ELECTRONIC CLINIC MANAGEMENT SYSTEM

BY

ADEBAYO PRAISE

MATRIC NUMBER: 17010301011

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SUBMITTED TO THE

DEPARTMENT OF COMPUTER SCIENCE, COLLEGE OF BASIC AND APPLIED SCIENCES, MOUNTAIN TOP UNIVERSITY, OGUN STATE, NIGERIA.

IN PARTIAL FUFILLMENT OF THE REQUIREMENT FOR THE AWARD OF A BACHELOR OF SCIENCE (B.SC.) DEGREE IN COMPUTER SCIENCE AND MATHEMATICS

DECLARATION

I hereby declare that this project has been written by me, Praise Adebayo, and is a record of my own research work. It had not been presented in any previous application for higher degree of this or any other university. All citation sources of information are clearly acknowledged by means of reference.

ADEBAYO, Praise

Date

CERTIFICATION

This is to certify that this project, ELECTRONIC CLINIC MANAGEMENT SYSTEM was carried out by me, Adebayo Praise (Matric number: 17010301011). Under the supervision of Dr. M. O. Adewole.

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Matthew O. Adewole, Ph.D DATE
(Supervisor)

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Matthew O. Adewole, Ph. D DATE
(Ag. Head of Department)

DEDICATION

This project is dedicated to my ever-unrelenting support, my mom.

ACKNOWLEDGEMENT

Appreciation to God, the giver of wisdom and understanding for smooth execution of this project. I'm grateful for the success of this project.

I owe my profound gratitude to my supervisor, Dr. M. O. Adewole who painstakingly took his time to attend to me, guide me all along, and motivate me to put in my best.

To all lecturers in the department, I sincerely thank you all for your teachings, mentoring and impact in my life. All along from 100 level to 400 level. Dr. M.O. Adewole, Late Dr. M.O. Oyetunji, Dr. (Mrs.) F.A. Kasali, Mr. O.J. Falana, Mr. J. Balogun, Dr. A. Taiwo, Mrs. O. Taiwo, Mr. Ebo, Mr. Michael Okunoye, amongst others, I acknowledge your mentorship and contribution to my academics.

I appreciate members of my family for your sponsorship, advice and prayers. Mrs. Fatoki, Mrs. Omileke, Mrs. Akanbi, Mr. and Mrs. Ayandare, amongst others; I say a big thank you to you all.

I will forever be grateful to my parents, who sacrificed time, wealth and other resources for my academic success. And to my siblings, I love you all.

Table of Contents

List of Figures

ABSTRACT

This project is based on the Design and Implementation of an Electronic Clinic Management System for use at the Mountain Top University Health Center. This project aims to design and develop an electronic health record system for the MTU clinic; to tackle complications of manual record system and improve administrative efficiency. To achieve the aim of this project, the requirements of the system was identified, system design was specified, and the system was implemented.

The system was built using Vue.js for the front-end development, JavaScript for the backend, and SQLite for the database. The code editor used was visual studio.

This system carefully mimics the clinic flow of operation at the clinic for easy use and making it relatable to users (students). The developed system was able to serve as an improvement to the manual method.

The electronic clinic management system will provide better services for the nurses and doctors such as reduction in time taken to find a folder, accuracy and timeliness of record preparation etc. It is recommended that hospitals who are still using the manual system should opt for the electronic system, to fit into the global trend of evolution of technology.

Keywords: Vue.js, SQLite, Front-end, Back-end, JavaScript.

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Advancement in technology has aided the improvement of various sectors of life; with numerous innovations over the years. Making tasks stress-free, and carried out more efficiently (Staff, 2020). The health care sector is one of the sectors of the economy that deals with highly sensitive information. Health care organizations are information-intensive, such that they spend a huge amount of money on information management and processing on inpatients and outpatient database systems (Welcome, 2011). This shows that techniques that would enhance the collection, storage, and handling of data would be helpful in hospital management. As a result, health-care companies are seeking to establish integrated computer-based information-management environments in order to consolidate the inevitable usage of big data in the field.

Data management is a severe hindrance to productivity because paper is the most prevalent medium for keeping medical records (Mandl, 2015). However, the promise of a more efficient hospital service is obvious through the use of electronic health records management systems (DSA, 2021). At the Mountain Top University clinic, medical data are preserved in physical folders and subsequently placed in cabinets. Patients' (students' and staff's) data are also stored in a variety of formats, resulting in record disorganization, which increases the chance of medical errors, duplicate operations, and time lost in searching and obtaining information.

Although manual record provides accountability, as the nurses can easily access the folders containing patient's record; it has its inherent challenges such as the difficulty of access, time-consuming to access and update records, security, and it is impossible to swiftly share records between different locations. Also, a disaster like a fire outbreak or flood could lead to data loss.

Hence, the need for an electronic record system for hospitals. Efforts are continuously being made in designing and developing economically and reliable database systems to satisfy an electronic record system for hospitals (Metropolitan State University Of Denver, 2021). This project encompasses the design and implementation of a web-based system for an efficient electronic record system for Mountain Top University health center.

The system store patients' (staff and student) records, drug inventory and dispensation, as well as other relevant medical information of the patient. Also, to handle management

enquires, process data swiftly and accurately, provide information when and where required. An electronic health record system would tackle and improve problems associated with the manual record system (Mandl, 2015).

Therefore, the purpose of this research to develop and implement an electronic health record system for Mountain Top University Health Center that will provide efficient management of patients' data, manage doctor's schedules, and appropriately stores patients' information and diagnosis data.

1.2 Statement of the Problem

It has been observed by students, that the Mountain Top University (MTU) health center has been operating on manual record-keeping of patients' (staff and students) data, drug inventory, and medical history of patients.

As discussed in the background of study to this project, several challenges have been connected with the manual method; such as difficulty in data access, time-consuming to update records, poor security, and privacy, high risk of data loss, as well as administrative inefficiency.

1.3 Aim and Objectives of the Study

The aim of this project is to design and develop an electronic health record system for the MTU clinic; to tackle complications of manual record system and improve administrative efficiency.

The specific objective of this project is to:

i. identify the requirements of the system.
ii. specify system design.
iii. implement the system.
iv. validate the system and test the system.

1.4 Scope of the Study

This project encompasses a record of patient’s medical data, drug prescription and its inventory, booking of appointments with the university doctor, and an efficient communication platform between students and doctors, within the MTU territory.

1.5 Limitation of the Study

In a university like MTU, where students are disallowed from having personal internet-connected devices, internet access would be a major constraint. Although the school

management has provided internet access, it is unfortunate that it is restricted to certain locations within the school, and unreliable in terms of network speed.

Hence, a major limitation to this study on the end of the users is that students won't have access to the system at will, due to internet constraints; as discussed above.

1.6 Methodology of the Study

This project is carried out painstakingly, abiding by the laid down standards involved in the design and implementation of software systems. The stages are discussed below;

1. Problem Identification: To identify problems associated with the clinic, their mode of operation should be understood. From a proper grasp and assessment of the clinic's activity and mode of operation, then the challenges and issues faced can be properly identified.
2. Requirement elicitation and analysis: All necessary information required for the database and user requirement of the system will be acquired by interacting with potential users (staff and students) and health workers at the clinic. An informal interview would be conducted.
3. System Modeling: After data collection and proper analysis of the data, information obtained will be used to create models to aid system development. Using the Unified Modeling Language (UML) diagram such as Use case diagram, Activity diagram, Class diagram, amongst others.
4. System Development and Implementation: This will involve the program design of the proposed system. The system would be developed using the Agile model methodology. In developing the system, JavaScript (Vue.Js) would be used for the front-end, JavaScript for the backend, alongside GraphQL as the query language for the backend API. And SQLite 3 for the database.

   After the system has been developed, it would be tested to ensure it fulfills the objectives of this project. Also, to ensure efficient execution of functionalities of the system. Beta testing would be appropriate for the system. Therefore, students who are potential users of the system would be admonished to test the system.

1.7 Significance of the Study

Having a system that supports large-scale sharing of medical details via network connections is apparently of great benefit to the clinic management, and the university community at large. As mentioned in the objectives, this study will help address the problem of security, the

confidentiality of patients' clinical data, among others. Most importantly, suppressing the manual method of record-keeping and clinic management is of great significance.

This project, which involves the design and implementation of a Clinic Management System is crucial to the provision of a smooth administrative run of the clinic, as well as quality health care to students and staff.

1.8 Definition of Terms

- Electronic Health Record (EHR**)-** This refers to a software system used for record-keeping of clinical activities, especially patients' medical information. Billing, scheduling, and other practice management tasks are usually included in this term.
- Mountain Top University (MTU)- MTU is a tertiary institution whose Electronic Health Record system is being developed.
- Database- This is a repository where information is stored. It may also be described as a data warehouse.
- Electronic Record- This refers to a method of storing data online.
- API- The Application Programming Interface (API) is a piece of software that acts as a middleman between two apps, allowing them to communicate with one another.
- GraphQL- It's both an API query language and a runtime for executing those queries using your current data. It's most commonly used to send data from a server to a client.
- SQLite 3- SQLite is a C package that creates a disk-based database without requiring a separate server process, and it can be searched using a non-standard Structure Query Language.
- Vue.Js- It's a front-end development framework based on JavaScript.
- JavaScript- This is a programming language that can be used for both front-end and backend development. It provides an interactive element on a webpage.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The need for the automation of activities in various sectors of life is essential to keep up with the competitive market. Also, the need to make use of sophisticated science and technology to enhance and optimize tasks (Staff, 2020). A computerized medical information system that gathers, stores, retrieves and displays patient information is referred to as an Electronic Clinic Management System (Sanjana, 2018). It contains information on drugs, equipment, human resources, and other relevant topics. It helps to organize and develop understandable patient data, as well as retrieve clinical information about specific patients.

Electronic Clinic management systems are intended to serve as an upgrade to the existing paper-based method of medical records which are already familiar to practitioners (Adroit Info Systems, 2019). Patient records have been kept on paper for generations, and over that time, they have taken up more and more space, delaying access to timely medical care (InnoCare, 2018). The adoption of technology in hospital or clinic management has been on the rise, as it allows hospitals to optimize and digitize all hospital processes. Also, it enhances the performance of the hospital. Therefore, improving customer service, streamline the search of medical records, etc. As we all know the vitality of the health sector in a country. Hence, a secured means of keeping patients' medical records is important.

2.2 Information System

"Information is key," as they say. Coming to the world of technology, we can as well say data is essential and crucial. In the digital age, data is generated by the second; transactional data, data from social media platforms, surveillance data, etc.

An information system is a collection of interconnected components that gather, store, and analyze data as well as provide information, knowledge, and digital products (Zwass, 2020). Information systems are used by businesses and other organizations to carry out and manage operations, engage with consumers and suppliers, and compete in the marketplace. Interorganizational operations are managed via information systems. Numerous organizations such as eBay, Amazon, Google, among others across the globe are built on information systems (Zwass, 2020). Herman Hollerith's tabulator is said to be the first large-scale mechanical information system (Britannica, 2021). Which was created for the United States Census of 1890.

2.2.1 Types of Information System

Information systems are used for several purposes; hence its classification is dependent on what such information system is designed for. The information systems may be used for production, marketing, accounting, as well as management purposes.

The types of information systems include;

a. Operations Support System

An operation support system is a system that allows the end-user to input data that is processed to generate information products (Juneja, 2015). The major essence of the operation support system is to alleviate transactions, control production in the organization, also to update the database of the organization.

Also, the operation support system is broken down into three, namely; transaction processing system, processing control system, enterprise collaboration system

b. Management Information System

A management information system may be described as a system that makes decision-making easy and efficient for managers in an organization (Nitta, 2014). From time to time in an organization, there will arise a need for the manager to make certain decisions about the organization. To make such decisions appropriately, he or she would require accurate information (Juneja, 2015).

2.2.2 Components of Information System

The information system comprises of major components such as software, hardware, telecommunications, database, data warehouse, human resources, and procedures (Zwass, 2020).

a. Computer hardware

Even the smallest enterprises and families now own or lease computers all around the world. Individuals may have a large number of computers, including smartphones, tablets, and other wearable devices (Hosch, 2020). Distributed computer systems, ranging from powerful parallel-processing servers in data centers to widely spread personal computers and mobile devices, are common in large enterprises.

Hardware costs have continuously and rapidly dropped while processing speed and storage capacity have skyrocketed. Moore's law has fueled this progress: the processing power of microprocessors at the heart of computing devices has doubled every 18 to 24 months on

average (Tardi, 2021). However, designers are concerned about hardware's usage of electricity and its impact on the environment. Computer and storage services are increasingly being offered from the cloud- from shared facilities that may be accessed over telecommunications networks

b. Computer Software

Computer software is divided into two categories: system software and application software (GeeksforGeeks, 2021). The most crucial piece of system software is the operating system. It looks after the hardware, data and software files, and other system resources on the computer, as well as providing a graphical user interface via which the user can operate the machine (Levy, 2018). Application software is a type of computer program that is used to perform specific activities for users. Individuals began to use smartphone apps to access information systems.

Other examples include general-purpose application suites that include spreadsheet and word-processing tools, as well as “vertical” programs that cater to a certain industry area, such as scheduling, routing, and dispatching apps (Levy, 2018).

c. Telecommunications

Telecommunications are used to connect or network computer systems, as well as portable and wearable devices, and to send and receive data (Russell, 2018). Wired or wireless technology can be used to make connections. Coaxial cable and fiber optics are examples of wired technology. Mobile computing is enabled via wireless technologies, which are primarily based on the transmission of microwaves and radio waves. Depending on an organization's needs, various computer network designs are feasible.

Local area networks (LANs) connect computers at a single location, such as an office or a college campus. Metropolitan area networks (MANs) are the electronic backbone of "smart cities," covering a small yet highly populated area (Cloudflare, 2020).

Wide area networks (WANs) connect disparate data centers, which are usually managed by separate companies. Peer-to-peer networks allow for extensive content exchange without the need for centralized oversight (Hemmendinger, 2021). The Internet is a collection of networks that connects billions of computers around the globe. Users obtain access to information resources, such as massive databases, and other resources through networking (Hemmendinger, 2021).

d. Database and Data warehouse

Many information systems are primarily vehicles for delivering data from databases. A database is a collection of interconnected data that is organized in such a way that individual records or groups of records can be retrieved to meet certain criteria (Editors, 2021). Employee records and product catalogs are two examples of databases. Databases help an organization's operations and management functions.

Data warehouses store historical data that can be mined for information in order to develop and promote new goods, better serve existing consumers, or reach out to prospective new customers (Gregersen, 2020). Anyone who has ever made a credit card purchase, whether in person, by mail, or online, is included in such data compilations.

e. Human resources

Any information system relies heavily on qualified personnel. Development and operations managers, business analysts, systems analysts and designers, database administrators, programmers, computer security specialists, and computer operators are all examples of technical personnel (Gregersen, 2020). Furthermore, all employees in an organization must be trained to fully utilize the capabilities of information systems.

2.3 Clinic Management System

Clinical management refers to programs that use systems, science, incentives, and data to enhance medical practice and help consumers and their support systems engage in a collaborative process to better manage medical, social, and behavioral health issues (Existek, 2019).

2.3.1 The Need for A Clinic Management System

According to research published by the Belgian Federal Public Service (FPS) in 2002, high-quality data storage, data speed, data sharing, and networking for hospital information systems (HIS) is required for efficient functioning (HIS) (The Investopedia Team, 2021). The data storage requirements of departments like radiology, in particular, are quite difficult.

The adoption of a hospital management system project delivers several benefits to the institution, including increased service quality and efficiency (Existek, 2019). It is designed for three types of users, as previously stated: patients, hospital personnel and management, and third parties such as medication suppliers and insurance organizations. The way they interact reflects the overall performance. Benefits gained by one set of users have a beneficial impact on the work of others. Cooperation and communication are essential in this situation. (SoftClinic, 2021)

To make a feature list for a hospital management system, you must first determine your priorities by selecting the advantages that are most important in your situation. Below are some of the need for a Clinic Management System;

a. Automated Processes

Automated Processes are one of the key advantages here. It aids in the enhancement of the user experience (Existek, 2019). Medical professionals, patients, and hospital administrators can communicate, schedule appointments, and share information over the internet.

b. Digital Medical records

All of the required patient information is stored in the hospital database. Doctors can quickly access illness history, test findings, and prescribed medication to establish an accurate diagnosis and monitor the patient's health. It reduces the chances of making a mistake.

c. Interaction between employees

For better coordination and collaboration, every one of your staff must be involved. They do not need to make specific requests or wait an extended period for a response. Each specialist will be in charge of a certain step of the process and will be able to share the results with colleagues with a single click (Adroit Info Systems, 2019).

d. Management of the facility

Hospital administrators may better manage their resources, assess employee performance, decrease equipment downtime, and improve the supply chain, among other things (Existek, 2019). Another point worth mentioning is that instead of dealing with endless paperwork, medical workers deal with digital data.

e. Improved client service

The therapy procedure might be less stressful because the clinic management system is patient-centered (DSA, 2021). Doctors have more time for examinations and patient contact. Furthermore, all of the necessary information is available online.

2.3.2 History of Clinic Management System

Clinic administration has been practiced over the years. Gone are the days when health professionals solely served societies affluent. Now, technology has progressed to the point where software allows authorized healthcare providers working in a clinic to get patient’s medical data quickly when they are necessary. The essence of keeping a record of patients' medical data, as well as their health record, is for health personnel to be well informed of their medical history (DSA, 2021). Hence, provide adequate and better health care services. Until a few decades back,

when some countries of the world opted for an electronic clinic management system for carrying out administrative functions, as well as keeping clinical records in a clinic, the manual method has been the order of the day (InnoCare, 2018).

The electronic clinic management system would store individual patient medical information online, and enable instant availability of this information to all providers in the healthcare chain and so assist in providing coherent and consistent care (Boonstra & Broekhuis, 2010). The importance of the clinic management system cannot be over-emphasized. It has been summarized according to (Yamato, 2006) as "optimizing the documentation of patient encounters, improving the communication of information to physicians, improving access to patients' medical information, reduction of mistakes, significant reduction of bills and improving compensation for services, forming a data repository for research and quality improvement, and reduction of paper". Also, in the field of medicine, the medical record is so essential. As it is evident that the motive is to provide better and quality healthcare through careful recording of every detail that concerns whichever patient (Huffman, 2001).

According to an author, late Patrick Chukwunyere Eleoba, he stated in his book that when computers were first introduced into hospitals, their primary use was for accounting, record-keeping purposes, and administrative purposes. But in recent times, the use of computers has been fully utilized to improve health records.

2.4 Evaluation of Health Care

Van der Loo conducted a literature review in 1995 to categorize evaluation studies of information systems in health care (van der Loo et al 1995). The goal was to have a better understanding of the various evaluation methodologies used. The evaluation comprised 76 papers that were published between 1974 and 1995. The studies used a variety of performance measurements and success variables. For every type of system, however, the variety of identified evaluation methods and effect factors was vast. Costs, changes in time spent by patients and healthcare professionals, changes in the care process, database utilization, user performance, patient outcomes, job satisfaction, and the number of medical tests conducted were all influence variables.

Several authors have proposed methods for evaluating healthcare information technology. These methods concerned the evaluation of technological, sociological, and organizational consequences. Delone and McLean (1992) conducted a literature assessment in

the field of management information systems intending to find drivers of system success (Roky & Meriouh, 2015).

They presented a framework with six dimensions of success -:

a. system quality,
b. information quality,
c. usage,
d. user satisfaction,
e. individual impact, and
f. organizational impact.

The goal of their study was to look at evaluation studies of inpatient patient care information systems that required data entry and retrieval by health care professionals that were published between 1991 and May 2001 to see what attributes were used to assess the success of these systems and how they were classified using the Delone and McLean framework. They also looked into how the qualities were measured and how the evaluation studies were conducted. Outpatient care was not included in their review.

2.5 System Development Life Cycle

The System Development Life Cycle (SDLC) marks the phases of development involved for an information system (Sommerville, Software Processes, 2011). SDLC is commonly used in various organizations. The SDLC begins with a planning phase, which is very essential. It's the phase where the project team identifies the problem, the business value of the system conducts a feasibility analysis, and plans the execution of the project. The second phase is referred to as the analysis phase. The team develops an analysis strategy, gathers information, and builds a set of analysis models. The team produces the design strategy, physical design, architecture design, interface design, database and file specifications, and program design in the third phase, which is the design phase (Sommerville, Software Processes, 2011). The system is constructed, installed, and maintained in the final phase, implementation.

2.5.1 System Development Models

SDLC models, which stands for Software Development Life Cycle models, are one of the most fundamental concepts in the software development process. SDLC – Software Development Life Cycle – is a continuous process that begins with the decision to initiate a project and concludes with its complete removal from use (Hoffer, 2011). There is no such thing as a single SDLC

model. They are classified into broad groupings, each with its own set of characteristics and flaws.

Their variety has grown greatly since they evolved from the earliest and oldest "waterfall" SDLC model. The large range of product kinds – from web application development to complicated medical software – determines the SDLC models' variability (Existek, 2019). And, if you use one of the SDLC models listed below as a starting point, it should be tailored to the specifics of the product, project, or assignment.

Some of the development models include:

a. Waterfall Model

   Waterfall is a cascading SDLC paradigm in which the development process resembles a flow, progressing through the phases of analysis, projecting, realization, testing, implementation, and support one step at a time (Rungta, 2021). This SDLC model contains the whole execution of each stage. Every aspect of the software development life cycle is meticulously documented and established, with features required at each stage.

b. Iterative Model

   The Iterative model embodies repetition. You implement a set of software needs, then test, assess, and identify more requirements, rather than starting with fully understood requirements. With each phase, or iteration, a new version of the software is created until the entire system is up and running (Half, 2021).

   This model has a benefit over other SDLC methodologies in that it produces a functional version early in the process, reducing the cost of changes. One problem is that resources might quickly exhaust if the technique is repeated repeatedly (Half, 2021).

c. Spiral Model

   The spiral model combines architecture and prototyping in a stage-based SDLC approach. It's a cross between the Iterative and Waterfall SDLC models, with a focus on risk analysis (Sommerville, Software Processes, 2011). The biggest issue with the spiral model is figuring out when it's time to move on to the next level. As a remedy to this problem, the usage of specified time frames is suggested.

   Even if the preceding stage's work isn't finished yet, the transition to the next stage is carried out according to plan (Half, 2021). The plan is based on statistical data gathered from prior projects, as well as the personal developer's experience.

Amongst Others.

2.5.2 Agile Development

The term "agile methodology" refers to a practice that encourages continuous development and testing throughout the project's software development lifecycle (Rungta, 2021). In the Agile paradigm in software testing, both development and testing operations are concurrent, unlike the Waterfall methodology.

One of the simplest and most successful ways to turn a vision for a company's needs into software solutions is to use the Agile software development methodology (Sommerville, Agile Development, 2011). Continuous planning, learning, improvement, team collaboration, evolutionary development, and early delivery are all terms used to describe agile software development methodologies. It increases adaptability in the face of change (Rungta, 2021).

The four fundamental values of agile software development are highlighted below;

a. Interactions between individuals and groups about processes and tools.
b. Working software trumps thorough documentation.
c. Collaboration with customers is preferred over contract negotiations.
d. Adapting to change following a strategy.

Advantages of the Agile Model includes the following (Rungta, 2021);

a. Functional requirement corrections are incorporated into the development process to ensure competitiveness.
b. Because of the flexible transition procedure, risks are minimized.
c. The initial production version was released quickly.

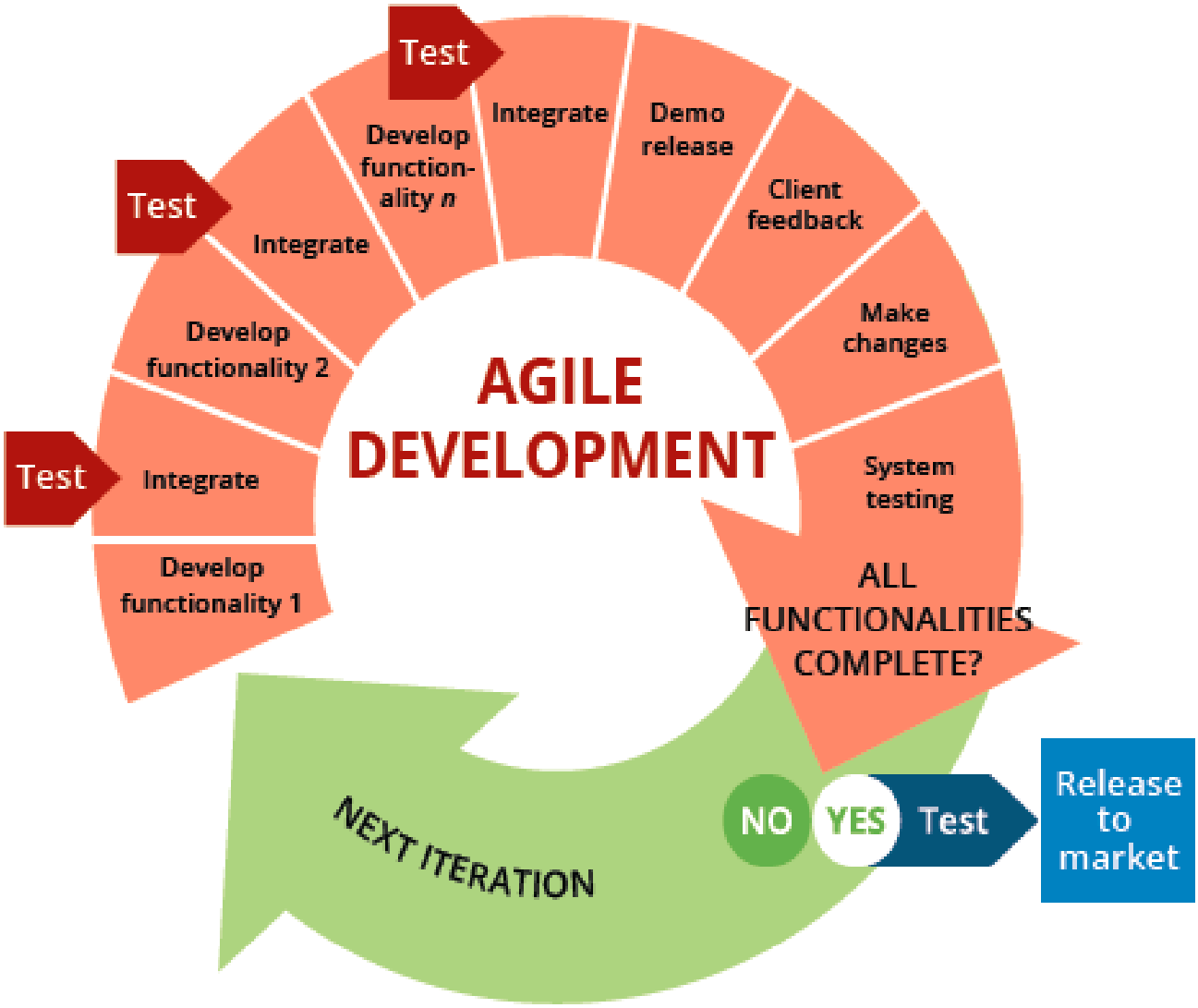

Figure 2.1: Agile development model.

2.6 Software Development

This project entails the development of an electronic clinic management system, aimed at eradicating the manual method (paper-based) of keeping records in the clinic. Software development is one of the software process activities in which the software is designed and programmed. In software engineering, there is a concept known as software process, which involves certain activities to be carried out in designing and implementing software. Software process may be described as interleaved sequences of technical, collaborative, and managerial activities with the overall goal of specifying, designing, implementing, and testing a software (Sommerville, 2011).

Software process activities include the below;

1. Software Specification

   This is the process of determining and specifying what services the system is required to provide, as well as establishing the system's operational and development restrictions (Editors, 2021). Requirement engineering is another name for this activity. The fact that errors made at this stage can cause problems in system design and development, makes this stage a critical one.

   Activities in software specification or requirement engineering process include the following;

a. Feasibility Study- This determines whether the proposed system can be developed within the budgetary constraints. Also, it makes sure whether the potential user of the system is satisfied using current software and hardware technologies (Elgabry, 2017).
b. Requirement elicitation and analysis- This involves getting to know the user requirements through thorough observation of existing systems and discussions with potential users.
c. Requirement Specification- Information gathered during analysis is converted to a document.
d. Requirement Validation- The information is checked if it meets the required standard.

2. Software Design and Implementation

   The previous stage, which is the software specification is converted to an executable system in this stage. It involves processes of design and programming (Elgabry, 2017).

3. Software Validation

   Validation involves checking processes, such as inspections and reviews, at each stage of the software process from user requirements definition to program development (Elgabry, 2017). The essence of software validation is to show that a system both conforms to its specification and that it also meets the expectations of the customer.

4. Software Evolution

   After the software has been launched for use to the general public, it should be flexible enough to change with the changing technology and user requirements and needs.

2.6.1 Front-End Development

This project, being a management system, hence the need for storage, retrieval, among others. Therefore, the most suitable form it could be is a web application. Concerning that, the front-end technologies to be used include HTML, CSS, JavaScript, alongside Vue.Js.

Many decisions must be made during the front-end phase. On the other hand, these decisions have a big impact on the project's strategic success. The front-end is more vulnerable than any other phase to the decisions made here, as well as to so-called "problematic behavior," which can lead to a failed project if not addressed (Flyvbjerg et al., 2009; Flyvbjerg, 2013; Eizakshiri et al., 2011). However, finding the appropriate concept, the proper answer to the stated need is critical to project success (Williams and Samset, 2010).

Vue.Js is a free and open-source JavaScript front-end toolkit for developing user interfaces and UI components. It has the best documentation in the industry, and it performs even better than React. With help from the core team, Vue provides more tools out of the box. You can easily set up a project with Vue CLI 4 and provide a market-ready solution in a matter of weeks. In this project, Vue.Js was used for the development of the Electronic Clinic Management System.

2.7 Related Works

In a research work carried out by Ogbobe Nkechi (2011), on the design and implementation of an automated hospital management system; to solve problems encountered with the manual system of hospital administration. She was concerned with the integrity and security of patient's data in the database. SQL was used for the database, which is the server-side of the website.

Okwor Emeka Daniel (2012) worked on the design and implementation of an Electronic Patient Management System. His main objective and goal were to abolish the poor documentation of payment records and the difficulty in getting patient payment data. Using the Rapid Application Development paradigm, he was able to create a reliable storage system for payment data while also reducing the amount of time spent during payment for services.

Ahmed and Usman created an Outpatient Management System (2017). They used the waterfall model to ensure that the quality of service provided by hospitals was improved through outpatient scheduling. Patients could easily schedule and manage their appointments. They could also receive SMS/e-mail reminders of their appointment times.

During the deployment of an online hospital administration system, Kapoor and Singh (2014) described the many challenges that were encountered. The study found that these challenges are not caused by technical concerns, but rather by a lack of funding, doctor behavior and attitude, and a lack of awareness, as well as a variety of other things.

In a university project carried out by Lajide Oluwagbotemi (2019), where he developed an Electronic Health Record System intending to design a health record database. The scope of his study was mainly on the patient's record, the drug prescription, available drugs, and the drug dispensed. For the implementation of the system, he used the Symfony MVC framework. The front-end was built using HTML, CSS, JavaScript, and jQuery. Then MySQL for the database. He recommended that clinics who were still using the manual method of record- keeping should opt for the automated method; as it is more efficient and reliable.

Suleiman A. Yahaya, Lydia J. Jilantikiri, Kehinde A. Hassan, Kareem A. Akande, Abdullahi Yahaya (2019) from the University of Ilorin were involved in the development of an Automated Healthcare Record Management System. Their project aimed to improve the University of Ilorin's health record management service by developing an electronic health record management system using a smartcard. The software was built using the XAMPP platform, and the smart card was made using a QR code generator. MySQL was utilized to create the database, and HTML, PHP, CSS, and Javascript were used to design the user interface, style it, and send queries.

In a research work carried out by Premkumar Balaraman and Kalpana Kosalra (2013), to identify the key performance indicators and standards of E - Hospital Management (E – HMS) & Hospital Information Systems (HIS) and to identify the key components of E - Hospital Management solutions. The research was qualitative and descriptive, with the majority of the

data coming from secondary survey sources. The study takes this technique because the research topic is wide and the data sources are dispersed across various sites.

Majed Hossam Oqaylan, a Majmaah University student, did the research. “The Hospital Management System is designed to replace any hospital's existing manual paper-based system,” he said. He created a new system to manage patient information, room availability, staff and operating room scheduling, and patient bills. These services will be delivered in a timely and cost-effective manner, with the goal of reducing the time and resources currently necessary for such tasks.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter presents a collection of methods and procedures used in this project. It contains the method of identification of user and system requirements, system design methods, system implementation, and approach used in testing the system.

The concept of research technique refers to how a study is planned (Okwor, 2012). With the constant and quick changes in technology, the strategy to building an automated management system is also subject to many modifications. The majority of the data in this study is based on secondary sources of survey data, and it is qualitative and descriptive. The study takes this technique because the research topic is wide and the data sources are dispersed across various sites. Analysis of existing survey data and specific successful case studies of HIS would yield a better result in finding answers to the research question asked to arrive at a definitive understanding of the wider picture on the project, Electronic Clinic Management, and Hospital Information Systems.

3.1 Identification of User and System Requirement

In requirement engineering, one of the activities known as Requirement elicitation and analysis is used here. The process of extracting system requirements through observation of current systems, interactions with future users and procurers, task analysis, and so on is known as requirement elicitation and analysis (Sommerville, 2011). This could entail creating one or more system models and prototypes. These aid in the detailed understanding of the system.

There are several ways of data collection; some of which are:

i. Interview
ii. Observation
iii. Literature
iv. Survey
v. Questionnaire.

3.1.1 Identification of System Requirement

A more extensive description of the functionality to be delivered is referred to as system requirements (Sommerville, 2011). During this project, the system requirements were identified

by observation and thorough study of existing systems, informal interviews with doctors and other medical personnel of the MTU clinic. Also, several books and journals were consulted to get and understand the need and significance of building an automated clinic management system.

Below is the requirement gathered;

a. Functional Requirements

The underlisted, are the functional requirement of the developed Electronic Clinic Management System:

1. The admin shall be able to retrieve, edit, and update patients' medical data.
2. The admin shall be able to access patients' folders digitally.
3. Each basic user (patient) registered on the system is eligible to book an appointment with the doctor.
4. Each patient shall be able to view and edit his/her bio-data and specific medical data.
5. The admin shall get notified of all appointments scheduled.

b. Non-functional Requirements

Non-functional requirements are security, performance, user limit, storage size constraints that the system should observe. They are usually not directly concerned with the specific services the system offers to its users.

For this project, the non-functional requirements are:

1. Patients' should be authorized before registration
2. Access to the system shall be managed by a unique username and password.
3. The system shall provide reliable service to its users.

c. Hardware Requirements

The hardware configuration is an essential factor to be considered when developing a system. Limited Random-Access Memory (RAM) size may affect the efficiency of the performance of the system for a user. When the RAM is faulty or is insufficient in size, it will affect the speed and reliability of the system. Aside from the RAM, the processor speed should be decent enough to handle the allocation of memory locations to processes.

Processor:	Core i3 (minimum requirement)
RAM:	2GB (minimum requirement)
Hard disk:	256GB

Monitor Display: LED

Processor speed: 1.8GHz

d. Software Requirements

The software requirements for the electronic clinic management system.

System operating system:	Windows 10, Linux distros, Mac OS
Web browser:	Mozilla Firefox(recommended), Google chrome

3.2 System Design Methods: UML Design

The Unified Modelling Language (UML) is a standard for describing, visualizing, creating, and documenting software systems and their components. It's a graphical language with a set of semantics and rules. The UML is concerned with the depiction of the system's conceptual and physical aspects. It captures the decisions and understandings that must be made regarding the systems that must be built. It is used to comprehend, develop, configure, maintain, and regulate system information.

The UML is a language for:

a. Visualizing
b. Specifying
c. Constructing
d. Documenting

3.2.1 Use Case Diagrams

In the Unified Modeling Language, a use case diagram can describe the details of your system's users (also known as actors) and their interactions with the system (UML). To make one, you'll need a set of specialized symbols and connectors.

a. Student Use case

The use case diagram below shows features of the system available to basic users. The basic users are the potential patients (staff and students). Every registered basic user is eligible to do the following on the system.

a. View Medical data- Not all medical data are usually made available to patients. This is due to medical ethics. Basic medical information like blood group, genotype, weight, and so on would be made available to users.

b. Edit Bio-data- Each user can alter his/her name, department, matric number with proper authorization.
c. Book Appointment- Staff and Student can book an appointment to see whichever doctor is on duty.

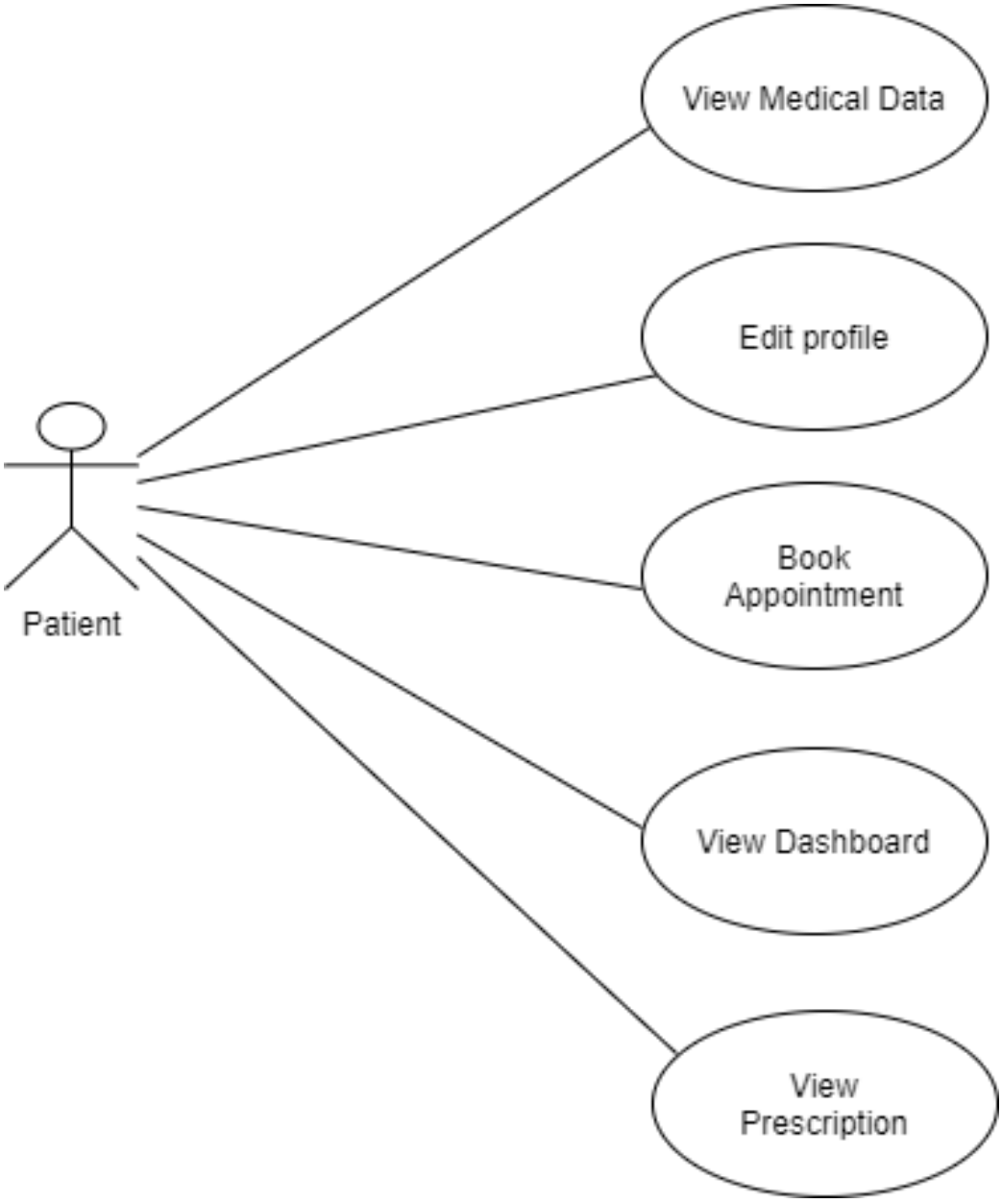

Figure 3.1: Use case diagram for a patient

b. Doctor Use case

The Admin user is the medical staff present at the clinic. They include the doctors, nurses, and other authorized medical personnel. The Admin user is eligible to do the following with the system.

a. View Patients' Medical data- The doctor can view the data and record of patients at his/her will. Just as the clinic doctor can decide to access the folders of any students while using the manual method. Aside from the doctors, the nurses can also view the folders of the patients.
b. Update Patients' File- From time to time, patients would visit the clinic in need of medical attention. On arrival at the clinic, the nurses would search for the patient's file using a unique identification number, then take records of the patient's temperature, blood pressure, and other data that change with time.
c. Record Patient's Diagnosis- Unlike the manual method, whereby the doctor has to write diagnostics down on paper, this system provides the doctor with suggestions of the likely ailment of the patient.
d. View Appointment Schedule- As basic users are eligible to book an appointment, on the doctor's end, he/she can view the appointment schedule for each day. Also, the doctor may decide to cancel the appointment.

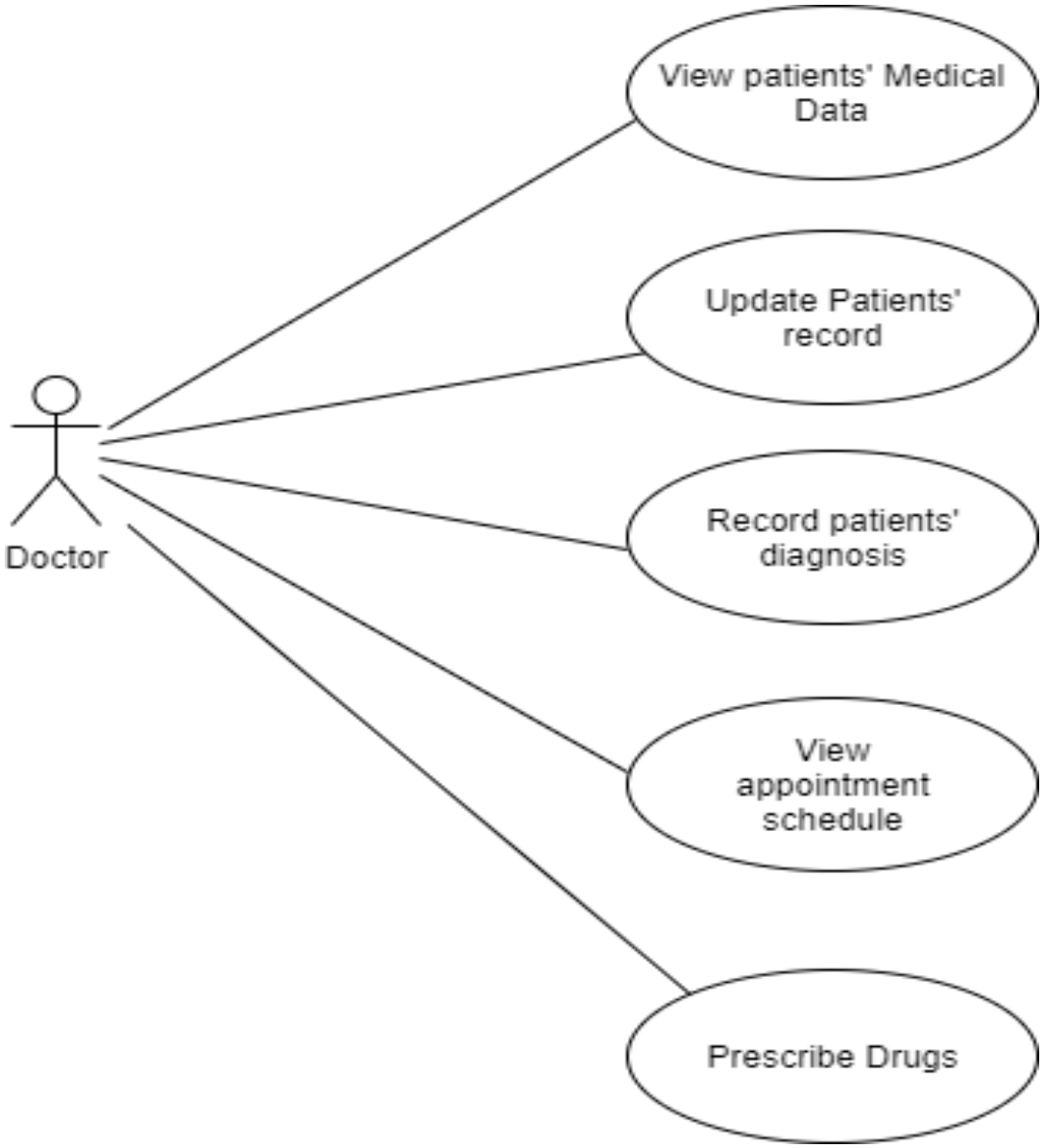

Figure 3.2: Use case diagram for the doctor

3.2.2 Flow Chart

The flow chart shows the transition and flow of operation on the system. The diagram in (Figure 3.3) carefully explains the transition of each phase of operation.

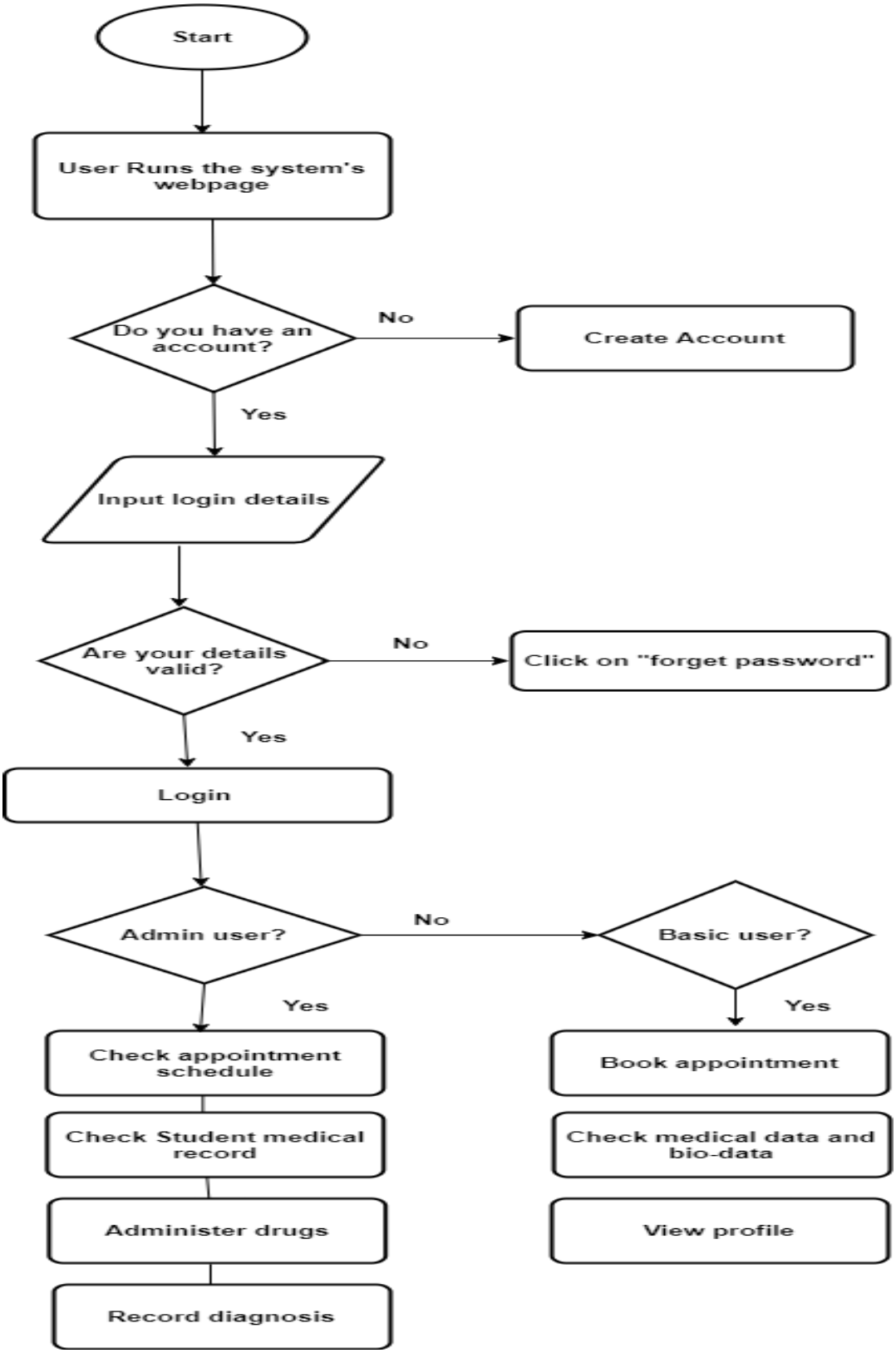

Figure 3.3: System flowchart

3.3 System Implementation

This part of the chapter contains details on how the development of the system was executed. The process of specifying how an information system should be built (physical system design), ensuring that the information system is operational and used, and ensuring that the information system fulfills quality standards is referred to as systems implementation (i.e., quality assurance).

To achieve the implementation goal of designing a system element that complies with the system's design features and requirements, the front-end implementation and the back-end implementation are put into consideration. The front-end may be referred to as the user interface with which potential users of a system have direct interaction. Front-end development can also be called client-side development.

The server-side of development, which is concerned with how the site functions, is known as back-end implementation. It is a component of system development that responds to any action taken by the user on the system's interface. A server, an application, and a database are commonly included in this form of web development. Back-end developers write the code that conveys database information to the browser.

3.3.1 Front-End Implementation

For the development of the Electronic Clinic Management system, a web application, front-end languages such as JavaScript (Vue.js), HTML, and CSS were used. Among other front-end frameworks, Vue.js was chosen for the reasons below;

- Testing and Debugging

  Vue.js makes testing easy, as it has already prepared documentation for component testing. It has a testing library tool, like Mocha, etc (E Spark Biz, 2021).
- Highly Flexible

  Vue is known for its adaptability, allowing you to quickly write and run it from within the software. ES6, JSX, components, direction, packaging, and other technologies can be used to create a wide range of applications, even complicated ones.
- Simple to Operate and Follow

  The simplicity of this structure is one of the reasons for its widespread use. Because of its fundamental structure, the client can easily include Vue.js into his web project.

3.3.2 Back-End Implementation

JavaScript was used for the back-end programming language, for its efficiency and versatility. Also, it is the only programming language that is native to the web browser, the most widely used programming language (Reactor, 2018). And most importantly, it's a pleasurable language to learn (Reactor, 2018). GraphQL was utilized for the back-end Application Program Interface (API). Send a GraphQL query to your API, and you'll get exactly what you need, no more, no less. The results of GraphQL queries are always predictable. GraphQL apps are fast and stable because they control the data, they receive rather than the server (GraphQL, 2021). Hence, GraphQL seems suitable.

The database for the system was populated using SQLite 3. A database is a structured collection of data stored on a computer system that can be accessed electronically. Version control systems, financial analysis tools, media cataloging, and editing suites, CAD packages, record keeping programs, and other desktop applications frequently employ SQLite as the on-disk file format. A few of the advantages of SQLite 3 are improved performance- reading and writing individual files from a disk is often faster than reading and writing from an SQLite database (Java T Point, 2021). Also, the cost and complexity of the application are reduced.

3.4 System Testing Approach

Beta testing was used to test the system. About fifteen students ranging from 100 level to 400 level were asked to test the functionality of the system. To ensure that the system is easy to use and the features of the system meet the requirements and objectives of the development of the system.

Jest, a JavaScript testing library was employed to test the codes of the system. Code that runs asynchronously is common in JavaScript. When testing asynchronous code, Jest needs to know when the code it is testing is finished before it can move on to the next test. Jest has a few options for dealing with this.

CHAPTER FOUR

IMPLEMENTATION AND TESTING

4.1 Implementation and Testing

The system implementation and testing were carried out in this chapter of the project employing the designs and defined requirements**.**

JavaScript (Vue.js) programming language was used for the front-end, Html for scripting, and CSS for styling were used to create the system. Additionally, the backend API uses GraphQL as the query language, SQLite3 as the database, and sequelize as the ORM.

4.2 System Interface

The images below are screenshots of the system interface.

4.2.1 Login Page

On this page, (Figure 4.1) both users would be prompted to login to the system; provided that they have an existing account on the system. Else, the user should register. To login, each user is required to input their e-mail and password.

4.2.2 Registration Page

Users with no registered account would be directed to register. On loading the system on a browser, information about registration for new users would be available. For registration, each user is required to provide a valid e-mail address, first name, last name and password. (Figure 4.2) shows the registration page.

4.2.3 System Dashboard

The feature available on the system dashboard is dependent on the user. As mentioned in this project, the users are doctors and the students. Hence, the dashboard may be classified into two.

a. Nurse Dashboard

   The nurse gets to search for the student's file using his/her unique clinic ID. Aside from searching for student's file, the nurse can also view the patients' record. The nurse can see appointment schedule. As shown in Figure 4.3 and Figure 4.4

b. Student dashboard (Figure 4.5)

   Registered students are eligible to book appointment with the doctor, view their profile, and a part of their medical data as approved by the doctor.

c. Doctor dashboard

The doctor can also administer drugs to students. Records of all drugs administered are recorded in the database of the system. The doctor can also see his appointment schedule or choose to cancel the appointment booked by whichever student.

Figure 4.1: Login Screen

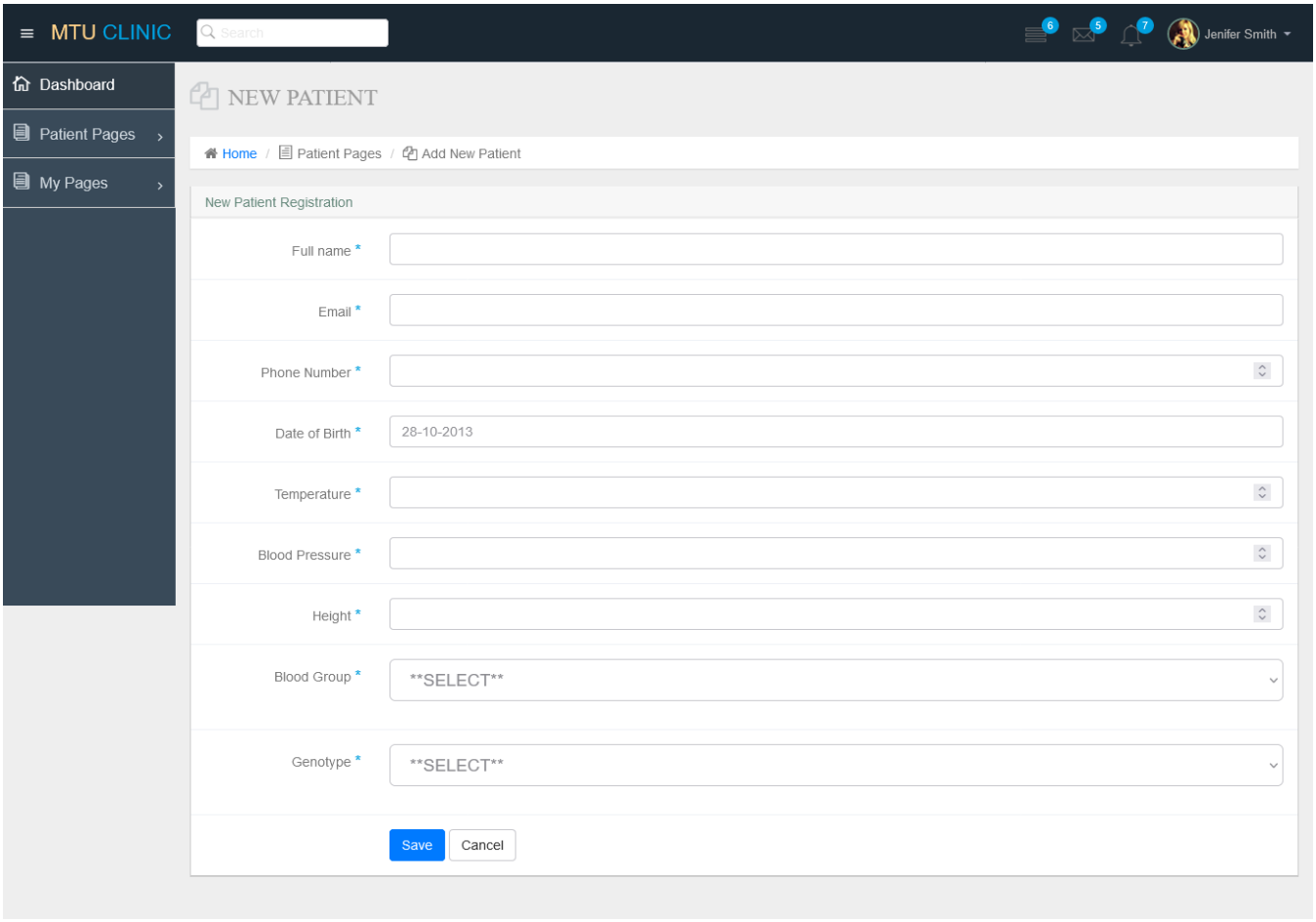

Figure 4.2: Registration page

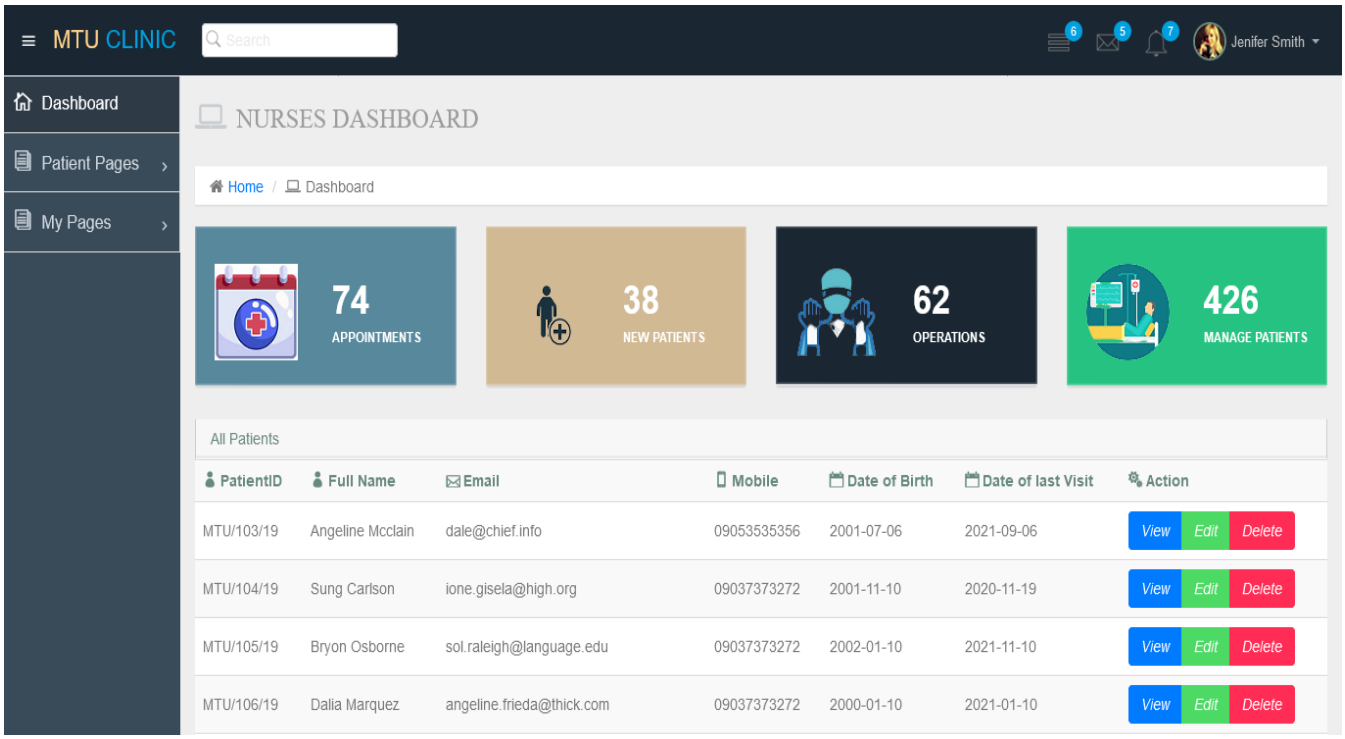

Figure 4.3: Nurse dashboard showing patients' record

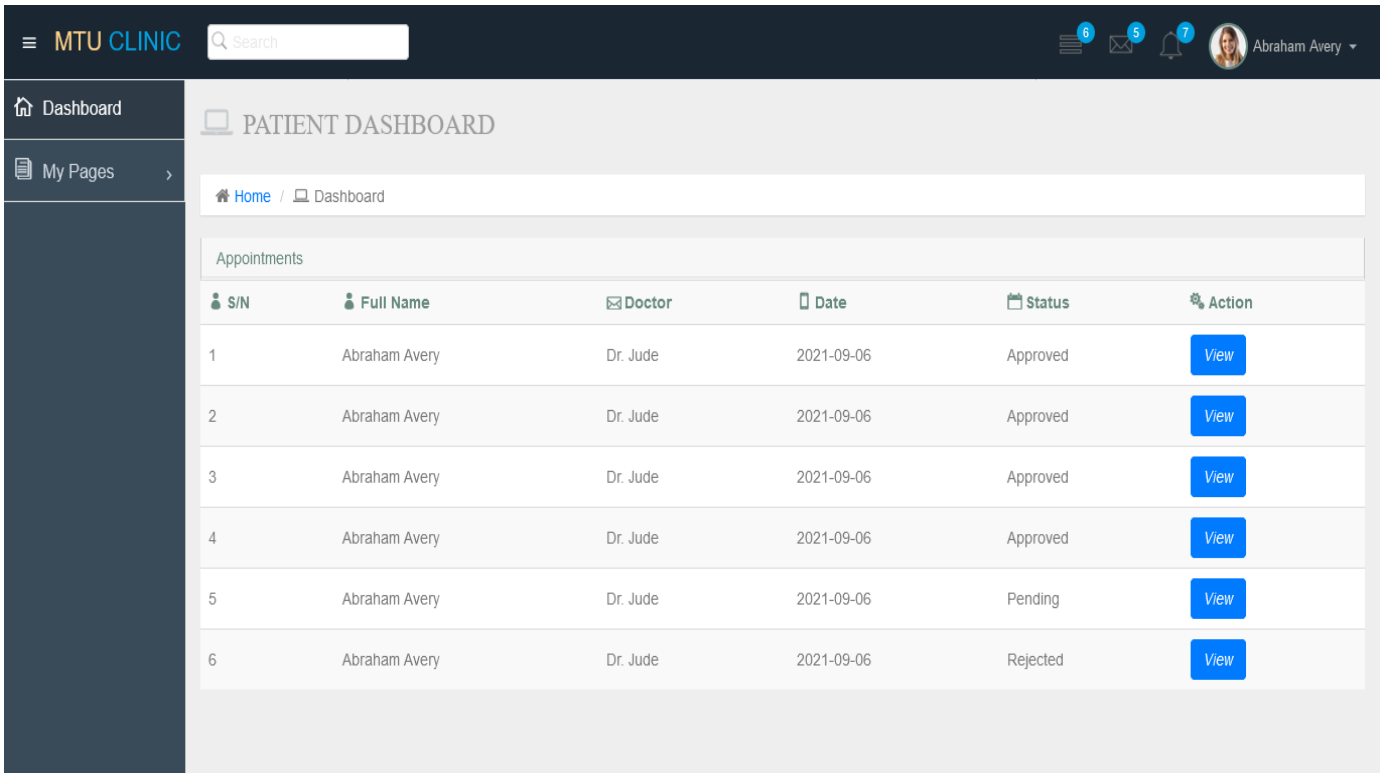

Figure 4.4: Nurse dashboard showing appointment schedule and status

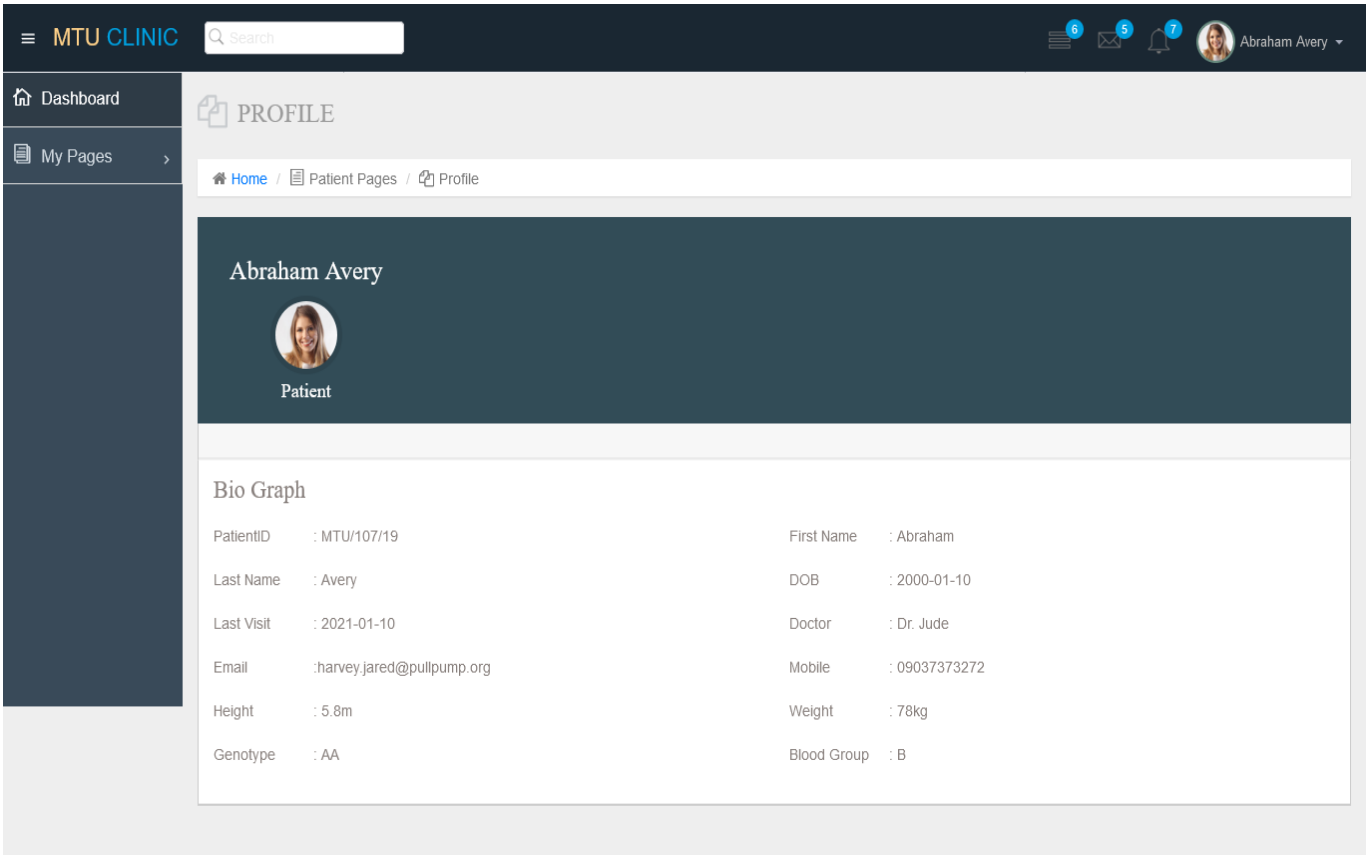

Figure 4.5: Student profile

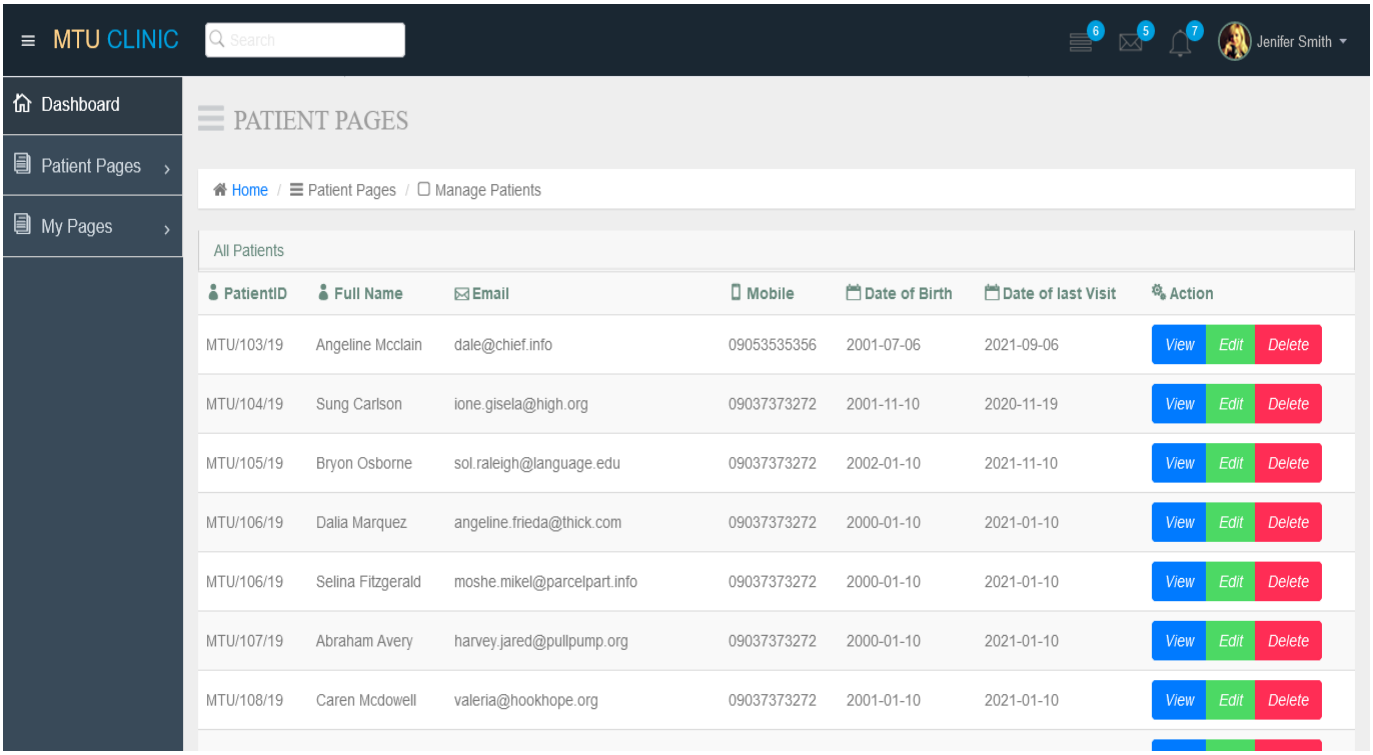

Figure 4.6: Doctor's interface showing patients' record

CHAPTER FIVE

SUMMARY AND CONCLUSION

5.1 Summary

After reviewing the shortcomings of the use of manual method of record-keeping and clinic management, this system would eradicate the problems associated with the manual method. With the design of this system, clinic management would be much more efficient, data loss would be non-existent, and there would be enhanced patient service. The clinic management system adds value to both the lives of staff and students, as well as the university community.

5.2 Recommendations

It is recommended that hospitals who are still using the manual system should opt for the electronic system, to fit into the global trend of evolution of technology. The following are also recommended.

i. Other types of frameworks such as AngularJS, React, Laravel, ASP.NET, Symfony can also be used for developing the system.
ii. Authentication methods such as single-factor, two-factor, can also be used to ensure a secured clinic management system

5.3 Conclusion

In designing the computerized system, a survey of the existing system was made. A complete design of a database application for searching and locating patient folders has been carried out. The electronic clinic management system will provide better services for the nurses and doctors such as reduction in time taken to find a folder, accuracy and timeliness of record preparation etc. In the implementation of this project much has been done to eliminate data redundancy, inconsistency and improve on the integrity of the data stored in the system. The software model used is the agile model. Structured design was also employed in the design stage. The security of the computerized system was also employed to avoid unauthorized person or persons having access to data.

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