need.

Being sick and having to visit a hospital is already something many people don't look forward to. It becomes even more of a task if they have to go back to their previous hospitals to get a printout of their previous records or if they have to go through the same processes again.

Electronic medical records (EMR) allow accurate, real-time access to patient health care data and have great potential to improve the quality of patient care through decision support to clinicians.

The proposed system aims to create a system that allows healthcare providers from different hospitals to securely store, access and share patient medical records. By doing so, receiving care in another facility becomes more effective and efficient.

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LIST OF ABBREVIATIONS

HER	Electronic Health Records
IT-	Information Technology
KMPDC –	Kenya Medical Practitioners and Dentists Council
MOH –	Ministry of Health
OOD –	Object Oriented Design
OOAD –	Object Oriented Analysis and Design
UI –	User Interface

CHAPTER ONE: INTRODUCTION

1.1 Background of the study

The implementation of electronic health records (EHR) in medical practice has seen a significant increase in recent years (Agno & Guo, 2013; Dornan et al., 2019). EHR systems present a valuable opportunity to improve health surveillance and evaluate service provision potentially leading to improvements in the management and the promotion of health. Findings suggest that most clinicians use the information available to examine the overall condition of the patient and inform clinical decision making and for shared communication across patient care teams (Dornan et al., 2019).

The widespread adoption of information technology (IT) brings many potential benefits to health care (Kim et al., 2017). Electronic Health Records (EHR) consists of a repository of information concerning the health status of individuals. In an EHR, health records are created and managed in digital formats. An EHR of a patient can contain medical history including operations, hospitalizations, medications, past diagnostic follow-up, laboratory results, radiology reports, and relevant health care information (Shah et al., 2014). It is a secure and reliable source of clinical information where health records can be safely shared. The history of clinical documentation is based on paper-based records, and they are cumbersome and ineffective. Efficient data sharing and retrieval is possible from EHR systems in ways that paper documentation is unable to do (National Research Council, 1997). Traditional medical records have restrictions in allowing a global vision of the patient's health conditions. An EHR instead, aims to gather health data, potentially generated by different sources at different times, and share those data with relevant healthcare systems (Hirsch et al., 1970; Q. Wu & Wu, 2015).

The sharing of healthcare information between providers using EHR has led to improved outcomes of care and reduced clinical errors (Nivens, 2020). The success of a health care system depends on maintaining patient's trust. When patients lose their trust in the privacy of their health information kept by the providers, it leads to potentially dangerous steps including patients not properly disclosing important health information, and can even culminate in consumer's refusal to the EHR system. Properly designed EHR systems eliminate the need to take down transcriptions on paper and can well organize physician workflows resulting in increased efficiency and productivity

(Hoye & Bryant, 1984; Jones et al., 2014). The use of EHR systems has helped the healthcare providers with the better exchange of laboratory results, scans reports and improved communication method with patients. A well-implemented health care system will reduce the inefficiencies, and promote a better health care. EHR standards are one of the essential building blocks for health care reform and an important component that supports efficient exchange of information between providers and health care organizations.

The ability of EHR to share information electronically provides a boost in quality in healthcare management. The main goals of EHR include providing a secure, reliable, and efficient way to register, gather and process all the clinical data related to the patient (De Block, 2019). Also, it supports the actions related to the clinical practice and patient treatment. When optimally implemented, EHR holds a tremendous potential benefit for healthcare systems, and can enhance how patient data are documented and organized. It is therefore important to study and find out the current issues regarding EHR to make it more efficient and useful (Bradley et al., 2018; Coles, 1988; Seymour et al., 2019).

1.2 Problem statement

Many patients experience a fragmented healthcare journey that involves transitions of care between multiple primary, secondary and tertiary care settings (Warren et al., 2019). To make informed and safe decisions for patients negotiating this complex system, clinicians need the right information about the right patient in the right place at the right time. However, contemporaneous, accurate patient information is often not available when it is required (Shah et al., 2014).

This results in ineffective care, duplication of tests and medical errors. For over a decade, the development and use of electronic health records (EHR) has been suggested as a key solution to the rising demands on healthcare systems (Warren et al., 2019). With increased movement of patients between health care providers, the need for a centralized system for collaboration couldn't have come a better time (Huang, 2010). Some patients either are illiterate or find the medical terms to be too technical to remember. Additionally, the hassle of carrying these medical records as one moves from one hospital to another sometimes prove to be a daunting task. In Kenya, for example, the idea of hospital referrals is very common where one may report their sickness at a local health centre and end up at a national referral hospital like Kenyatta National Hospital. Patients' health

records are progressive in nature thus the need to have the medical history of a particular patient when handling a case. However, this has been a challenge for most hospitals due to the lack of a centralized system where providers can retrieve these medical records as and when needed.

1.3 Aim

The main aim is to develop a system, owned by the Government of Kenya and managed by the Ministry of Health for electronically keeping health records and sharing them with healthcare providers in Kenya.

1.4 Specific Objectives

- i. To review the current state of electronic record keeping and sharing among hospitals in Kenya and globally.
- ii. To analyze the challenges that exist in the record sharing process being used now.
- iii. To develop a system that will be used by healthcare and other related facilities such as insurances to store and share patient records with each other across Kenya.
- iv. To carry out testing of the system in healthcare facilities all over Kenya to ensure full functionality.

1.5 Justification

The advent of technology has led to tremendous advancement in all sectors, the health sector notwithstanding. Continuous investment in technology means we have a robust solution to most issues that have constantly been a hurdle in the medical sector. The viability of this system is pegged on the reliability of technology whereby efficiency has been enhanced for most sectors. While in the past it was difficult to implement technology-based solutions, this is no longer the case as most challenges have been dealt with. Accessibility to technology has been enhanced as well as the literacy levels among most people. The introduction of the laptop project in Kenya is one of the projects that ensures children are introduced to computers at a very tender age. Additionally, the infrastructure has been revamped as is more efficient and reliable. The cost of these devices has significantly dropped meaning most people can afford them. Various systems are already in place even in hospital and having this particular one will ensure a seamless operation between health providers. The system also overcomes the barrier of space and time as it will be

accessible to all health providers. Being a dynamic system, it will be possible to make necessary adjustments as time goes thus ensuring flexibility.

1.6 Scope and limitations

The proposed solution will be web based rather than a mobile application. Making the system web based assumes that all hospitals in the country have access to at least one machine that can be connected to the internet.

The system will not be accessible to patients to avoid them making any alterations to their records in their favor. It will also only be accessible to authorized medical practitioners and this, the Ministry of Health can ensure in conjunction with the Kenya Medical Practitioners and Dentist Council (KMPDC).

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter provides a review of what is known regarding the topic and other points of view regarding this topic. The review aims at sharing results of other studies closely related to the study and helping to establish the importance of it which then allows for better comparisons.

2.2 Current methods of patient record keeping in healthcare facilities

The world is continuously being affected by pandemics of all proportions. Developing countries are the most affected by this for reasons such as inadequate resources to improve their healthcare facilities. There is still a lot of room for development and deployment of ICT to improve health care services in Africa.

In 2012, a study to document the availability of EHRs, in sub-Saharan Africa, and highlight the challenges hindering their wider adoption in the region was carried out.

Akanbi (2012) states that although African nations are still lagging behind developed countries in the availability and use of EHRs, there has been an impressive increase in the availability and utilization of EHRs in Africa over the last decade. This increase has been enabled by joint works between African institutions and international collaborators mostly in the area of HIV/AIDS treatment and care.

The increase in EHRs in sub-Saharan Africa has been facilitated by several factors, key factors being the increased availability of personal computers <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4167769/> - R12 and improved access to internet. Internet access in Africa has grown by 2,357.3% from 2000 to 2010. This however represents only 10% of the population, far behind the 30% world average coverage as of 2011 (Internet usage and population statistics for Africa., 2011) Although the internet is present in all 54 African countries, access is often concentrated in urban centers, with no access in most rural centers where over 80% of the population reside (F. Wu et al., 2002). This inequitable distribution has affected the realization of the full benefits of EHRs in sub-Saharan Africa.

Summary of publications on the use of electronic medical records in sub-Saharan Africa

Publications	Country	Software	Setting
Identification of losses to follow-up in a community based antiretroviral therapy clinic in South Africa using a computerized pharmacy tracking system ³⁰	South Africa	Open Source (iDART)	HIV care
Leapfrogging paper-based records using handheld technology: experience from Western Kenya ¹⁵	Kenya	Open Source	Home based care
Innovative approaches to application of information technology in disease surveillance and prevention in Western Kenya ¹⁶	Kenya	Open Source	Injury surveillance
The Mosoriot medical record system: design and implementation of an outpatient electronic record system in rural Kenya ¹⁷	Kenya	Open Source	Tertiary care
“Talkin’ about a revolution”: How electronic health records can facilitate the scale-up of HIV care and treatment and catalyze primary care in resource-constrained settings ¹⁸	Kenya	Open Source (Open MRS)	HIV care
Experience with implementing electronic health records in three East African countries ¹⁹	Kenya, Tanzania & Uganda.	Open Source (Open MRS)	HIV care
Combining vital events registration, verbal autopsy and electronic medical records in rural Ghana for improved health service delivery ¹⁰	Ghana	Open Source (MGV-net)	Vital registration
Implementing OpenMRS for patient monitoring in an HIV/AIDS care and treatment program in rural Mozambique ³⁴	Mozambique	Open Source (Open MRS)	HIV care

Figure 1 Use of Electronic health records in sub-Saharan Africa as at 2012.
(Akanbi, 2012)

A survey that shows how hospital administrators in low-income countries such as Kenya have started to invest in new EHR systems directly to improve administrative efficiencies in their hospitals and increase financial accountability. In Kenya, these systems have largely been developed by local Kenyan companies with developers and support staff working closely with hospitals to meet specific needs. There is little published research on locally developed EHR systems outside of Kenya.

2.3 Existing platforms

2.3.1 ChartLogic

ChartLogic is an electronic health record system that captures the clinical encounter electronically without making you change your workflow. By combining easy-to-use technology with a tool that users have been using all along—their voices—they’ve made charting more efficient than ever.

Everything from medical history to diagnosis codes to referral reply letters can be accessed from this screen, making it easy for users to complete a comprehensive note without getting lost in forms and files. (Electronic Health Record Software (EHR Software), 2019)

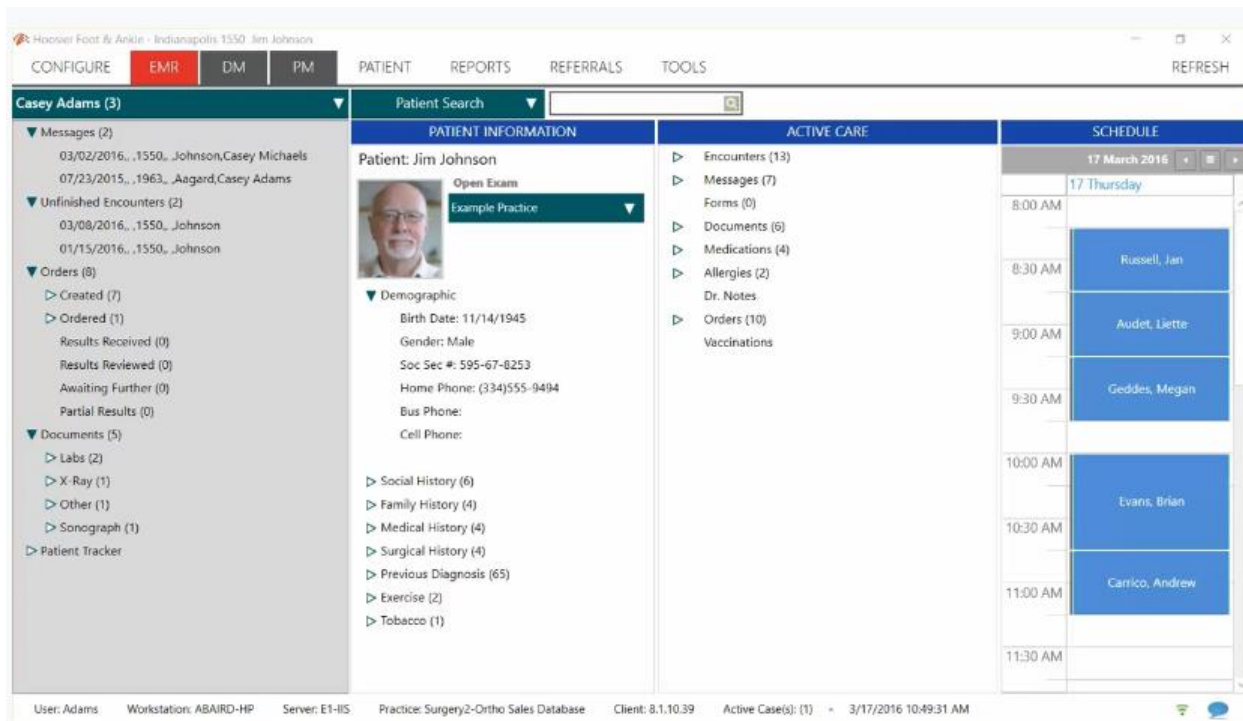


Figure 2 Home Page of ChartLogic system.

(Electronic Health Record Software (EHR Software), 2019)

2.3.2 OpenMRS

To deal with challenges that developing countries were facing with management of health information, OpenMRS, a multi-institution, non-profit collaborative led by Regenstrief Institute, a world-renowned leader in medical informatics research and Partners In Health, a Boston-based philanthropic organization, was formed in 2004 (Blin et al., 2015). It is a common platform upon which medical informatics efforts in developing countries can be built. The system is based on a conceptual database structure which is not dependent on the actual types of medical information required to be collected or on particular data collection forms and so can be customized for different uses.

OpenMRS is based on the principle that information should be stored in a way which makes it easy to summarize and analyze, i.e., minimal use of free text and maximum use of coded

information. It stores all diagnosis, tests, procedures, drugs and other general questions and potential answers. OpenMRS is a client-server application, which means it is designed to work in an environment where many client computers access the same information on a server.

2.3.3 Medbook

This is a universal health platform that allows a user to securely store, access and share their medical records at the touch of a button. Other than record keeping, Medbook offers its users a variety of other services such as connecting users to insurance plans. With your digitized medical history standardized to a universally accepted format, Medbook plugs you into a diverse pool of medical practitioners as well as pairing you with an insurance provider who will meet your precise needs. It proposes an interactive medium to allow various stakeholders to access the patient data securely utilizing the latest technologies in data encryption and access authentication (Forgionne & Kohli, 1995).

Medbook can predict, prevent or at the very least, minimize the physical and financial burden that epidemics and outbreaks cause countrywide.

For insurance firms, the challenge faced is not just that most medical records are paper-based and scattered in many institutions, but for it, incidences of fraud claims have risen dramatically. With the Medbook platform, the immediate benefit is the markedly reduced expenditure commitment to verifying claims. It also replaces the billing system employed making your operations more effective and efficient.

The options to log onto this system are as a doctor or a patient.

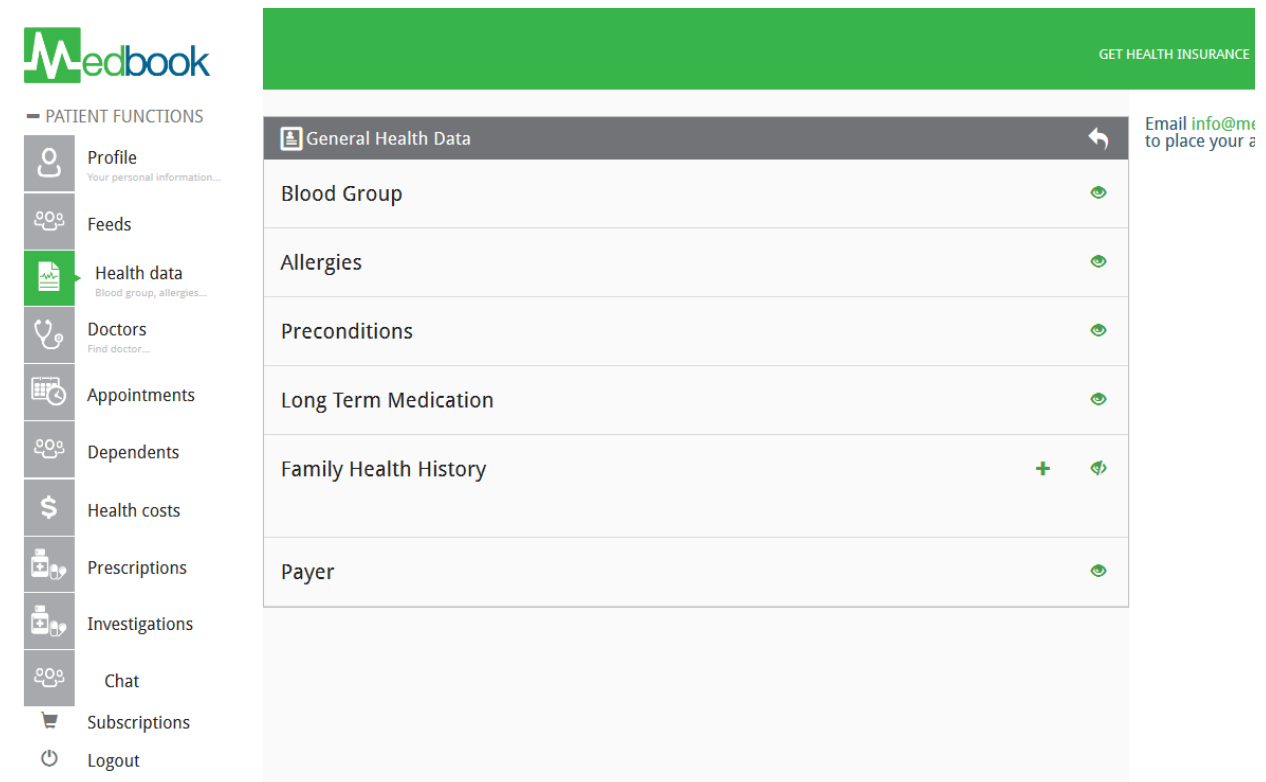


Figure 3 Medbook User Interface (Medbook, 2018)

Medbook, despite its many advantages, has its own downfalls.

Patients fill in their medical history and information themselves. Medbook claims to be able to verify and know what's not true, they still can't control what the patients enter as their information. During a hospital visit, not all that is said by healthcare providers is understood. This makes it impossible to be very sure when entering your own details in the system.

The system is not only for record keeping. It offers its users other functionalities. This is a disadvantage only because when a system has a lot of functionality, some of them aren't as well managed as others.

2.3.4 AfyaEHMS

AfyaEHMS was first implemented in Machakos County in Kenya and later rolled out to different levels of healthcare facilities within other counties. Machakos County hospital was using an existing ICT system but were motivated to install a Ministry of Health-backed system in order to lower costs, improve system performance, and increase access to technical support (Muinga, 2018)

The implementation of this HER in Machakos encountered some difficulty because of a number of reasons such as; rather than switching completely over to the new system, the manual paper file

system ran in parallel. This led health workers to choose the paper system over the electronic system. The challenge was compounded by the feeling that the EHR was complex to use and health workers had not received adequate training. Also, there were workflow challenges that made the EHR incompatible with the clinical workflow, making it difficult to use the system effectively.

2.4 Conceptual Framework

The system has several users. The administrator or the owner of this system will be the Ministry of Health of Kenya (MOH). Hospitals, pharmacies, insurances and any other facility offering healthcare services are required by law to register with the MOH. When this proposed system is implemented, these facilities will also be required, by law, to submit patient information to it as a way of record keeping. This will also ensure that no unauthorized people have access to this sensitive information.

Unique numbers, for example, the Huduma Namba can be used to identify patients. First time patients are registered by the facility they are visiting and over time as they visit other facilities, their information is regularly updated.

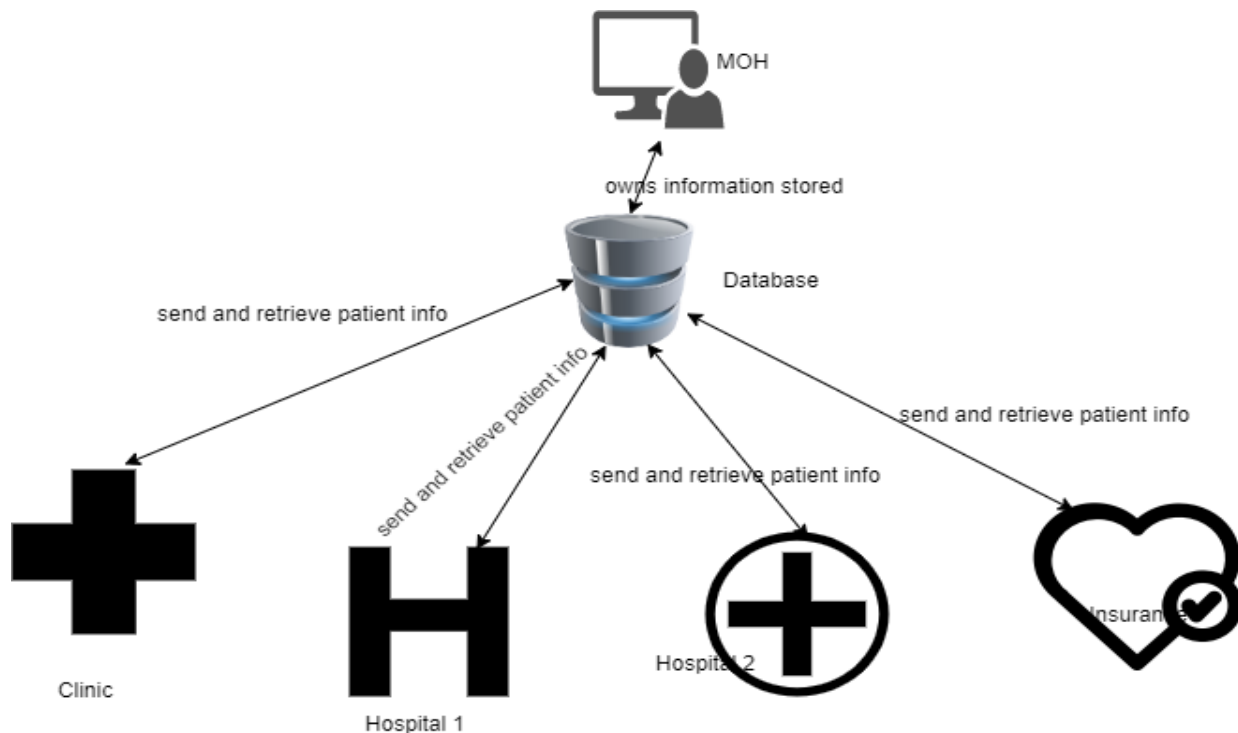


Figure 4 Conceptual Framework Diagram

CHAPTER THREE: RESEARCH METHODOLOGY

3.1 Introduction

This research aims at developing a web-based system that allows healthcare providers to share patient information amongst each other in Kenya. The system will then be deployed for testing countrywide. This chapter describes the methodology used to develop this system, methods to collect and analyze data for the research and the tools and technologies necessary to develop the system.

3.2 Agile model

Agile methods break the product into small incremental builds. These builds are provided in iterations. Each iteration typically lasts from about one to three weeks. Every iteration involves cross functional teams working simultaneously on various areas like –

- Planning
- Requirements Analysis
- Design
- Coding
- Testing and
- Maintenance

At the end of the iteration, a working product is displayed to the customer and important stakeholders. (SDLC - Agile Model, n.d.) The researcher chose agile methodology given the frequent reviews that were needed occasionally. This helped to compare notes with other system stakeholders and improve every phase of the program.

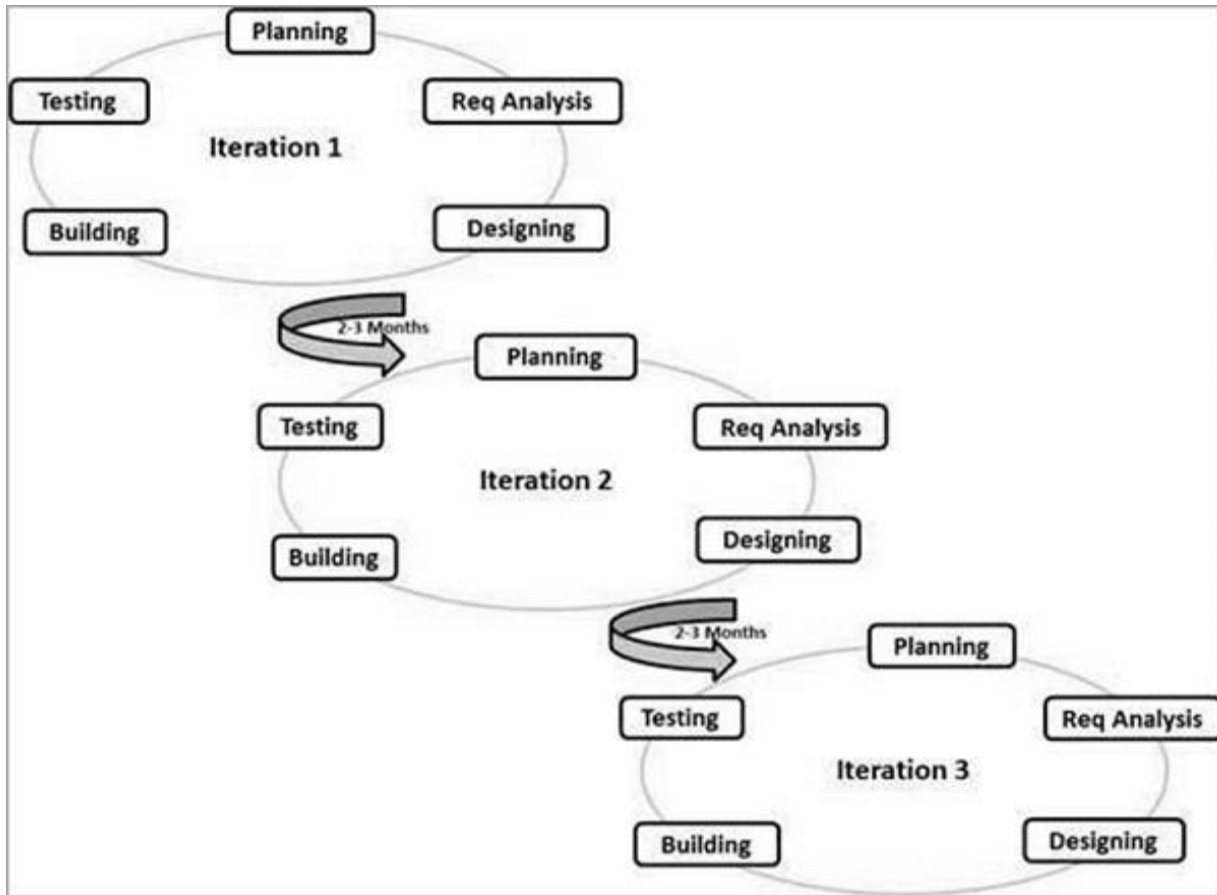


Figure 5 Agile model (SDLC - Agile Model, n.d.)

For this particular project, in order to develop an efficient healthcare system, the following requirements were considered:

3.3 Research Design

The research will use both qualitative and quantitative research methods, Qualitative research will be used to observe through the eyes of the target population, the healthcare providers and patients, through conversations and interviews. This will help the researcher to understand the current state of record keeping in hospitals and how easily or difficult it is to share these records with other hospitals. The quantitative research will be used to count the number of people who will be open to using the system once it is developed.

Also, at this point, a blueprint or architecture of the software program is generated. Ideas are consolidated into pictorial or visual impressions of the final software program in mind. Use case

diagrams and flow charts that speak directly to a person may be involved. The researcher deployed Mockflow (<https://www.mockflow.com/>), as a design tool for developing the initial system prototype and design. These included database mock ups, front end UI and backend UI.

3.4 System analysis

The Object-oriented Analysis and Design (OOAD) process is a sequential set of steps that begin with gaining a clear understanding of the needs and requirements of the customer and ends with a final blueprint or design of the application that matches, as closely as possible, the requirements of the customer. The framework is divided into four distinct phases, which include planning, requirements gathering, implementation and transition.

Object-oriented analysis is a method of analysis that examines requirements from the perspective of the classes and objects found in the vocabulary of the problem domain. (Booch, 1998).

3.5 System Design

Object oriented design will be used to help design the system architecture or layout after object oriented analysis of requirements is completed. The OOD process takes the conceptual systems model, use cases, system relational model, user interface (UI) and other analysis data as input from the OOA phase. This is used in OOD to identify, define and design systems classes and objects, as well as their relationship, interface and implementation.

Class diagrams will be used to show the main actors in the system and how each actor interacts with the system. Entity Relationship Diagrams which are a visual representation of how objects will relate to each other, will be used.

3.6 Coding

This is the stage of software development where actual programming of the application occurs. The programming language of the application will be informed by the type of app required, it could be a web app, mobile based or USSD. PHP and HTML 5 will be used to develop this system because they are cross-platform, meaning as long as your device supports them, it doesn't matter what platform you open your system on. The backend of the system will be done using Laravel, which is a PHP web-based framework. This framework was chosen because it is lightweight,

enables faster development and integrates seamlessly with backend processes. Bootstrap will be used for the user interface and MySQL language for the database.

3.7 Testing

Unit testing and integration testing will be done. Unit testing is the process of ensuring individual components of a piece of software at the code level are functional and work as they were designed to. After each unit is tested, it is integrated with other units to create modules or components that are designed to perform specific tasks or activities. They are then tested as group through integration testing to ensure whole segments of an application behave as expected.

3.8 Handover

Once software has been developed to full, the resulting application is then handed over to the client or entity that requested it, this could be an organization, person or government ministry. The product should come along with a detailed documentation for the end user to read and follow as procedure on using the application. The researcher has fully documented this app as per and would be needed by the end user.

3.9 Maintenance

The final stage is maintenance of the application and this could be done by a chosen team member in the client organization or by the party that developed the application program. This can always be used as reference by anyone using the application. The researcher being the developer of this application and has a 360 degrees understanding of the system is endowed to fully support and maintain the app. In case of partnerships with other entities or third party agencies then a developer would be chosen to support the system in its place.

3.10 Domain Execution

The proposed solution will be a web-based system. Data in web-based systems is stored in one central location, thus enabling users to share data.

CHAPTER FOUR: SYSTEM ANALYSIS AND DESIGN

4.1 Introduction

Every software development requires a well-planned and executed process. There are different software development paradigms. A paradigm is defined as the approach taken when designing a particular software program.

4.2 Requirements gathering

Involves the collection of all tools and expertise required in the problem statement. At this state, the skills of a systems analyst are engaged in order to identify which are the requirements needed to accomplish these. Requirements may be in the form of tools such as software programs, hardware materials or user skills and experience. For this project, the researcher included sample data from hospitals and health institutions nearby as part of the final testing process. Moreover, technical user skills and knowledge was also sought in trying to gather the best computer machine and software for this program development.

4.3 System Requirements

4.3.1 *Functional requirements*

Functional requirements describe the functions that a software must perform.

- i. The proposed system should allow the administrator to register all users who will interact with the system.
- ii. The proposed system should allow the users to login upon registration.
- iii. The proposed system should allow nurses/doctors or any authorized healthcare provider to add new users and fill in their biodata.
- iv. The proposed system should allow healthcare providers have access to patient information from anywhere in the country provided they have been granted access.
- v. The proposed system should allow for insurances to have access to the information needed to carry out their services.

4.3.2 Non-functional requirements

Non-functional requirements represent a set of standards used to judge the specific operation of a system.

- i. All healthcare providers need to provide their registration details issued by the Kenya Medical Practitioners and Dentists Council in order to be registered into the system.
- ii. The proposed system should be able to open on all types of web browsers for example Chrome, Mozilla Firefox etc.
- iii. The proposed system should have a backup plan in case of failure to allow for recovery.

4.4 System architecture

A system's architecture is the conceptual model that defines the structure, behavior, and more views of a system. An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. We can broadly categorize them into centralized and decentralized organizations.

4.4.1 Online healthcare system architecture

This project employs the use of centralized server architecture. The system greatly relies on get/post requests on server as shown below:

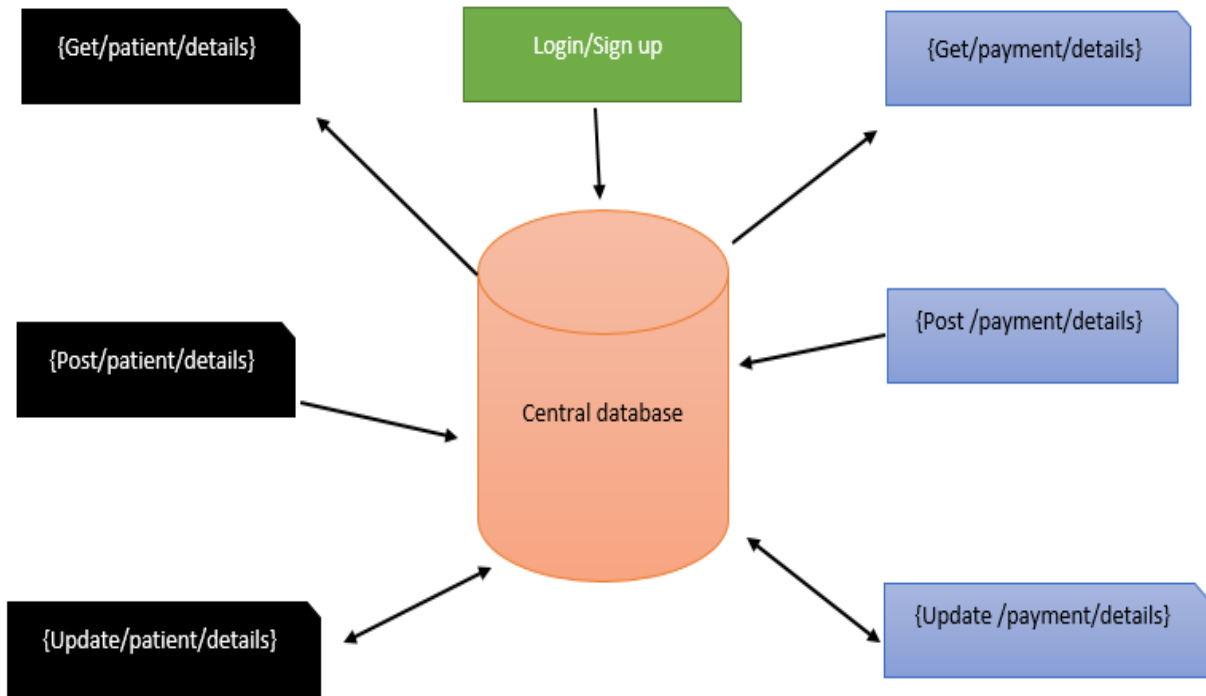
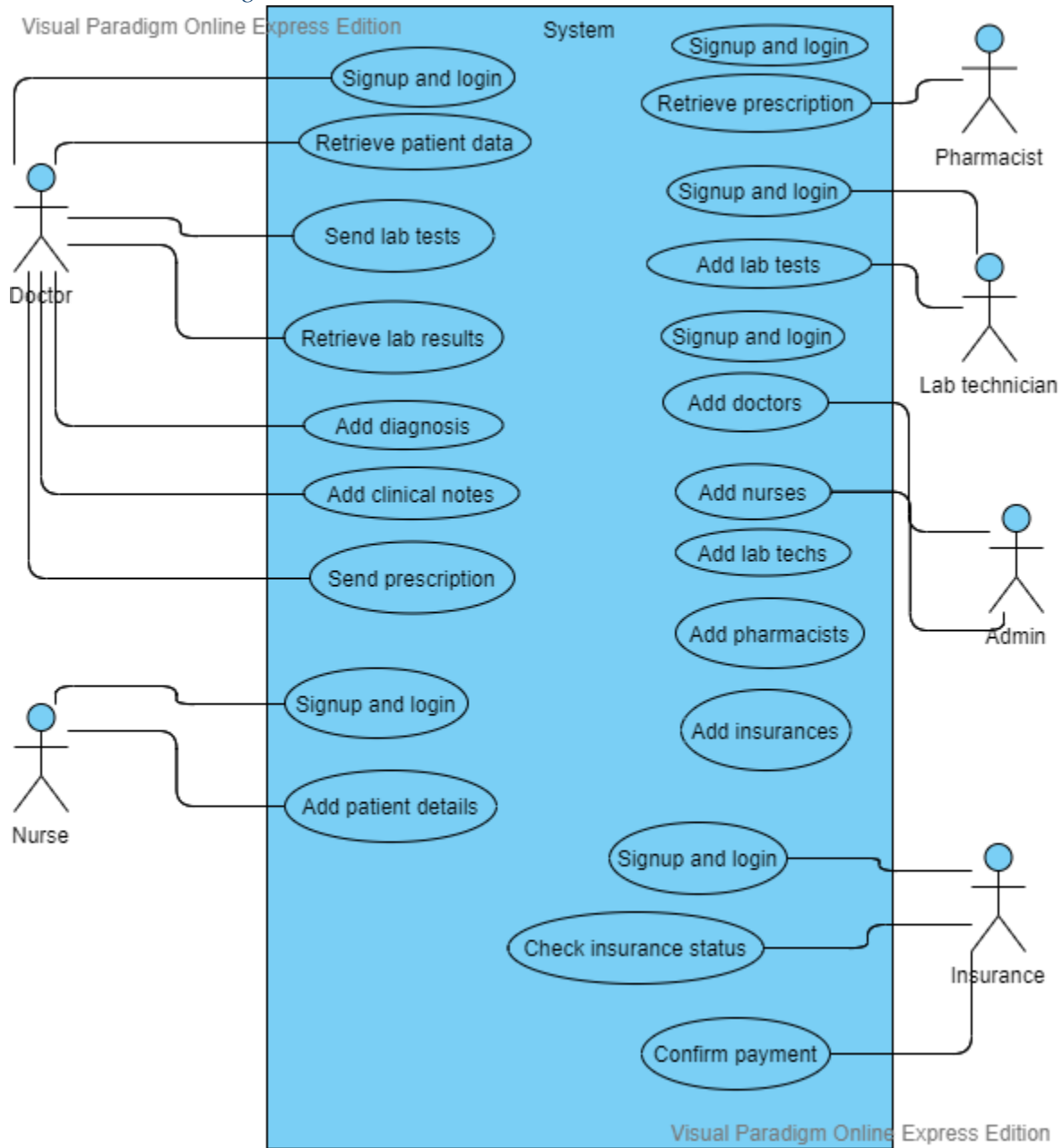


Figure 6 Online healthcare architecture

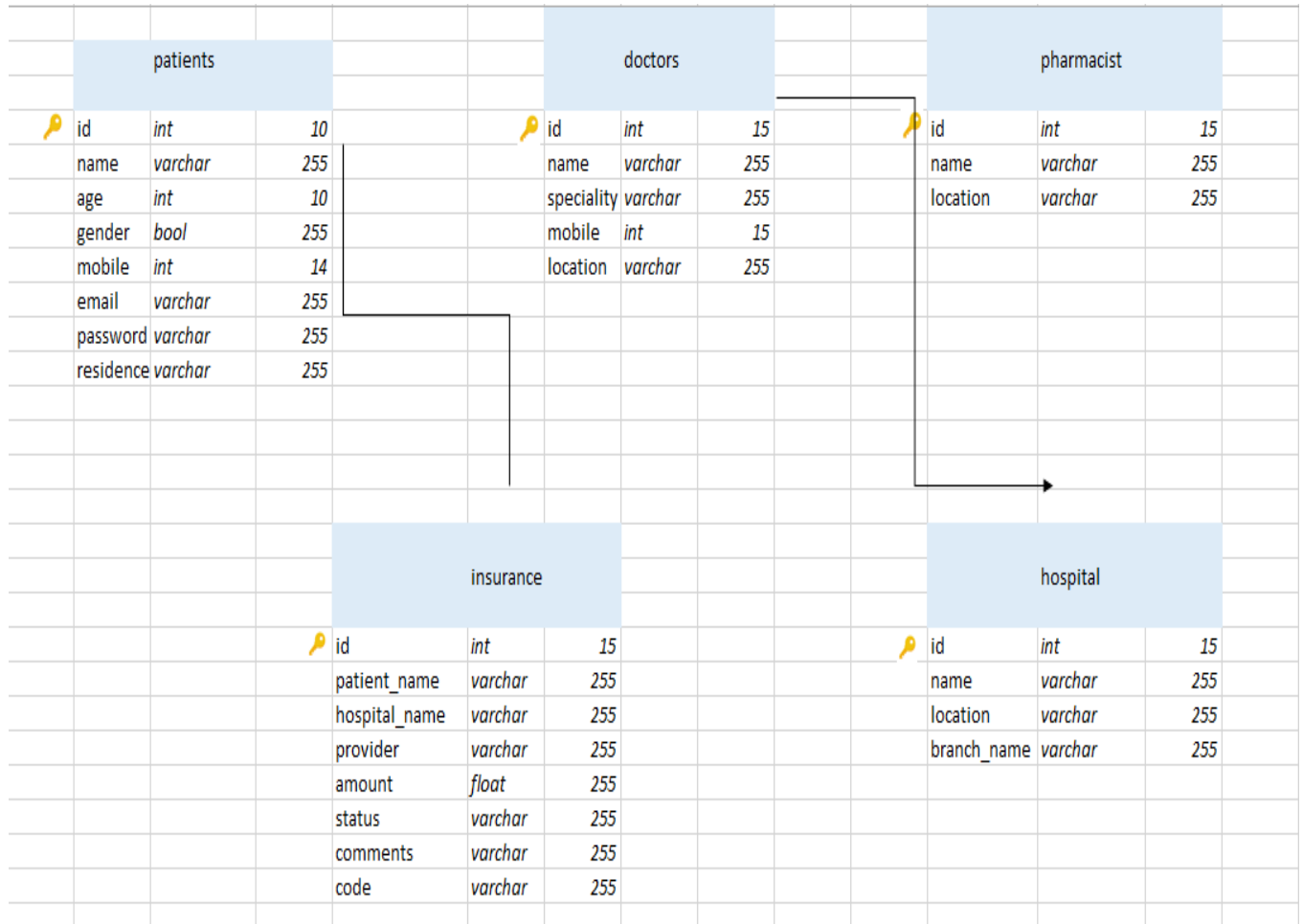
4.5 Analysis

4.5.1 Use case diagram

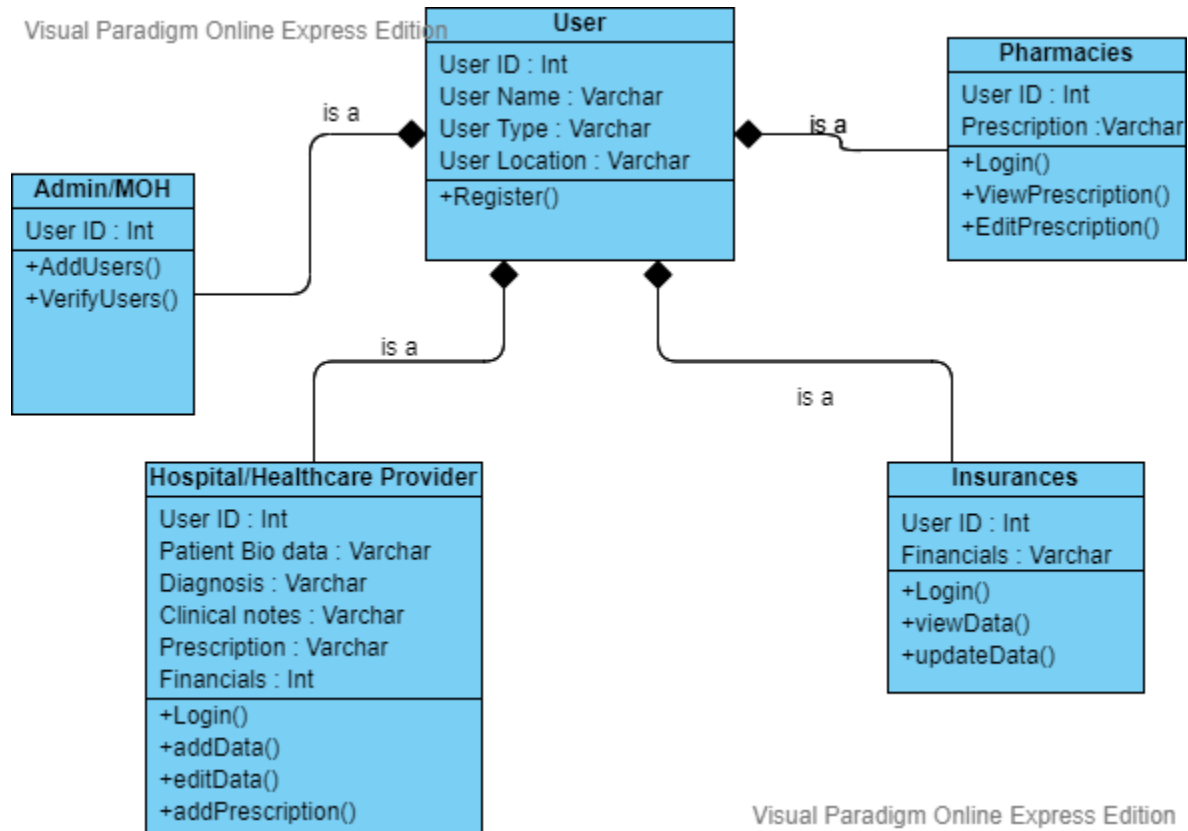


4.6 Designs

4.6.1 Entity relationship diagram



4.6.2 Class diagram



4.6.3 Database schema

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
<input type="checkbox"/> 1	id	int(11)			No	None		AUTO_INCREMENT
<input type="checkbox"/> 2	user_id	int(10)			No	None		
<input type="checkbox"/> 3	username	varchar(50)	utf8_general_ci		Yes	NULL		
<input type="checkbox"/> 4	password	varchar(50)	utf8_general_ci		Yes	NULL		
<input type="checkbox"/> 5	childs	text	utf8_general_ci		No	None		
<input type="checkbox"/> 6	role	varchar(30)	utf8_general_ci		No	None		
<input type="checkbox"/> 7	verification_code	varchar(200)	utf8_general_ci		No	None		
<input type="checkbox"/> 8	is_active	varchar(255)	utf8_general_ci		Yes	yes		
<input type="checkbox"/> 9	created_at	timestamp			No	current_timestamp()		ON UPDATE CURRENT_TIMESTAMP()

Figure 7 User table schema

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
<input type="checkbox"/>	1	id	int(11)		No	None		AUTO_INCREMENT
<input type="checkbox"/>	2	medicine_name	varchar(200)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	3	medicine_category_id	varchar(50)	utf8_general_ci	No	None		
<input type="checkbox"/>	4	medicine_image	varchar(200)	utf8_general_ci	No	None		
<input type="checkbox"/>	5	medicine_company	varchar(100)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	6	medicine_composition	varchar(100)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	7	medicine_group	varchar(100)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	8	unit	varchar(50)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	9	min_level	varchar(50)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	10	reorder_level	varchar(50)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	11	vat	varchar(50)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	12	unit_packing	varchar(50)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	13	supplier	varchar(50)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	14	vat_ac	varchar(50)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	15	note	varchar(200)	utf8_general_ci	No	None		
<input type="checkbox"/>	16	is_active	varchar(200)	utf8_general_ci	No	None		
<input type="checkbox"/>	17	created_at	timestamp		No	current_timestamp()		

Figure 8 medical stock table schema

#	Name	Type	Collation	Attributes	Null	Default	Comments	Extra
<input type="checkbox"/>	1	id	int(11)		No	None		AUTO_INCREMENT
<input type="checkbox"/>	2	name	varchar(100)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	3	slug	varchar(150)	utf8_general_ci	Yes	NULL		
<input type="checkbox"/>	4	is_active	int(11)		Yes	0		
<input type="checkbox"/>	5	is_system	int(1)		No	0		
<input type="checkbox"/>	6	is_superuser	int(11)		No	0		
<input type="checkbox"/>	7	created_at	timestamp		No	current_timestamp()		ON UPDATE CURRENT_TIMESTAMP()

Figure 9 Roles table schema

4.7 System Mockups

At this point, we explore an in-depth illustration of the system, what components are component of the system and how these components basically connect with each other to achieve the expected output.

4.7.1 User login

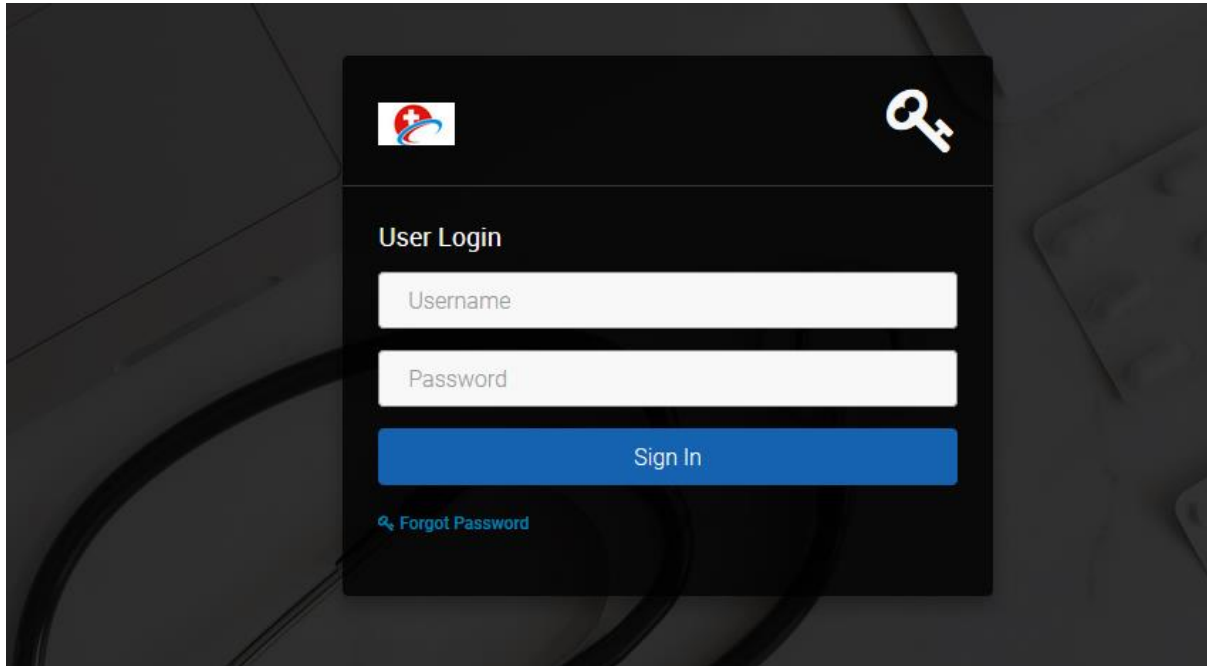


Figure 10 End user interface

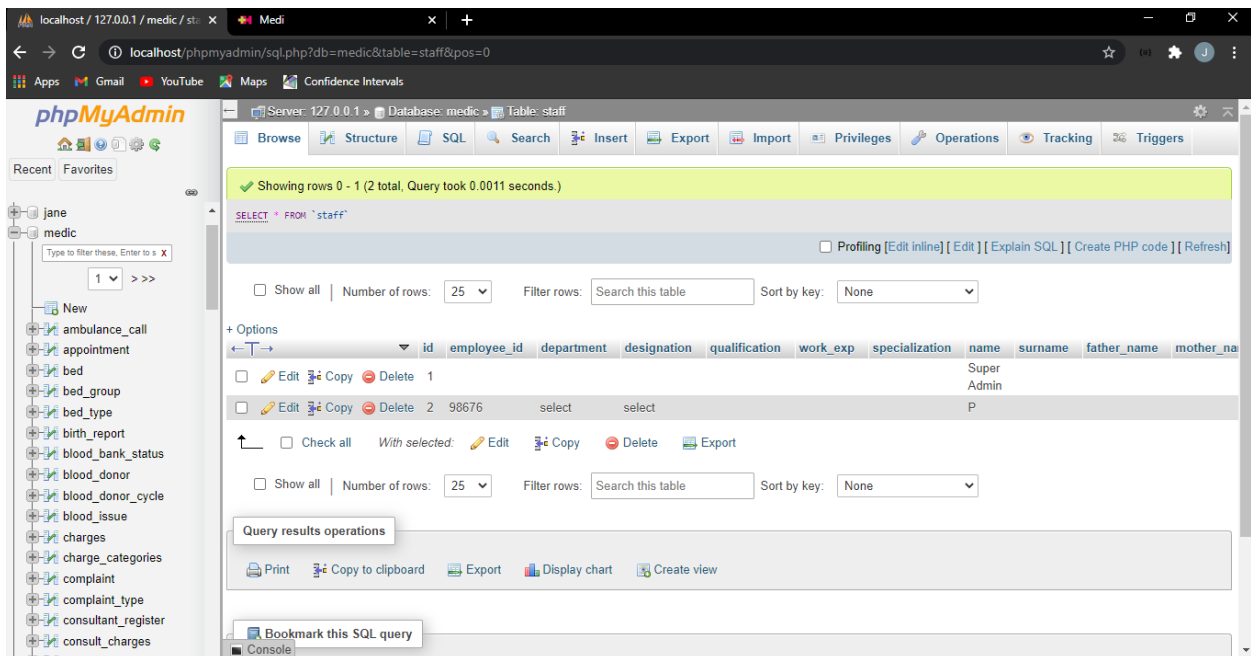
CHAPTER FIVE: SYSTEM IMPLEMENTATION AND TESTING

5.1 Introduction

System implementation involves coding the application to achieve the final system. The following are strategic processes that were followed to achieve this. A combination of Laravel and MySQL database was used.

5.2 Backend

5.2.1 Database modelling:



5.2.2 Development of eloquent models

```

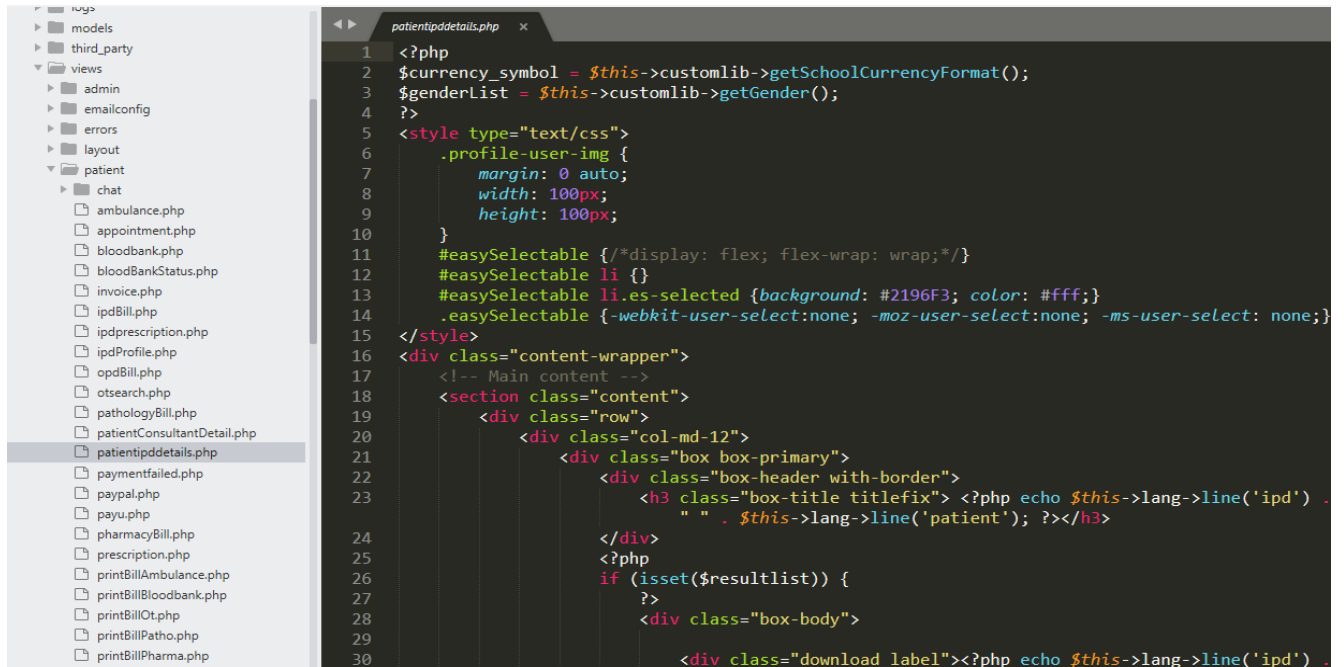
1 <?php
2
3 class Patient_model extends CI_Model {
4
5     public function add($data) {
6         if (isset($data['id'])) {
7             $this->db->where('id', $data['id']);
8             $this->db->update('patients', $data);
9         } else {
10            $this->db->insert('patients', $data);
11            return $this->db->insert_id();
12        }
13    }
14
15    public function add_patient($data) {
16        if (isset($data['id'])) {
17            $this->db->where('id', $data['id']);
18            $this->db->update('patients', $data);
19        } else {
20            $this->db->insert('patients', $data);
21            return $this->db->insert_id();
22        }
23    }
24
25    public function valid_patient($id) {
26
27        $this->db->select('ipd_details.patient_id,patients.discharged,patients.id as pid');
28        $this->db->join('patients', 'patients.id=ipd_details.patient_id');
29        $this->db->where('patient_id', $id);
30        $this->db->where('patients.discharged', 'no');
31        $query = $this->db->get('ipd_details');
```

5.2.3 Definition of controllers

```

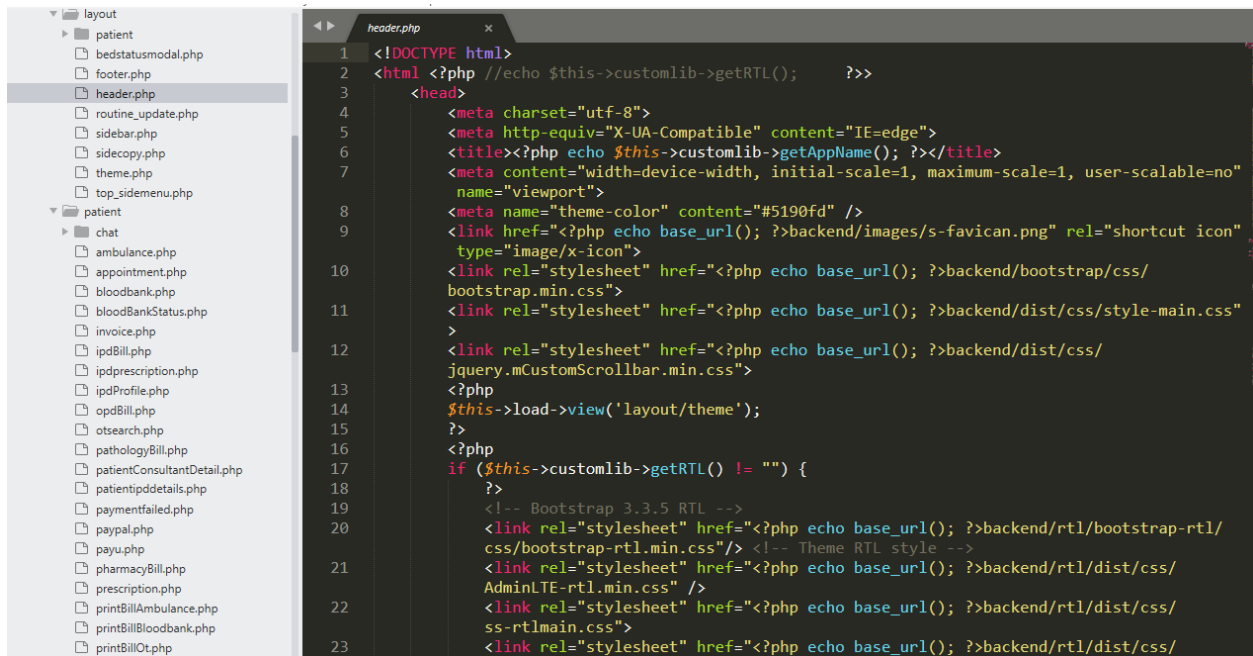
1 <?php
2
3 if (!defined('BASEPATH'))
4     exit('No direct script access allowed');
5
6 class patient extends Admin_Controller {
7
8     function __construct() {
9         parent::__construct();
10        $this->config->load("payroll");
11        $this->config->load("image_valid");
12        $this->config->load("mailsms");
13        $this->notification = $this->config->item('notification');
14        $this->notificationurl = $this->config->item('notification_url');
15        $this->patient_notificationurl = $this->config->item('patient_notification_url');
16        $this->load->library('Enc_lib');
17        $this->load->library('encoding_lib');
18        $this->load->library('mailsmsconf');
19        $this->load->library('CSVReader');
20        $this->load->library('Customlib');
21        $this->marital_status = $this->config->item('marital_status');
22        $this->payment_mode = $this->config->item('payment_mode');
23        $this->search_type = $this->config->item('search_type');
24        $this->blood_group = $this->config->item('bloodgroup');
25
26        $this->charge_type = $this->config->item('charge_type');
27        $data["charge_type"] = $this->charge_type;
28        $this->patient_login_prefix = "pat";
29    }
30
31    public function unauthorized() {
```

5.2.4 Definition of views



```
1 <?php
2 $currency_symbol = $this->customlib->getSchoolCurrencyFormat();
3 $genderList = $this->customlib->getGender();
4 ?>
5 <style type="text/css">
6     .profile-user-img {
7         margin: 0 auto;
8         width: 100px;
9         height: 100px;
10    }
11    #easySelectable { /*display: flex; flex-wrap: wrap;*/}
12    #easySelectable li {}
13    #easySelectable li.es-selected {background: #2196F3; color: #fff;}
14    .easySelectable {-webkit-user-select:none; -moz-user-select:none; -ms-user-select: none;}
15 </style>
16 <div class="content-wrapper">
17     <!-- Main content -->
18     <section class="content">
19         <div class="row">
20             <div class="col-md-12">
21                 <div class="box box-primary">
22                     <div class="box-header with-border">
23                         <h3 class="box-title titlefix"> <?php echo $this->lang->line('ipd')
24                             " " . $this->lang->line('patient'); ?></h3>
25                     </div>
26                     <?php
27                     if (isset($resultlist)) {
28                         ?>
29                         <div class="box-body">
30                             <div class="download_label"><?php echo $this->lang->line('ipd')
```

5.2.5 Definition of layouts



```
1 <!DOCTYPE html>
2 <html <?php //echo $this->customlib->getRTL(); ?>>
3 <head>
4     <meta charset="utf-8">
5     <meta http-equiv="X-UA-Compatible" content="IE=edge">
6     <title><?php echo $this->customlib->getAppName(); ?></title>
7     <meta content="width=device-width, initial-scale=1, maximum-scale=1, user-scalable=no"
8     name="viewport">
9     <meta name="theme-color" content="#5190fd" />
10    <link href="<?php echo base_url(); ?>backend/images/s-favican.png" rel="shortcut icon"
11    type="image/x-icon">
12    <link rel="stylesheet" href="<?php echo base_url(); ?>backend/bootstrap/css/
13    bootstrap_min.css">
14    <link rel="stylesheet" href="<?php echo base_url(); ?>backend/dist/css/style-main.css"
15    >
16    <link rel="stylesheet" href="<?php echo base_url(); ?>backend/dist/css/
17    jquery.mCustomScrollbar.min.css">
18    <?php
19    $this->load->view('layout/theme');
20    ?>
21    <?php
22    if ($this->customlib->getRTL() != "") {
23        ?>
24        <!-- Bootstrap 3.3.5 RTL -->
25        <link rel="stylesheet" href="<?php echo base_url(); ?>backend/rtl/bootstrap-rtl/
26        css/bootstrap-rtl.min.css"/> <!-- Theme RTL style -->
27        <link rel="stylesheet" href="<?php echo base_url(); ?>backend/rtl/dist/css/
28        AdminLTE-rtl.min.css" />
29        <link rel="stylesheet" href="<?php echo base_url(); ?>backend/rtl/dist/css/
30        ss-rtlmain.css">
31        <link rel="stylesheet" href="<?php echo base_url(); ?>backend/rtl/dist/css/
```

5.2.6 Logic definition and set-up

```
Find Results x Department.php x
1 <?php
2
3 if (!defined('BASEPATH'))
4     exit('No direct script access allowed');
5
6 class Department extends Admin_Controller {
7
8     function __construct() {
9
10        parent::__construct();
11        $this->load->library('datatables');
12        $this->load->helper('file');
13        $this->config->load("payroll");
14    }
15
16    function index() {
17
18        $this->session->set_userdata('top_menu', 'setup');
19        $this->session->set_userdata('sub_menu', 'hr/index');
20
21        $this->form_validation->set_rules(
22            'type', 'Department Name', array('required',
23            array('check_exists', array($this->department_model, 'valid_departm
24            )
25        );
26
27        $data["title"] = "Add Department";
28        if ($this->form_validation->run()) {
29
```

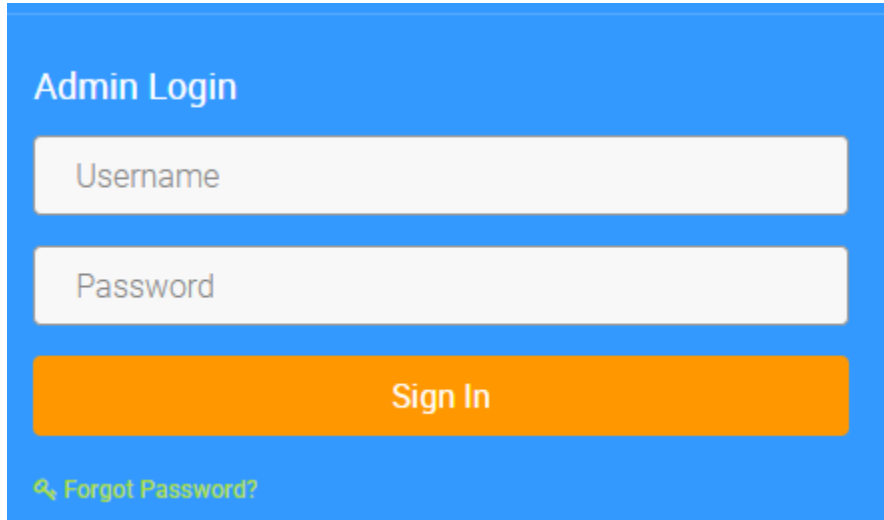
5.3 System installation:

Whether on local server or hosted server, the installation is quite easy. One needs to just follow the procedures below:

On local host

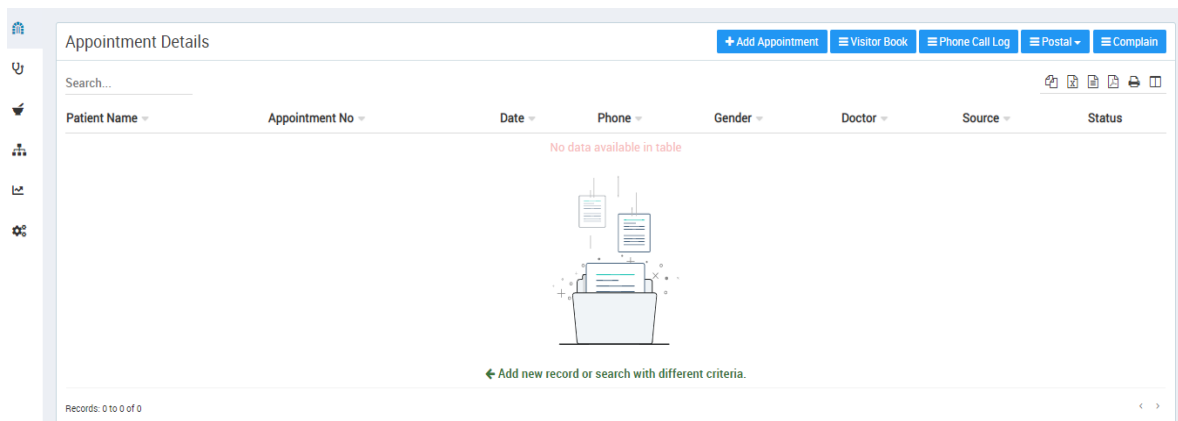
1. Unzip the project folder in your working Xamp directory e.g medilab
2. Create a database and edit database connection details in .env file of the application as defined on the MySQL client
3. On your terminal or cmd, type \$- php artisan migrate. This will install all the required tables in the database
4. Now go to your cmd/ terminal again and type -php artisan serve, this will start the Laravel application
5. Now go to your browser and type <http://localhost/{name}> of your parent folder}

6. Hurrah! Your site is up and running



The image shows an 'Admin Login' form on a blue background. It features two input fields: 'Username' and 'Password'. Below these fields is a large orange button labeled 'Sign In'. At the bottom left of the form, there is a link with a magnifying glass icon that says 'Forgot Password?'.

After successful login you will reach to Admin Dashboard. Below you can find navigational overview of user screen.



The image shows a screenshot of the 'Appointment Details' dashboard. The dashboard has a light blue header with the title 'Appointment Details' and several action buttons: '+ Add Appointment', 'Visitor Book', 'Phone Call Log', 'Postal', and 'Complain'. Below the header is a search bar and a table with columns: 'Patient Name', 'Appointment No', 'Date', 'Phone', 'Gender', 'Doctor', 'Source', and 'Status'. The table is currently empty, displaying the message 'No data available in table' in red text. Below the table is an illustration of a printer and a document, with the text '← Add new record or search with different criteria.' below it. At the bottom left, it says 'Records: 0 to 0 of 0' and at the bottom right, there are navigation arrows.

5.4 Roles

5.4.1 Roles by access

Role

Name

Save

Role List

Search...

Role	Type	Action
Admin	System	
Accountant	System	
Doctor	System	
Pharmacist	System	
Pathologist	System	
Radiologist	System	
Super Admin	System	
Receptionist	System	

Records: 1 to 8 of 8 < 1 >

Figure 11 Roles

5.4.2 Roles by permissions

Assign Permission (Doctor)

Module	Feature	View	Add	Edit	Delete
OPD	OPD Patient	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Prescription	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Revisit	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	OPD Diagnosis	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	OPD Timeline	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	OPD Prescription Print Header Footer	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Move Patient in IPD	<input checked="" type="checkbox"/>			
	Manual Prescription	<input checked="" type="checkbox"/>			
	Charges	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Payment	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
IPD	Bill	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	IPD Patients	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>
	Discharged Patients	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>

Figure 12 Permissions

CHAPTER 6: DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

6.1 Introduction

The purpose of this chapter is to recall the objectives mentioned in chapter 1 and discuss what was achieved and what wasn't. It also looks at what was concluded from the discussions on each objective.

Finally, it looks at what needs to be done to access and use the system and finally what the future of the system looks like.

6.2 Discussion

Hospitals in Kenya are seeking to automate most, if not all, of their services to ensure maximum efficiency and to cut down on the amount of paperwork required in their daily running. Electronic health record keeping is an area that is still not as developed as it should be. For a person to get their records from one doctor and share them with another one, they have to go through a tedious process that most times involves having to contact the former either physically or by phone.

The way to try and work around this is to have a system that allows healthcare providers access to the patient information they require. The information can then be updated and shared if need be while still ensuring the confidentiality that health records require.

6.3 Conclusions

It was found that ensuring the safety of client information should be the priority when creating a health records storage system. These records are extremely sensitive and under no circumstances should patients feel that their information could be accessed by unauthorized personnel.

For ease of record retrieval, a unique number, in this case, the Huduma Namba was to be used but because these numbers are yet to be assigned by the government, another solution had to be found. Now, the system automatically generates a unique number for each patient and this is what will be used instead.

It was also necessary to have access to the list of registered health facilities in Kenya which is compiled by the Kenya Medical Practitioners and Dentists Board. This was done so that when a patient's records are being viewed, the new healthcare provider can be able to confirm that the validity of the information by confirming from which facility they were entered.

6.4 Recommendations

For this system to work, it should be hosted on a virtual server and access to it will require the internet. If the system is not hosted then the whole aim of creating this system is lost.

6.5 Future works

A system that can be used outside the country is the biggest part of the future works for this system. Many patients, especially cancer patients, are sent to India for treatment. They have to travel with their records or have new tests done once they get there. To many, just going abroad is already too much financially, physically and mentally. Any way to make this whole process even the slightest bit easier is welcome.

This might take a while because as mentioned, patient information is very sensitive and it would also be a heavily funded operation. But with governments collaboration, maybe it would be easier.

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Appendix A: Time Schedule

