CLOUD-BASED HEALTH ACCESS INFORMATION SYSTEM (CBHAIS)

Case Study: NABILATUK HEALTH CENTRE IV (NHC)

BY

LOKEE MICHAEL

BU/UP/2020/0631

Faculty of Science and Education

Department of Computer Studies

A project Report submitted to the Faculty of Science and Education

For the study Leading to a project in partial fulfillment of the

Requirement for the award of the degree of Bachelor of

Science and Education of

Busitema University

Supervisor

Mr. Oboth Andrew Okoth

Department of Computer studies

November, 2023

DECLARATION.

I, **LOKEE MICHAEL** do hereby declare that this dissertation titled "**Cloud-based Health Access Information System**" a case Study of **Nabilatuk Health Centre IV** is a result of my own effort and has not been submitted to any institution of higher learning before for academic award and should not be reproduced without my consent.

Sign: .....

Date:.....8/02/2024.....

LOKEE MICHAEL

SUPERVISOR'S APPROVAL

This study project has been done under my supervision as his university supervisor and submitted with my approval.

Sign:.....Date: 8th Feb/24

MR.OBOTH ANDREW OKOTH

Supervisor

DEDICATION

First and foremost, I thank the Almighty God who has successfully enabled me to complete with a sound mind and good health. I then dedicate this report to my inspiration of all times my mother Lobunei Gloria. Sincerest appreciation to my sponsor straight talk foundation the implementing partner and Irish Aid Embassy. Thank you so much for the support and may the Almighty reward you abundantly. I also dedicate this report to my dear supervisor **MR. OBOTH ANDREW OKOTH** who guided me on the dos and don'ts of making this report a success. For if it was not him, maybe I would not shoot the tip of this mountain. Lastly, I would like to express my sincere gratitude to my course mates **Etoju Francis, Wangusi Emmanuel, Akor James, Baisuku Billy Nicholas, Bwire Dally, and Wakwale Daniel, Kipyeko Johnson**. I dedicate this report to them too, since I wouldn't have completed this research without their help. Thank you, my dear friends.

ACKNOWLEDGEMENT

I would like to thank the Almighty God for enabling me pass through the entire period of my research and doing of my project. This attachment was successful due to the cooperation, guidance and support of a number of people who have enabled me gain much more than the scholastic aspects the program could have given. A special feeling of gratitude goes to my lovely mother, **Lobunei Gloria** for continuously extending her strong words of encouragement as well as financial support throughout the research period. I also acknowledge my guardian, Mr. Lomokol Celestine Amogos for always being there for me as well. Furthermore, I would like to also appreciate the guidance and support of my fellow course mates especially **Etoju Francis, Wangusi Emmanuel, Akor James, Baisuku Billy Nicholas, Bwire Dally, and Wakwale Daniel, Kipyeko Johnson** throughout the entire research period. May the good Lord bless you all. Lastly, I would like to thank my Supervisor, **MR. OBOTH ANDREW OKOTH** for his un-ending encouragement, guidance and support during my entire research. I will forever be grateful.

LIST OF ABBREVIATIONS AND ACRONYMS

CBHAIS	Cloud-Based Health Access Information System
EHRs	Electronic Health Records
HIS	Health Information System
NHC	Nabilatuk Health Centre
IS	Information System
ICT	Information Communication Technology
IoT	Internet of Things

DEFINITION OF TERMS

cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and intelligence—over the Internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale.

A **cloud** is a place where you can securely store your data and access from anywhere.

A health system is a complex network of organizations, people, and resources that deliver health care services to meet the health needs of a population.

Electronic Health Records (EHRs) are digital versions of patients' medical records that contain comprehensive information about their health history, diagnoses, treatments, medications, and more**.**

A health Access Information System (HAIS) is a software system that manages patient health information and enables healthcare providers to access and share patient data securely.

A health information system (HIS) refers to a system designed to manage healthcare data. This includes systems that collect, store, manage and transmit a patient's electronic medical record, a hospital's operational management or a system supporting healthcare policy decisions.

A system is a regularly interacting or interdependent group of items forming a unified whole.

Table of Contents

ABSTRACT

This is a computerized CBHAIS study that was conducted at Nabilatuk Health Center IV in Nabilatuk Town council, Nabilatuk district- karamoja (Uganda). Its main objective is to develop a health access information system that enables healthcare providers and patients to access and share patient data securely. It also reduces data silos in the health centres in Nabilatuk District as health centres will have a centralized database for access, storage and sharing of patients' records.

To come up with the system, data was collected through interviewing the doctors of NHC IV, health workers and patients as well as observation and focus group discussion. The data collected was analyzed and then used to design and implement the system using RAD model approach. The system was developed using the Unifying Modeling Languages with frontend and back-end interfaces with a database system. The developing software tools included PHP, HTML, JavaScript, Visual Studio, and Xampp together with MYSQL. The database stores records of patients and other health related information. The system also enables doctor and other system users to update, edit, delete, view, share prescriptions to patients' inquiries at any time.

CHAPTER ONE

1.0 Introduction

Information and communication Technology (ICT) has considerable potential to improve healthcare communication and to respond to the growing demand for better and more efficient communication. It can resolve many problems and improve patient safety accordingly.

One of the primary ways ICT facilitates health record management is through Electronic Health Records (EHRs). Electronic Health Records (EHRs) are digital versions of patients' medical records that contain comprehensive information about their health history, diagnoses, treatments, medications, and more (Kavitha, 2016). ICT enables the creation and maintenance of EHRs by providing the necessary infrastructure and software applications. EHRs offer numerous benefits over traditional paper-based records, including:

According to (Bhuiyan, 2018, May), with EHRs, healthcare providers can access patient information instantly from any authorized location. This eliminates the need for physical record retrieval and allows for quick decision-making based on up-to-date information.

According to (Rothman, 2012), ICT tools provide features like data validation checks and automated alerts that help reduce errors in health records. Additionally, electronic data entry minimizes the risk of illegible handwriting or missing information commonly found in paper records.

According to (Zhang, 2018), ICT enables seamless sharing of health records among different healthcare providers and institutions. This promotes better coordination of care, reduces duplication of tests or procedures, and improves overall healthcare outcomes.

According to (Hyppönen, 2014), Health Information Exchange (HIE): HIE systems allow for secure sharing of patient information across different healthcare organizations or regions. This enables healthcare providers to access relevant data from external sources, such as laboratories or pharmacies, ensuring comprehensive and integrated care. Through the use of ICT, cloud computing services in the health facilities have been delivered.

Therefore, cloud computing is the delivery of computing services including servers, storage, databases, networking, software, analytics, and intelligence over the Internet "the cloud" to offer faster innovation, flexible resources, and economies of scale (Mishra, Das, Dehuri, & Jagadev, 2018).

A cloud solution for healthcare solves many common challenges and helps providers focus on what matters most: patient. The cloud acts as a place where you can securely store your data and access from anywhere. The cloud can be public or private, users can have any services if the cloud is public otherwise service allow limiting of users to access on that service when it is private. Non-cloud storage solutions keep information on a physical hard drive or internal server. The cloud however, allows data to live on a global network of secure data centers.

When using cloud computing for e-health then there is opportunity to access for patient data quickly or find some information about patient like medical history, allergy, medicine, and diseases to allow doctor treat patient quickly. On the other hand patients need privacy for their medical information which is available on cloud computing. Healthcare organizations use the cloud for connecting, storing, and maintaining traditional personal health information such as blood test results, as well as other consumer data like contact preferences. All information is accessed securely from a single console across the organization. Providers have many sources of information that can create data silos.

A cloud solution improved the work of healthcare organizations through the following: streamlined operations- Teams can access all the data they need from a single program or app, instead of switching between systems, and they can see everything at an aggregate level (Wang, Ranjan, Chen, & Benatallah, 2017). This makes it easier to quickly answer patient questions, manage preferences, and turn insights into actions.

Personalize patient care. With a single source of truth for data, care coordinators can access a complete view of a patient's health (Dalal et al., 2016). The coordinator can easily view the treatment history, social determinants of health, recent tests and procedures, and the extended care team.

Engage anywhere. The cloud enables doctors and other care providers to access patient information even outside the office (Sultan, 2014). For example, a physician who is at home,

at another facility, or away at a conference can still access patient information from a single dashboard. Or, when patients need to see a provider but time constraints, weather conditions, or lack of transportation make it challenging, they can opt for a virtual appointment instead. Ultimately, patients have more options to engage with their providers, and providers have more access to their patients. This connectivity helps reduce time to care and improve patient outcomes.

According to (Nutley, 2013), a health information system (HIS) refers to a system designed to manage healthcare data. This includes systems that collect, store, manage and transmit a patient's electronic medical record, a hospital's operational management or a system supporting healthcare policy decisions. Health information systems also include those systems that handle data related to the activities of providers and health organizations. As an integrated effort, these may be leveraged to improve patient outcomes, inform research, and influence policy-making and decision-making because health information systems commonly access, process, or maintain large volumes of sensitive data, security is a primary concern.

According to (Allin & Rudoler, 2019), Canada has a publicly funded, universal health care system known as Medicare which is funded by taxes and covers medically necessary services such as hospital care, physician services, and prescription drugs.

According to (Thorlby & Arora, 2020), The United Kingdom has a National Health Service (NHS) which provides free health care to all residents and is funded by taxes and covers medically necessary services such as hospital care, physician services, and prescription drugs

According to (Matsuda, 2020), Japan has a universal health care system which is funded by a combination of taxes and premiums paid by citizens and covers medically necessary services such as hospital care, physician services, and prescription drugs.

Healthcare systems are now increasingly challenged with regard to managing chronically ill patients and those with multiple morbidity who need the collaborative care of different healthcare professionals. Therefore, the current healthcare systems are making an inevitable migration from an acute to chronic-oriented and from centralized to decentralized care practices. Furthermore, healthcare professionals become progressively focused on their specialty domain, and speak to each other using domain-specific terms and jargons. Hence, it

is difficult for professionals from different domains to understand each other. These factors contribute to the fragmentation challenge in healthcare, thus threatening the possibility of team work between diverse professionals, and making it difficult to provide integrated care for patients.

As healthcare technology advances, there will continue to be even more platforms for collecting and storing patient data digitally. While these systems are convenient and efficient for healthcare providers, not all communicate and share information, creating data silos. Data silos occur when you have patient data stored on different systems and applications that do not communicate with each other. A patient that sees multiple healthcare providers will have data repeated or hidden on the systems used by those providers. Data silos in healthcare can also occur within an organization if multiple departments use different applications. Silos create various challenges for healthcare providers, making it difficult to comprehensively understand a patient's health status, medical history, and treatment options.

Operating in silos in healthcare systems prevent providers from accessing all the necessary data required to make informed decisions and provide the best possible care.

Fragmentation in healthcare system can also affect privacy and security. When you have data stored across different systems, each with its own authentication process, the risk of a data breach increases. Each system needs to be secured separately, and a strong security model in one system does not mean the other systems are secure. Identifying the people accessing the data in those silos also becomes more complex, leading to unauthorized access and compromised patient privacy and security.

However, in recent years, many approaches and methods have been proposed to integrate the fragmented elements of patient care practices and to make them function smoothly. The core of every solution to meet the fragmentation challenge contains an effective system of communication between the stakeholders in patient care. To furnish efficient and qualitative care, effective communication is required, especially for those healthcare organizations and providers that work on the same group of diseases or on the same group of patients.

Therefore, the Cloud-Based Health Access Information System (CBHAIS) was intended to break down the challenge of health centers operating in silos or having fragmentation in the

healthcare system, which breaks down data silos and improve patient care due to the following reasons:

Enabling data-driven decision-making**:** Breaking down fragmentation challenge is crucial for enabling data-driven decision-making. Integrating data from different sources gives healthcare providers a more comprehensive understanding of a patient's health status, medical history, and treatment options. So they can make more informed decisions and better tailor care to the patient's needs.

Improving privacy and security in healthcare: Breaking down operating in silos is crucial for improving privacy and security in healthcare. By integrating data from different sources, healthcare providers can develop a more comprehensive view of patient data, making it easier to identify who can access patient data and monitor breaches. Integrated systems with modern authentication processes, such as single sign-on, mean there is only one platform to manage access controls and permissions, enabling providers to prevent unauthorized access to patient information.

Putting patients in control with access to their data: By integrating data from different sources, patients can access a comprehensive view of their health information, enabling them to take a more active role in managing their health. In this way, breaking down silos can improve patient outcomes by facilitating more informed decision-making and empowering patients to take a proactive approach to their health. Patient portals are example of how breaking down data silos in healthcare has given patients access to their data and improved patient care and outcomes. Patient portals are secure online platforms that allow patients to access their health records, schedule appointments, and communicate with healthcare providers. By integrating data from different sources, patient portals provide patients with a comprehensive view of their health data and connect them with providers, enabling them to take a more active role in their own healthcare journey.

Therefore, a cloud-based health access information system (CBHAIS) is capable of solving the fragmentation challenge in the health care systems and improves patient safety.

1.1 Background of the study

NABILATUK HEALTH CENTRE IV (NHC) is located in Nabilatuk Town council, opposite Nabilatuk Town council offices in Nabilatuk District, Karamoja sub-Region-Uganda. It is a

government-owned facility affiliated by the ministry of Health and setup in the pre-colonial era in 1956. It is managed by Nabilatuk District Local Government providing supervision and monitoring of all health activities, including those in the private sector in Nabilatuk district. Provide preventive, promotive, outpatient, curative, in patient, maternity, laboratory, ultra sound, emergency, and blood transfusion and mortuary services. Nabilatuk HC IV is a mini hospital having all kinds of services at health Centre III and has wards for men, women and children. It admits patients, has a senior medical officer and other doctors and nurses as well as a theatre for carrying out emergency operations. The HC handles all patients referred to from all health Centre IIIs (Lolachat HC III and Lorengedwat HC III) and IIs (Natirae HC II, Nabilatuk mission HC II, Nakudep HC II) in Nabilatuk district in the sub-counties of Nabilatuk, Lorengedwat, Lolachat, Kosike and Natirae.

Currently health facilities in Nabilatuk district are operating in silos: they are apart, disconnected, and clustered together without communication and input between one another. The problem of health care silos from an organization-wide perspective creates real problems for the individuals inside it. whenever patients are referred to the health center four from either health center three or health center two, the data about the patients is there at the respective health centers but not shared which creates various challenges for healthcare providers, making it difficult to comprehensively understand a patient's health status, medical history, and treatment options and results into repeated diagnosis which may harm the patient, cost incurred from repeated diagnosis which can be costly to the government because every time a patient is referred tests are repeated, also time the patient takes to carry more tests is wasted- patients' health care problems don't get solved on time leading to high rates of death.

This research project was intended to develop a cloud-based health access information system which enables stakeholders (authorized doctors and patients) at health facilities to have access to the health records online via web browsers which enables quick access to patients records for more coordinated efficient care, improve clinical decision making, reduce duplication of diagnostic testing, imaging and history taking, better medication management hence serving the needs of both the individual doctors and individual patients.

1.2 Problem statement

All over the world, patient information share has been a big nightmare with most organizations operating in silos. Research reveals that several attempts have been put in place to attain interoperability across health facilities but complete interoperability still remains an open area for research. Nabilatuk health facility is not an exception. Operating in a siloed manner creates a lot of challenges when it comes to health care and patient safety such as fragmented care which can lead to duplication of services, missed diagnoses, and delays in treatment, inefficient use of resources- health centers may purchase the same equipment or supplies unnecessarily, or they may not be able to refer patients to the most appropriate specialist, Patients may not receive the full range of services they need, and they may not be able to easily transition between different levels of care, difficult to track patient progress over time.

Developing a cloud-based health access information system (CBHAIS) can overcome these challenges by allowing healthcare providers to access quickly and easily patient records, enabling them to make informed decisions about patient care, improve the response time to the demands of the patient care because it would automate the process of collecting, collaborating and retrieving patient information, provide the stakeholders the ability to request and receive any data in the system in the most efficient manner with confidence of a high level of accuracy, result in cost-savings, time savings, and also greatly improve on records management at the health Centre IV. The authorized doctors and nurses can add patients, view patients, view their medical history, view lab results, update patients information and patients can view their medical history, view lab results, and make appointments online which eradicates manual access to data and data silos among the health Centers in Nabilatuk district and leads to easy access and sharing of patients records securely.

1.3 Main objective

The main objective of this study was to develop a cloud-based health access information system that enables healthcare providers and patients to access and share patient data securely.

1.3.1 Specific objectives:

The specific objectives of the study were as follows

i. To review the literature and determine the requirements for developing the cloud-based health access information system.
ii. To analyze the requirements and design a health access information system.
iii. To implement the cloud-based health access information system.
iv. To test and validate the cloud-based health access information system.

1.4 Significance of the study

In designing and developing the cloud-based health access information system for patients and doctors, it was hoped that the system should have the following impacts on the patients and doctors at Nabilatuk Health Centre IV;

- Allow healthcare providers to access quickly and easily patient records, enabling them to make informed decisions about patient care.
- Improve the response time to the demands of the patient care because it would automate the process of collecting, collaborating and retrieving patient information.
- Provide the stakeholders the ability to request and receive any data in the system in the most efficient manner with confidence of a high level of accuracy.
- Result in cost-savings, time savings, and also greatly improve on records management at the health Centre IV. The development of the cloud-based health access information system was intended to lead to better access to operational data.

1.5 Scope of the study

The scope provides for the boundary of the study in terms of depth of investigation, content, and methodology, geographical and the theoretical coverage.

1.5.1 Geographical scope

The system was designed and developed for the doctors and patients in Nabilatuk Health Centre IV and therefore the study was carried out at that health Centre.

1.5.2 Content scope

The study was centered on designing and implementing a web-based health Access information system for health Centre IV for doctors at Nabilatuk Health Centre IV. Web-based in this sense means that the authorized administrator was able to access the system admin panel over the web in a web browser, where he/she would capture the patient's records required for decision making.

1.5.3 Technological scope

The health access information system was designed in a way that makes it possible to be accessed through any web browser program. The web browser supported interface would be dynamic and backed by a database system that would enable the user to have ability to input data, access from the database. HTML (Hyper Text Markup Language) and CSS (Cascading Style Sheets) was used as languages of preferences for the design of user interface. In the interface, java script was used as the admin validation tool. PHP was used as a scripting language for linking the interfaces to the SQL database(s). PHP is a server-side scripting language that enables one to have the ability to insert into a web interface, instructions that web server software can execute before sending a response to the web browser. SQL would be used as the programming language developing the database. SQL is the de facto standard language used to manipulate and retrieve data from the relational databases.

XAMPP as a local server environment and an integrated database creation software tool was used as the software for creating MYSQL database. Whereas it provides a local server environment, it would be used for testing the system locally before considering it to host online.

The system will run on windows operating system and will preferably use Microsoft Edge or chrome browser with a friendly user-interface.

1.5.4 Time scope

The concept of time scope defines the estimated time frame in which the project can be accomplished. This time frame can sometime be long enough that the project is completed before the assigned period or the project can go beyond the time frame than it had been allocated. This can be due to changes in the system requirements as may be requested by the

client, for the case of this system, the estimated time frame was three months to come up with a working online health access information system and this is if everything went well as planned.

CHAPTER TWO
LITERATURE REVIEW

2.0 Introduction

This chapter comprises of a comprehensive analysis of information on theoretical and practical views of other research projects conducted in hospitals and clinic facilities for access of patient records both manually and electronically(on cloud). This research study combines factors that other researchers have done that would result in the better access of the patients records at Nabilatuk Health Centre IV (NHC IV) and other health centers in Nabilatuk District. This chapter is subdivided into different sections for example Information Systems, Access Information Systems, health access Information System, Cloud-based systems, Cloud-based health access information system, Current cloud-based health access Information System, design of cloud-based health access Information System and technologies needed for its implementation, advantages and disadvantages.

2.1 A system

A system is a group of interacting or interrelated elements that act according to a set of rules to form a unified whole. A system, surrounded and influenced by its environment, is described by its boundaries, structure and purpose and is expressed in its functioning.

2.2 Information system

An information system is a combination of software, hardware, and telecommunication networks to collect useful data, especially in an organization. Many businesses use information technology to complete and manage their operations, interact with their consumers, and stay ahead of their competition. Some companies today are completely built on information technology, like eBay, Amazon, Alibaba, and Google.

The typical components of information systems include:

Hardware – This is the physical component of the technology. It includes computers, hard disks, keyboards, etc. The hardware cost has decreased rapidly while its speed and storage capacity has increased significantly. Nowadays, storage services are offered from the cloud,

which can be accessed from telecommunications networks. **Software** –system software and application software. The system software is an operating system that manages the hardware, program files, and other resources while offering the user to control the PC using GUI. Application software is designed to manage particular tasks by the users. In short, system software makes the hardware usable while application software handles specific tasks. **Data** – Data is a collection of facts and is useless by themselves, but when collected and organized together, it can be very powerful for business operations. Businesses collect all the data and use it to make decisions that can be analyzed for the effectiveness of the business operations. **Telecommunications** – Telecommunication is used to connect with the computer system or other devices to disseminate information. The network can be established using wired or wireless modes. Wired technologies include fiber optic and coaxial cable, while wireless technologies include radio waves and microwaves.

Examples of information systems are a generalized information system that provides a general service like a database management system where software helps organize the general form of data. On the contrary, a specialized information system is built to perform a specific function for a business, for example, expert system that solves complex problems.

2.3 Access information system

Access to information system means gaining control or ability to use any part or whole of an information system whether or not through infringing any security measure. The means to accessing to information include: archives, libraries, management information systems, museums, and records management.

The Access approach to information management makes silos crumble. It's a holistic approach to caring for both physical and digital information at any stage. It's one, cohesive records management philosophy that gives you the tools to access your critical information, anywhere, and at any time.

2.4 Health access information system

Health access information system (HAIS) is a digital system that collects, organizes, and analyzes data to help people access healthcare services. HAIS can be used to track things like: where people are getting healthcare services, what types of services they are getting, how long

they are waiting for services, whether they are able to afford services, whether they are satisfied with the services they receive.

HAIS data can be used to identify and address barriers to healthcare access. For example, if data shows that people in a certain area are waiting a long time for appointments, policymakers can work to increase the number of doctors or clinics in that area.

HAIS can also be used to improve the quality of healthcare services. For example, if data shows that a certain hospital has a high rate of patient infections, the hospital can take steps to reduce the risk of infections. If data shows that a certain clinic is not prescribing the right medications for diabetes patients, the clinic can provide training to its staff on diabetes treatment.

HAIS are becoming increasingly important as healthcare systems around the world move towards digital transformation. By collecting and analyzing data, HAIS can help healthcare systems to improve access, quality, and efficiency.

Here are some examples of how HAIS are being used today: In the United States, the Centers for Medicare and Medicaid Services (CMS), uses HAIS data to track the performance of hospitals and other healthcare providers. CMS uses this data to make decisions about how to allocate Medicare and Medicaid funding. In Rwanda, the government is using HAIS data to improve the quality of maternal and child health services.

2.5 Cloud-based system

A cloud-based system, often known as cloud computing, is a broad term for anything that involves the delivery of hosted services via the Internet. A cloud can be either private or public. A public cloud sells services to anybody who has access to the internet.

A private cloud is a proprietary network or data center that provides services for a small group of individuals with limited access and rights. Cloud computing, whether private or public, aims to give easy access to computer resources and information technology services.

Hybrid cloud. Any cloud infrastructure system that incorporates both public and private cloud solutions is referred to as a hybrid cloud.

2.6 Cloud-based health access information system

Cloud-based health access information systems (CBHAIS) are HAIS that are hosted in the cloud. This means that they are not stored on local servers, but rather on a network of remote servers. This has a number of advantages, including:

Scalability: Cloud-based HAIS can be easily scaled up or down to meet the needs of a healthcare organization. This is important because healthcare organizations often experience fluctuations in demand, such as during a flu pandemic.

Accessibility: Cloud-based HAIS can be accessed from anywhere with an internet connection. This is important for healthcare organizations with multiple locations or for healthcare providers who need to access patient information remotely.

Security: Cloud-based HAIS are typically very secure. Cloud providers invest heavily in security measures to protect their customers' data.

2.7 The benefits of using the cloud-based health access information system

Cloud-based HAIS are becoming increasingly popular as healthcare organizations move towards digital transformation. Some of the benefits of using cloud-based HAIS include:

Reduced costs: Cloud-based HAIS can help healthcare organizations to reduce costs associated with hardware, software, and IT staff. **Improved efficiency**: Cloud-based HAIS can help healthcare organizations to improve efficiency by streamlining workflows and automating tasks. **Enhanced collaboration**: Cloud-based HAIS can help healthcare organizations to improve collaboration by making it easier for healthcare providers to share patient information. **Improved patient care**: Cloud-based HAIS can help healthcare organizations to improve patient care by providing patients with access to their own health information and by making it easier for healthcare providers to coordinate care.

Cloud-based health information management systems provide general cloud computing benefits for example high availability, reduced hardware maintenance, reduced operation expenses and added benefits particularly for larger organizations. On-site control and maintenance is not required, so institutions with multiple locations do not need resident IT departments to manage information apps.

Here are some examples of cloud-based HAIS:

Epic MyChart: Epic MyChart is a cloud-based patient portal that allows patients to access their medical records, schedule appointments, and communicate with their healthcare providers.

Cerner HealtheIntent: Cerner HealtheIntent is a cloud-based population health management platform that helps healthcare organizations to identify and manage high-risk patients.

Allscripts Care Coordination Platform: Allscripts Care Coordination Platform is a cloud-based care coordination platform that helps healthcare organizations to coordinate care for patients with complex medical conditions.

2.8 The current cloud-based health access information

The current cloud-based health access information landscape is rapidly evolving, with new technologies and applications emerging all the time. Some of the most important trends in cloud-based health access information include:

The rise of artificial intelligence (AI): AI is being used to develop new ways to access and analyze health data. For example, AI-powered chatbots can be used to answer patient questions about their health and to schedule appointments. AI can also be used to develop predictive analytics tools that can help healthcare providers to identify patients who are at risk of developing certain diseases.

The growth of the Internet of Things (IoT): The IoT is a network of physical devices that are connected to the internet and that can collect and share data. IoT devices are being used in healthcare to collect data about patients' health, such as vital signs and activity levels. This data can be used to improve patient care and to develop new health management tools.

The increasing popularity of block chain technology: Block chain is a distributed ledger technology that can be used to create secure and tamper-proof records. Block chain is being used in healthcare to develop new ways to store and share patient data. For example, block chain can be used to create a secure patient portal that allows patients to control access to their own health information.

2.9 Requirements of the cloud-based health access information system

Information systems are designed to fulfill a set of requirements. These requirements describe, among other aspects, the functionality of the system. The set of requirements that describes the functional necessities of the system are Functional Requirements. Functional requirements are based on system objectives or are in need of future users of the system.

Non-functional requirements in software system engineering are requirements that describe not what the software will do but how the software will do it, for example software performance requirements, software external interface requirements, design constraints, and software quality attributes. They are difficult to test; therefore they are usually evaluated subjectively.

Examples are understandability, usability, modifiability, interoperability, reliability, portability, maintainability, scalability, customizability, adaptability, variability, volatility, traceability, security, simplicity, clarity, integrity, user-friendliness, responsiveness, correctness, completeness, timeliness, robustness, performance, efficiency, accuracy, precision, cost development, and so on.

CHAPTER THREE

3.0 Introduction

This chapter describes the methods that were used to achieve the objectives of the study. This describes how data was collected using literature review, interviews, observation, focus groups and how collected data will be analyzed to aid the system development.

The method chosen for data collection of this project is qualitative, which is often the best and most efficient approach of collecting complete information from the small population and horse mouth of the administrator. Qualitative methods are for conducting researches that rely on open ended exploration of people's action, words, thoughts and intentions. Qualitative methods include Observation, Focus Groups and Interview. RAD (Rapid Application Development) model is used in the System Development Life Cycle (SDLC). RAD is an adaptive software development approach where a software prototype is rapidly updated based on user feedback and iteratively delivered until it meets all client requirements.

3.1 Area of Study

This study was conducted at Nabilatuk Health Centre IV in Nabilatuk town council, Nabilatuk district. NHC IV was chosen due to the existing problems identified by the system, above all, it is near and data can be collected easily. The study covered the departments that directly deal with clinical services and only medical records were considered and these includes; Patient Personal Information, Laboratory Examinations, Diagnosis, Prescriptions and Treatment and Follow-Up of the Patient.

3.2 Population and Sampling

Population refers to the entire group of people, events or subjects of interests that the researcher wishes to investigate whereas sampling refers to the process of selecting a sufficient number of elements (sample) from the population. The purpose of the study determined the number of participants that were involved in the study. The participants were segregated by many factors such as employment title, age, gender and other dimension that would benefit the study. In this research, twenty participants were involved in the study. The Doctors, four (04) were involved

and the other participants came from the other Focus Group which is the patient(s). A total sample size of ten (10) male and zero (0) female participants were involved in the study as shown in the table 3.3.1 below, between the age group of (20-44years).

The method of sampling was Purposive; to select key informants, (people with deep knowledge under investigation) for example the Doctors with different specialties.

Simple Random Sampling was adopted to select other participants in the Focus Groups at NHC IV.

Table 1: sample size of participants

Focus Groups	**Doctor**	**Patients**	**Total**
Number of participants	04	06	10
Male	04	06	10
Female	-	-	-
Day	**Day 1**	**Day 2**	

3.3 Data Collection

The method chosen for data collection of this project is qualitative, which is often the best and most efficient approach of collecting complete information from the small population and horse mouth of the administrator. Qualitative methods are for conducting researches that rely on open ended exploration of people's action, words, thoughts and intentions. Qualitative methods include Observation, Focus Groups and Interview which were used for data collection

3.3.1 Sampling methods

The study considered non probability sampling i.e. purposive sampling as it involved the researcher to use their expertise to select a sample that was most useful to the purposes of research. It was used in qualitative research as one got detailed knowledge about a specific phenomenon rather than making statistical references.

3.4 Rapid Application Development (RAD)

RAD (Rapid Application Development) model is used in the System Development Life Cycle (SDLC). RAD is an adaptive software development approach where a software prototype is rapidly updated based on user feedback and iteratively delivered until it meets all client requirements.

3.4.1 Data collection tools

3.4.2 Interview

This is the most commonly used and normally most useful fact-finding technique used by the researchers to collect information from the participants face to face. There can be several objectives of using interviewing such as finding out facts, generating user interest and feelings of involvement, identifying the requirements and gathering ideas and options. Interview technique is credited in the following ways; it allows an interviewer to follow up an interesting comment made by interviewee, it also allows the interviewer to adopt or re-ward questions during interview, it allows interviewer to observe interviewee's bodily language, interviewee can also respond freely and openly to questions. However, it has drawbacks such as Very time consuming and costly, and therefore maybe impractical; Success is dependent on communication skills of interviewee.

3.4.3 Observation

This technique was used to gather accurate information about how the system actually operates particularly about processes. This technique enabled the researcher to systematically observe and record the behavior and characteristics of operations and processes in the health Centre. The method gives more detailed and context related information, permits the collection of information, permits tests of the reliability of the responses to the view operations of a system as they are actually occurring, and can adapt to events as they occur. It is important in that; Observer can see exactly what is being done, it allows the validity of facts and data to be checked, it is relatively inexpensive and the observer can obtain data describing the physical environment of the task.

The observation technique becomes impractical in that people may knowingly or unknowingly perform differently when being observed, also some tasks may not always be performed in the manner in which they are observed.

3.4.4 Document Review

This tool was used to understand what has been written on the subject matter of capacity building of patient records and access in Nabilatuk HC IV. A thorough review of the documents was used in the health Centre with the intent to study how things are done and discover areas where improvement is necessary. It enables the researcher to investigate gaps, problems and benefits of the existing system. A number of documents were reviewed including patient charts, registers, tally sheets, periodic reports and laboratory reports among others. This method was used because; It is inexpensive due to the availability of data, it permits examination of trends over the past, does not interrupt program or client's routine in program, and there are few biases about information. From the above available data technique, the researcher used document reviews to understand what has been written on the subject matter of capacity building of access to patient records.

3.4.5 Focus Group discussion

According to (Lambert & Loiselle, 2008), a Focus Group is one type of group interviews where the interviewed individuals are put together in groups by the researchers. Furthermore, Focus

Groups are not to be conducted as several as one-to-one interviews simultaneously, instead

Focus Groups is about creating a situation of open discussion concerning this area under investigation where all participants feel comforted in expressing their opinions and responding to the other opinions around them. Before execution of Focus Group discussion, open ended questions are set by the researcher to provide him with the opportunity of creating a discussion environment among the members of a focus group (Drury, Conboy, & Power, 2012). However, (Cyr, 2019) discussed that one of the biggest challenges of Focus Groups is that it requires resources to gather the participants. Also, the participants may not give the right information as required by the researcher under the area of investigation.

3.4.6 System Design

This describes how the functions of the Cloud-based Health Access Information System were realized. This was done through the use of system design tools as discussed below

3.4.7 DFD

A data flow diagram maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs, storage points and routes between each destination. They can be used to analyze an existing system or model a new one, a DFD can often visually say things that would be hard to explain in words, and they work for both technical and nontechnical audiences.

3.4.8 Context Diagrams

Context diagrams focus on how external entities interact with your system. It the most basic form of a data flow diagram, providing a broad view of the system and external entities in an easily digestible way. It is drawn using three diagramming elements which are the context bubble, external entities and data flows

3.4.9 ERDs

An entity relationship diagram (ERD), also known as an entity relationship model, is a graphical representation that depicts relationships among people, objects, places, concepts or events within an information technology system. They are important for creating and understanding database structure. They help database users find information and organize data by providing a map of connections and relationships.

3.4.10 Use-case Diagram

A use case diagram is a representation of a user's interaction with the system that shows the relationship between users and different cases in which the user is involved. A use case diagram was used to identify the type of users of the system and the different use cases.

"System Designs are important because they provide roadmaps for how to rigorously conduct studies to best meet certain objectives" (Alturki, Gable, & Bandara, 2011).

3.5 System Implementation Software and Tools

3.5.1 The client-side

In wed development, client-side is a term that describes where application code runs. The client-side is everything in a wed application displayed or occurring on end user's device, including what they see – images, text and the rest of User interface. HTML (Hyper Text Markup

Language) was used for creating dynamic and interactive Webpages, PHP for connecting the system interfaces to the databases, JavaScript for validating the system web pages and CSS files for modifying the appearance of the font and web pages

3.5.2 The server-side (backend)

The backend software was installed in the web server and user computer or mobile phone. To enable the whole system to fully operate, visual studio code, JavaScript, HTML, PHP, Xampp server were used to implement the system.

Xampp server has MYSQL components that enable us to create the system databases and tables that provide the platform from which the system information is stored. The Xampp server used is a Relational Database Management System (RDMS) whose primary Query Language is MYSQL. MYSQL supports different data types including primary types such as integer, float, decimal, char (including character strings), varchar (variable length character strings), Binary (for unstructured blobs of data), text (for textual data) among others.

3.6 Data Analysis and Presentation

According to (Tracy, 2019) elucidated the process of analyzing the collected data as a translation of the gathered data by different methodologies through research and refer gathered data to the literature review to construct the proper results for the research and fulfill the purpose.

In this research, the information gathered from interviewees was analyzed by consensus and presented descriptively in verbatim.

The qualitative data collected by Interview, Observation, Document Review and Focus Groups was analyzed according to the qualitative analysis method. Qualitative analysis is the use of non-quantifiable methods to evaluate investment or business opportunities and make decisions. In qualitative analysis, the data collected is structured in a proper sequence, basing on the method of collection.(Rahman, 2020), argued that Qualitative approaches are employed to achieve deeper insights into issues related to designing, administering and interpreting language assessment. Categorization for the common data was approached to demonstrate the data in a suitable way for interpretation. Along with the coding process proceeded and the data based on

determined themes that will clarify the valuable findings of the operated discussions was described.

3.7 Testing

Both unit testing and integration testing were performed on the cloud-based health access information system to clarify the specifications of the system to reveal possible faults and establish confidence in the system.

3.7.1 Unit testing

Unit testing focused on one function at a time in that whenever the researcher designed a function, it would be tested instantly before proceeding to design another function

3.7.2 Integration testing

Integration testing was done after all the different modules had been put together to make a complete system. Integration aimed at ensuring that all the modules of the system work hand in hand and that they could be integrated to form a complete working system.

In the end, user testing was performed. This involved the potential users of the system to test the system if it met their requirements

CHAPTER FOUR:

4.0 Introduction

In this chapter, the background information; current system of the organization is presented, the strength and weaknesses of the current system shall be presented; then system requirements that involve functional and non-functional requirements are also presented, after, system design for Nabilatuk Health Centre IV is also presented.

4.1 System study and Analysis

The study was carried out at Nabilatuk Health Centre IV in Nabilatuk Town council in Nabilatuk district. The main purpose of the study was to develop a cloud-based health access information system that enables healthcare providers and patients to access and share patient data secure. It involved studying the existing system of Nabilatuk health Centre, identifying its strengths and weaknesses. The information acquired from the study was done by employing a number of data collection methods including observation, an interview guide, and focus group discussion.

4.2 Findings from interviews

A total of 10 respondents were interviewed and the responses are presented below; the opinions of the respondents were solicited based on the questions asked;

a) Why is it important to access patient records?

The respondents responded that enable healthcare providers to make informed decisions about patient care. Improve the response time to the demands of the patient care because it would automate the process of collecting, collaborating and retrieving patient information. Provide the stakeholders the ability to request and receive any data in the system in the most efficient manner with confidence of a high level of accuracy. Result in cost-savings, time savings, and also greatly improve on records management at the health Centre IV. In addition, lead to better access to operational data.

b) Discuss the challenges that you have registered as a result of patients and health care providers accessing patient information manually?

As the patient arrives at the facility for treatment, he/she enters at the reception where the receptionist records their details in the patient enrollment book and refers him/ her to the doctor. The doctor interacts with the patient to assess whether to admit the patient or not. The details of the admitted patient are captured and the type of diagnosis to be done in the form, this form shall later be produced into two copies, one of which is given to the patient during discharge and the other remains for further reference and also providing information to be entered into the books of records. The patient at the In-patient department is handed over to the nurse who provides the necessary medical care and captures patient records in the Patient Diagnosis Form. The patient who is referred to the Laboratory is received by the Doctor who carries out appropriate tests relevant to the patient problem. The Doctor may either refer the patient to the Out-patient Department (Pharmacy) or In-Ward for treatment depending on the test results. Test results captured in the records book for further reference.. A Patient who has recovered or even died is sent home a long with the discharge form, which then becomes his/her responsibility to keep it well and present it at the health Centre's next visit for other treatments. The diagnosis records and discharge conditions are captured and then recorded into the book for accountability, report preparation and other statistical purposes.

c) Which measures can be taken to curb the challenges you have cited, many of the respondents suggested that a cloud based health access information system should be employed at Nabilatuk health Centre IV to allow healthcare providers to access quickly and easily patient records, enabling them to make informed decisions about patient care. Improve the response time to the demands of the patient care because it would automate the process of collecting, collaborating and retrieving patient information. Provide the stakeholders the ability to request and receive any data in the system in the most efficient manner with confidence of a high level of accuracy. Result in cost-savings, time savings, and also greatly improve on records management at the health Centre IV. In addition, lead to better access to operational data.

d) "Which features can be included in the cloud based health access information system to make your work more satisfying to its needs?" This question was directed to the staff members of Nabilatuk health Centre IV in Nabilatuk town council. The respondents suggested that the tool should give Provisions of a login form to enable the doctor enter Email as well as a password before accessing the dashboard. Provision of a dashboard to display medical history, lab reports, scheduled sessions, appointments, patients. Interfaces for displaying the medical history, lab

reports, and scheduled sessions. Provision of buttons for adding record, taking lab report, viewing patient details.

4.3 Strength of Nabilatuk Health Centre IV

The Current Information System at NHC IV gives patient chance to interact with the Doctor physically thus explaining their problems in details.

Close Supervision of the Nurses and other workers by the Doctor towards handling patient diagnosis.

It gives patients an opportunity to visit to any other health facility with the discharge form describing the previous treatments.

It does not require specific skills and knowledge in the field of ICT to handle patient problems and records.

4.4 Weakness of Nabilatuk Health Centre IV

1. Use of manual system of patient information access and storage
2. Departments in the health Centre operate in silos

4.5 Features of the cloud-Based health access information system

Basing on the data collected, some of the features to be included in the system are given in the table below.

Table 2: Features of the cloud based health access information system.

Requirement	Feature
The Administrator should be able to login and manage doctors, patients, schedule sessions, cancel appointments	Provisions of a login form to enable the admin enter Email as well as a password before accessing the dashboard. Provision of a dashboard to display the different doctors, patients. Interfaces for displaying the different doctors' and patients' details, scheduling sessions. Provision of buttons for adding, updating, and deleting patients, doctors, Canceling appointments.

The Patient should be able to login and view medical history, lab reports, scheduled sessions, bookings, view doctors	Provisions of a login form to enable the patient enter Email as well as a password before accessing the dashboard. Provision of a dashboard to display medical history, lab reports, scheduled sessions, bookings, doctors. Interfaces for displaying the medical history, lab reports, scheduled sessions, new bookings. Provision of buttons for adding and canceling booking.
The Doctor should be able to login and view medical history, lab reports of his/her patient, scheduled sessions, view appointments, view patients , add record, take lab report	Provisions of a login form to enable the doctor enter Email as well as a password before accessing the dashboard. Provision of a dashboard to display medical history, lab reports, scheduled sessions, appointments, patients. Interfaces for displaying the medical history, lab reports, and scheduled sessions. Provision of buttons for adding record, taking lab report, viewing patient details

4.6 User requirements

The major users of the system include the customers and the administrators. Their user requirements include the following.

i. The Patient should be able to login and view medical history, lab reports, scheduled sessions, bookings, view doctors. Should also be able to change password
ii. The Doctor should be able to login and view medical history, lab reports of his/her patient, scheduled sessions, view appointments, view patients , add record, take lab report
iii. The Administrator should be able to access the dashboard and manage doctors, patients, schedule sessions, cancel appointments, change password.

4.7 Functional requirement

i. Patient requirement: The patient should be able to visit the cloud based health access information system and register for the first time by filling in his/her details i.e. full name, phone number, email, address, NIN, and create account by filling in the email, mobile number and password and confirm password that can be used to login. The Patient should be able to login and view medical history, lab reports, scheduled sessions, bookings, view doctors. Should also be able to change password. Furthermore he/she should be able to manage account details

ii. The Administrator should be able to login and manage doctors, patients, schedule sessions, cancel appointments, change the password of the doctors and patients if need be.

iii. The Doctor should be able to login and view medical history, lab reports of his/her patient, scheduled sessions, view appointments, view patients , add record, take lab report

4.8 Non-functional requirements

Non-functional requirement is any requirement that is not a functional, data or process requirement concerned with defining the precision which the solution will record or produce data. Non-functional requirements support the functional requirements and determine how the system must perform. Generally non-functional requirements should be;

i. **Performance**: System performance defines how fast a system can respond to a particular user's action under a certain workload.

ii. **Reliability**: Is the probability and percentage of the software performing without failure for a specific number of uses or amount of time.

iii. **Flexibility requirement**: Each part of the system should be independent, so that changing of one part does not affect the other part and new parts can be added to increase functionality.

iv. **Accuracy requirement**: The System should be more accurate in terms of computing the total revenue accumulated after an order is successfully delivered.

v. **Usability**: This feature concerns the users i.e. it indicates how effectively they can learn and use the system.

4.9 Hardware/ Software requirements

4.9.1 Hardware requirements

The hardware requirements include;

i. A Universal hard disk drive.

ii. A hard disk of at least 80GB.

iii. Random Access Memory (RAM) not less than 1GB.

iv. An uninterruptible power supply (UPS).

4.9.2 Software Requirements

The software specifications required on the computer system include;

i. XAMPP (Version3. 2.4).

ii. Windows 7 or higher version.

iii. Internet browser such as Mozilla Firefox and Google Chrome.

iv. The system should have 32/64 bits Operating System.

4.10 System Development approach.

The requirements determined were used to design the cloud based health access information system. The major development approach that was employed for this project was the Structured System Analysis and Design methodology. SSADM followed the waterfall life cycle model starting from the feasibility study to the physical design stage of development. One of the main features of SSADM is the intensive user involvement in the requirements analysis stage**.**

4.11 Requirement Analysis and Definition

This stage involved consulting the stakeholders of the system such as the doctors, nurses of Nabilatuk health Centre IV and a few patients so as to establish the requirements and services that the end-user expected from the system. It involved proper definition of the nature of the scope of the problem.

4.12 System design

The design follows system development methods. In this study, Rapid Application Development derived from Structural System Analysis and Design Methods was invoked. The design stages

included; system architecture, Context Flow Diagram, Data Flow Diagram and System modeling using Use Case Diagrams.

4.12.1 System architecture/architectural design

This is the block outlook of the system components.

The user interface component provides an interface for users to interact with the Cloud based health access information system. The UI allows users to view and manage patient-related information, initiate debt collection processes, generate reports, and perform other relevant tasks. The database component stores all the data related to patients, appointments, medical history, scheduled sessions, lab results and other relevant information. It provides a structured and organized way to store and retrieve data efficiently. The database was a relational database management system (MySQL). This component manages patient-related information, such as contact details, purchase history, credit limits, and outstanding debts. It allows the administrator to add new doctor, manage doctors; schedule sessions view all doctors, update their information, and maintain an accurate record of doctors. The system is responsible for allowing patients to update their account information, view medical history, view lab results, view scheduled sessions, and view his or her bookings.

4.13 Context diagram

Context diagrams focus on how external entities interact with your system. It the most basic form of a data flow diagram, providing a broad view of the system and external entities in an easily digestible way. It is drawn using three diagramming elements which are the context bubble, external entities and data flows.

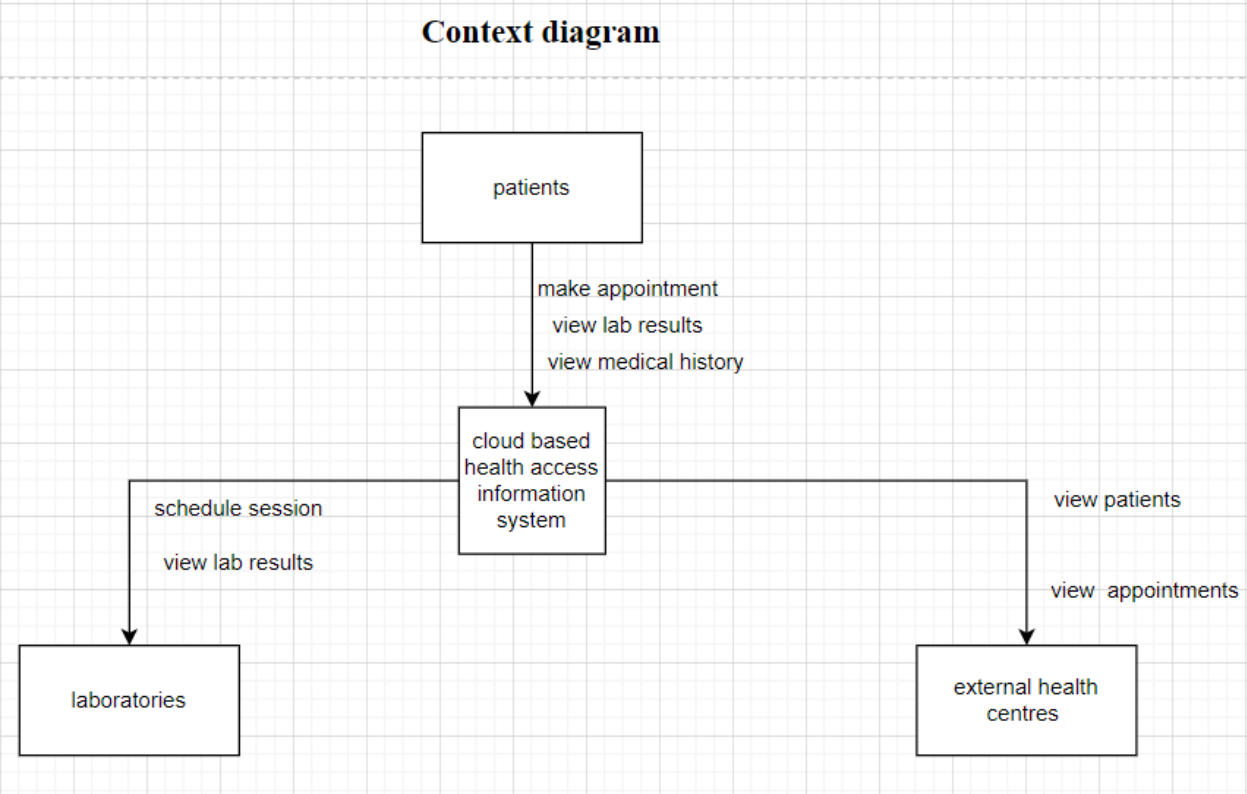

Figure 1: Context flow diagram

4.14 Use case diagram

A use case diagram is a representation of a user's interaction with the system that shows the relationship between users and different cases in which the user is involved. A use case diagram

was used to identify the type of users of the system and the different use cases.

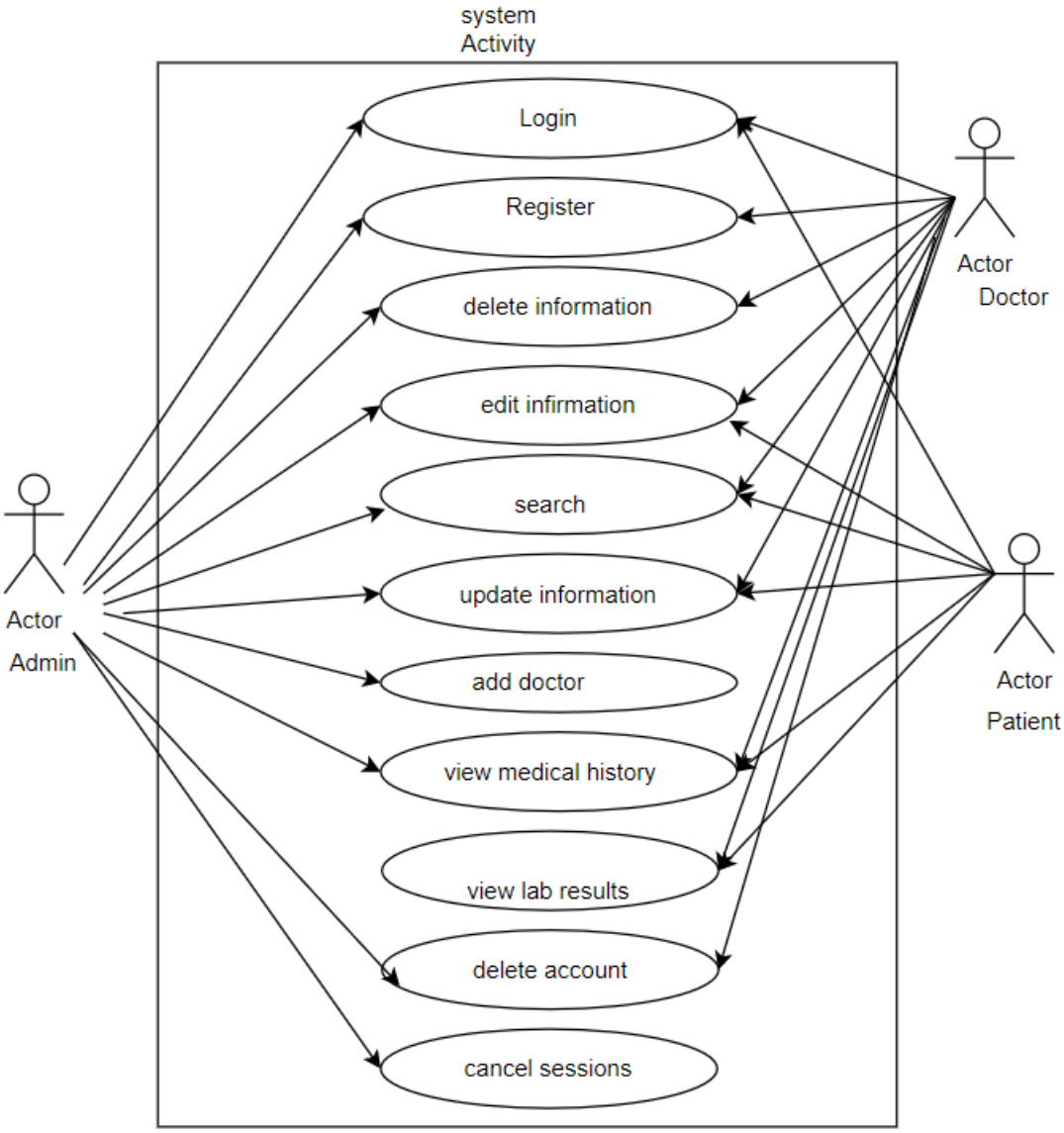

Figure 2: Use case diagram for the system

4.15 Data Flow Diagram (DFD)

A data flow diagram maps out the flow of information for any process or system. It uses defined symbols like rectangles, circles and arrows, plus short text labels, to show data inputs, outputs, storage points and routes between each destination. They can be used to analyze an existing system or model a new one, a DFD can often visually say things that would be hard to explain in words, and they work for both technical and nontechnical audiences.

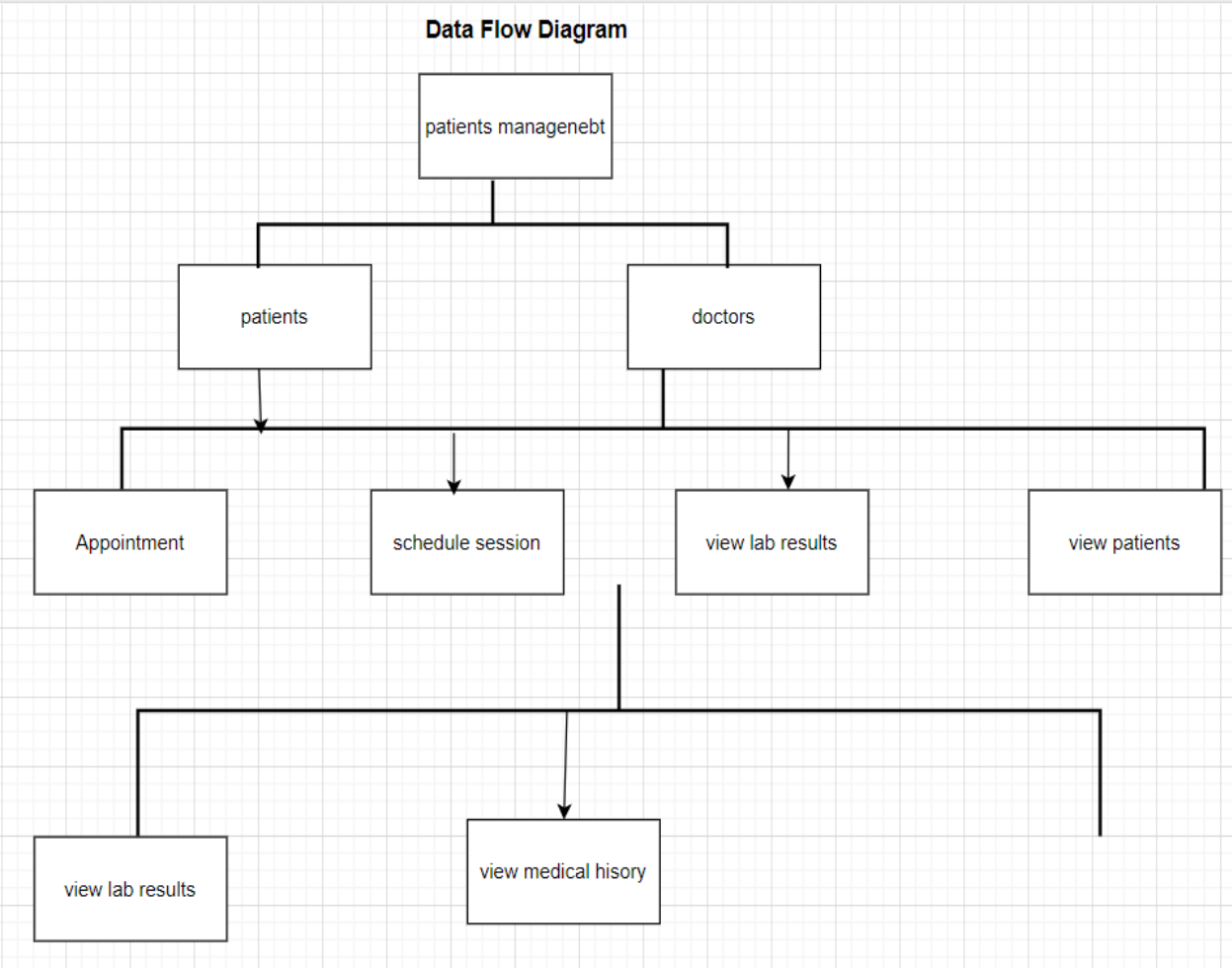

Figure 3: DFD

4.16 Entity relationship diagram

An entity relationship diagram (ERD), also known as an entity relationship model, is a graphical representation that depicts relationships among people, objects, places, concepts or events within an information technology system. They are important for creating and understanding database structure. They help database users find information and organize data by providing a map of connections and relationships.

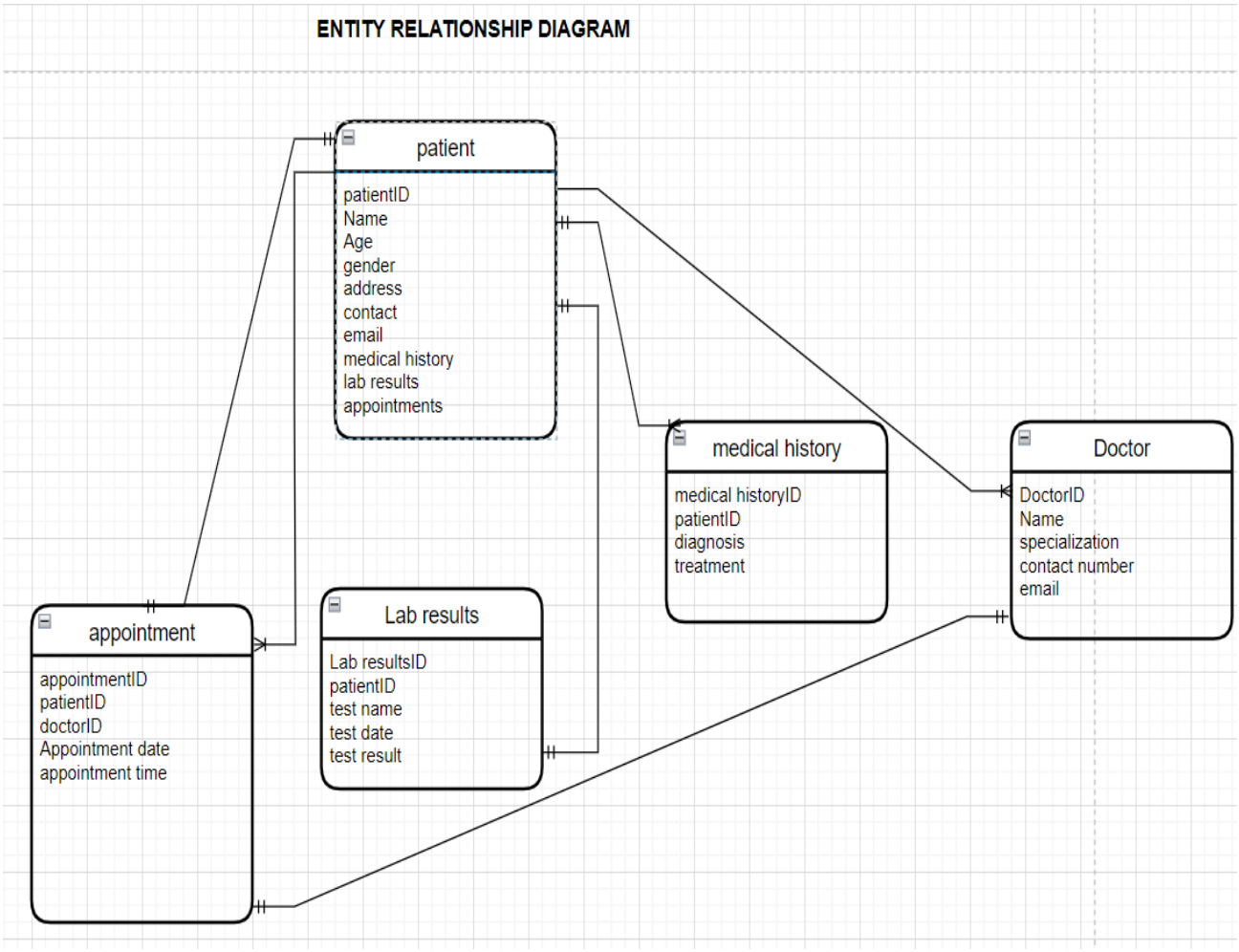

Figure 4: entity relationship diagram

CHAPTER FIVE:

5.0 Introduction

This chapter presents how the system was implemented. The explanations and screenshots are included in the report as follows.

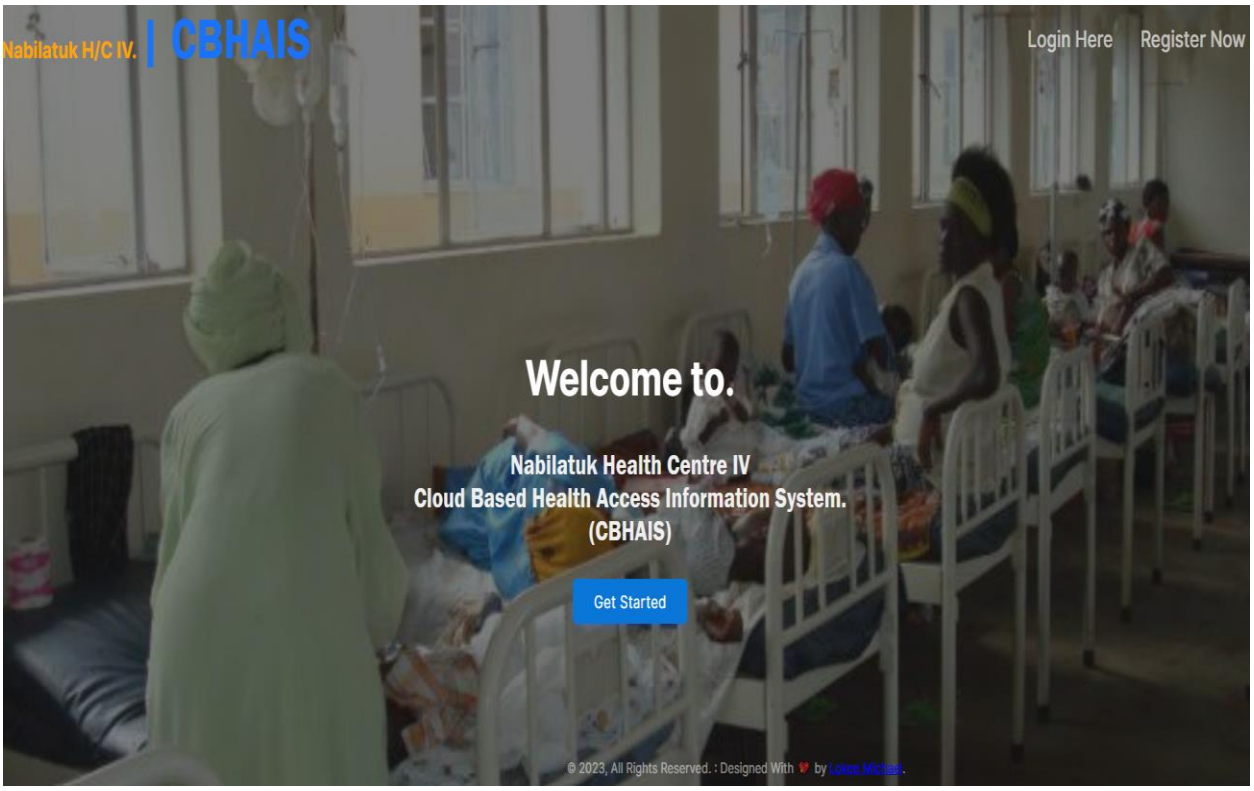

Figure 5: Home page of Nabilatuk H/C IV CBHAIS

5.1 System security

For secure system, all users must be checked using email and password

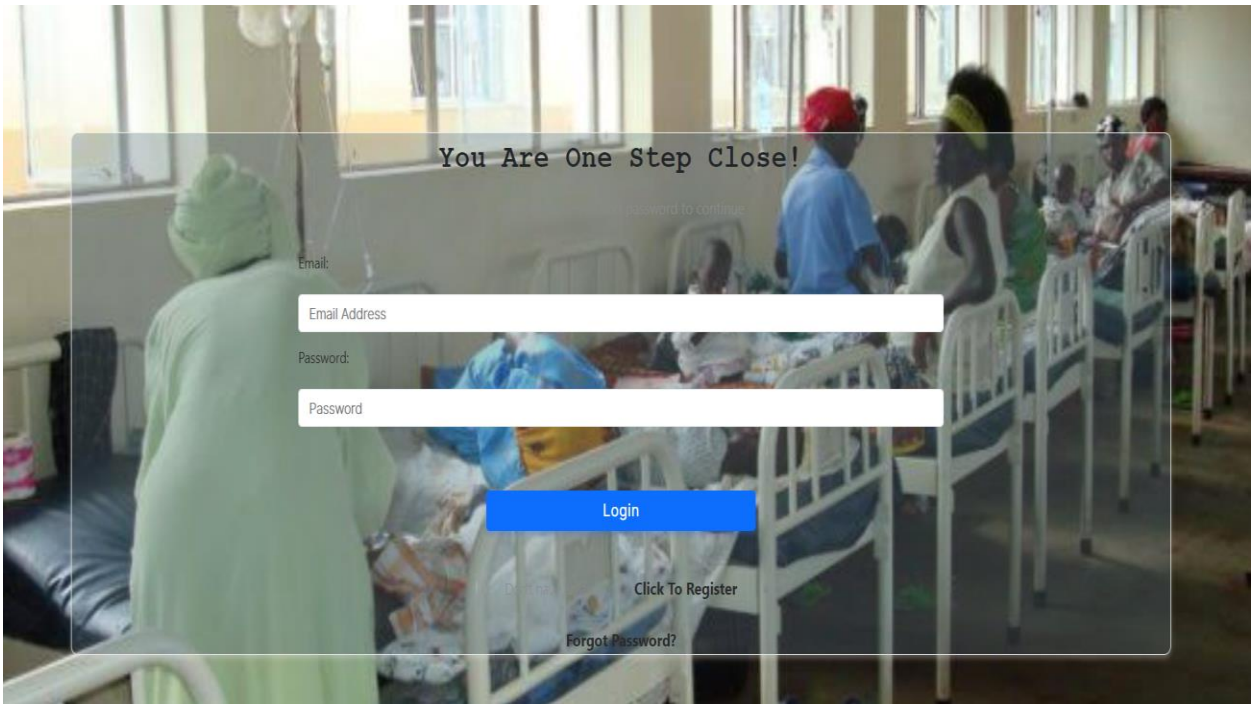

Figure 6: Login page of all users

The figure 2 is used for authentication so that only registered users can be able to access the system. This is for security purpose of the system.

5.2 New patient Registration

The interface shown in the figure below enables the patient or Receptionist to capture the details of the patient into the system.

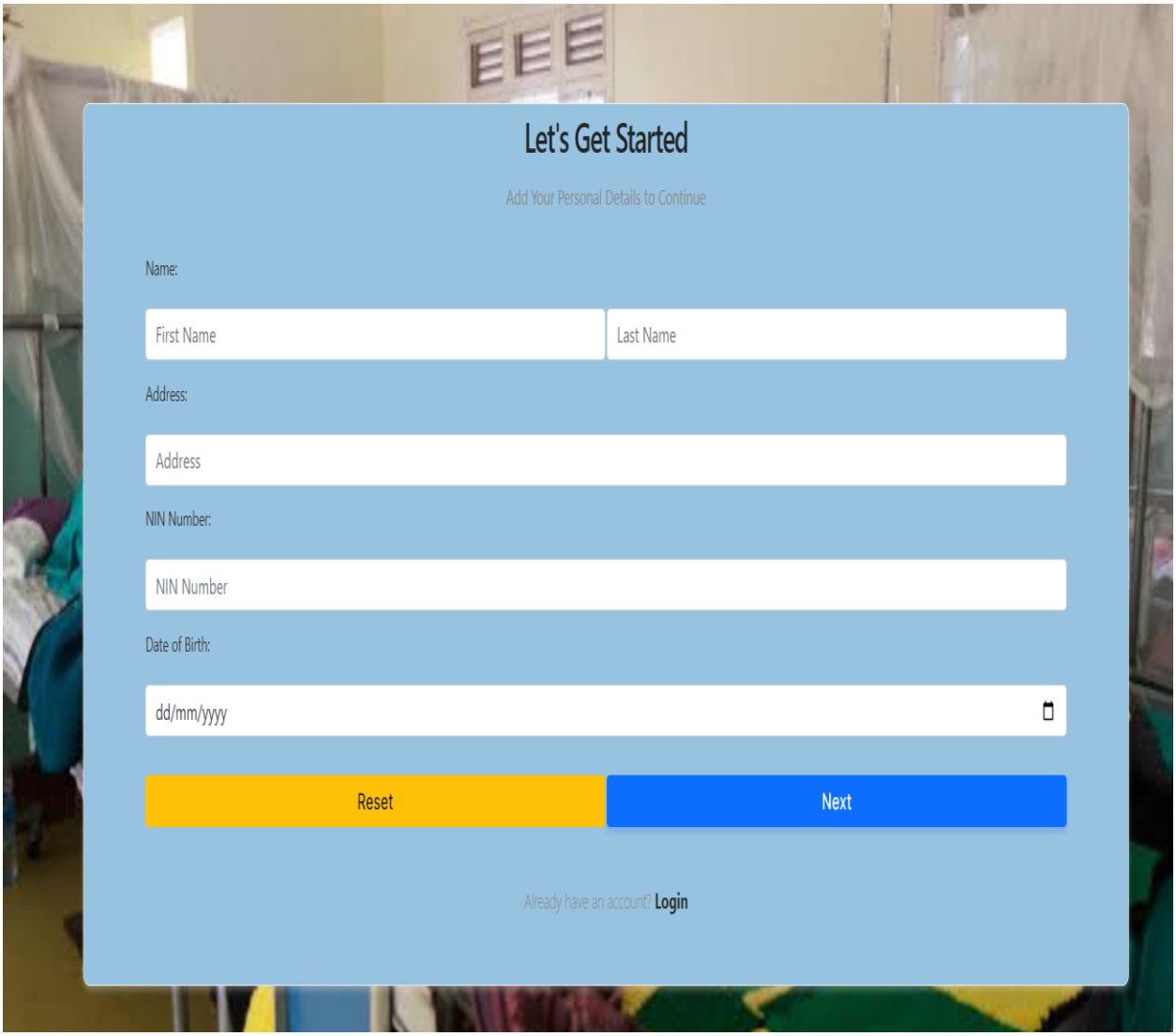

Figure 7: New patient registration page

5.3 User account creation

The figure below is used for registration of the system users so that they can login to access the system.

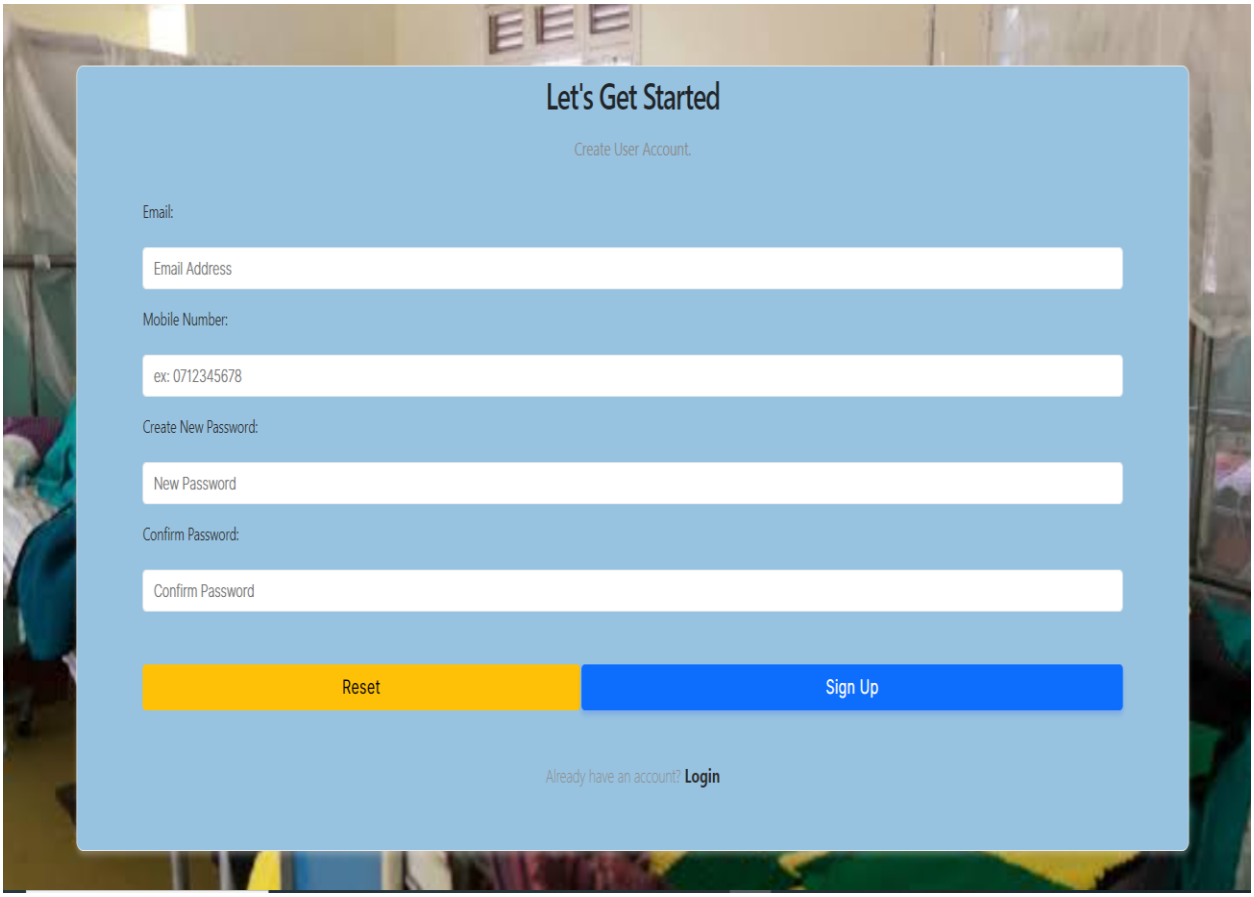

Figure 8: User account registration

The figure 5.2 is used for registration of the system users so that they can login to access the system.

5.4 Administrator's privileges

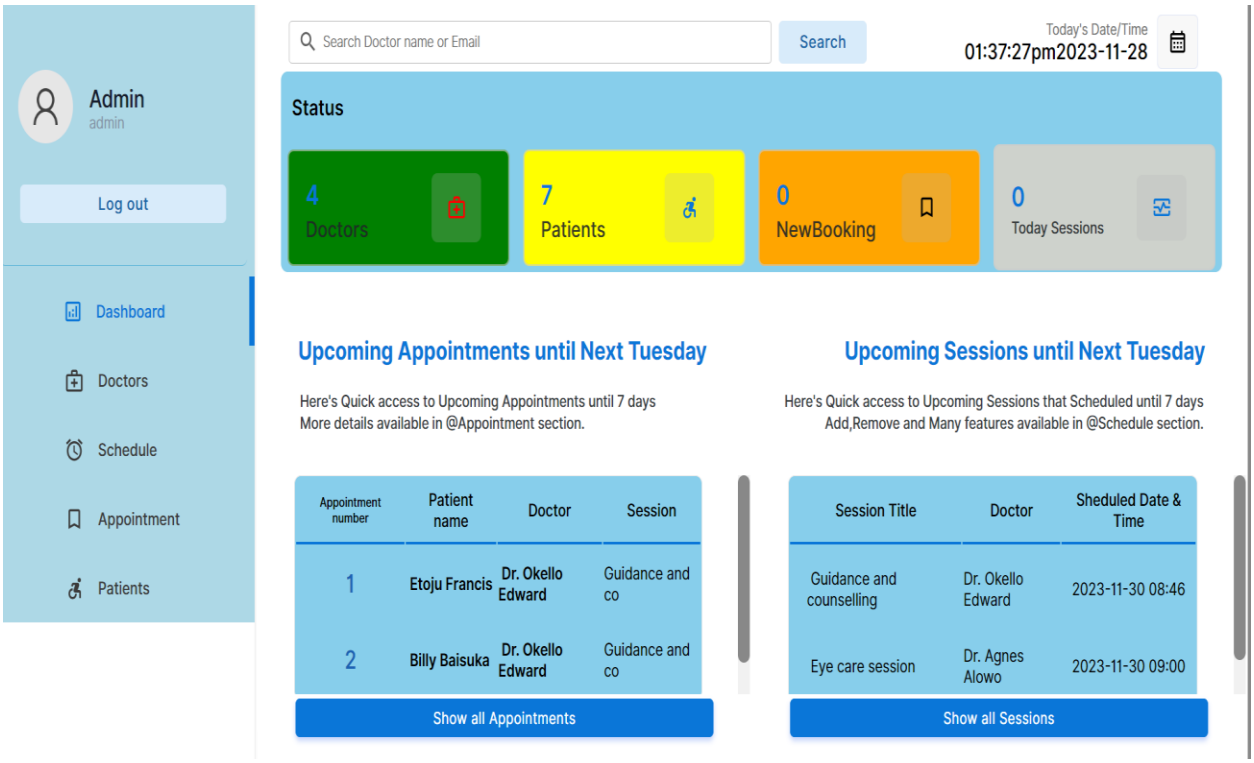

Figure 9: Administrators Dashboard

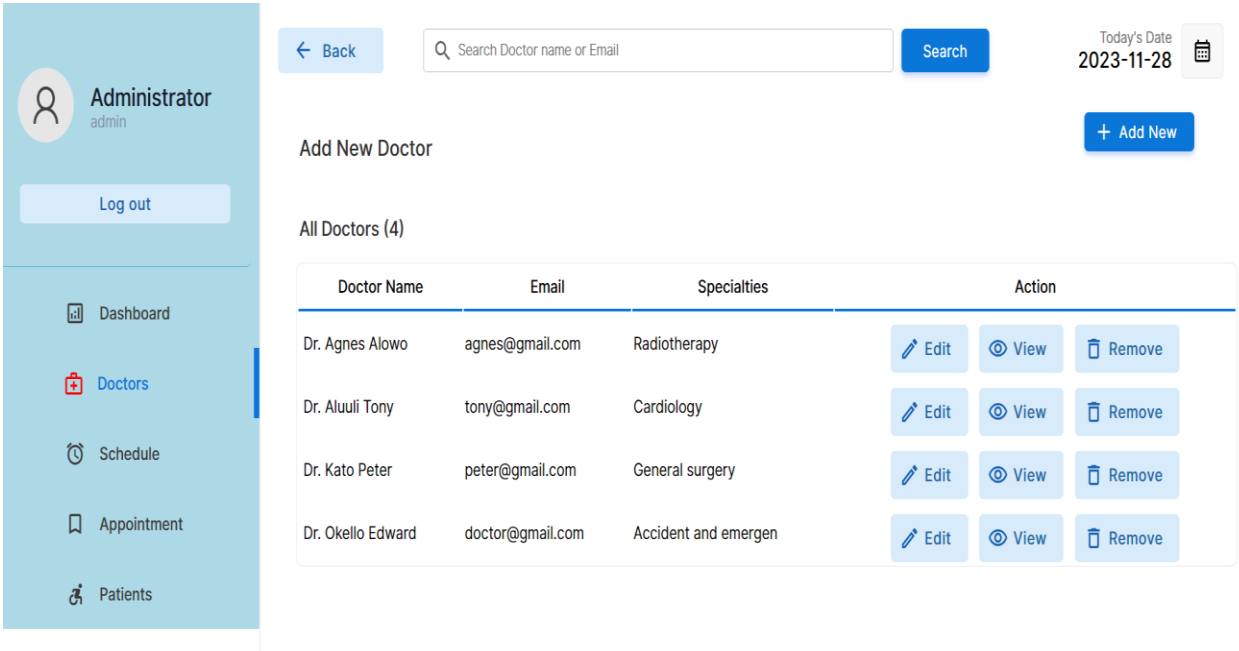

Figure 10: Administrator to edit, view, remove and add doctors

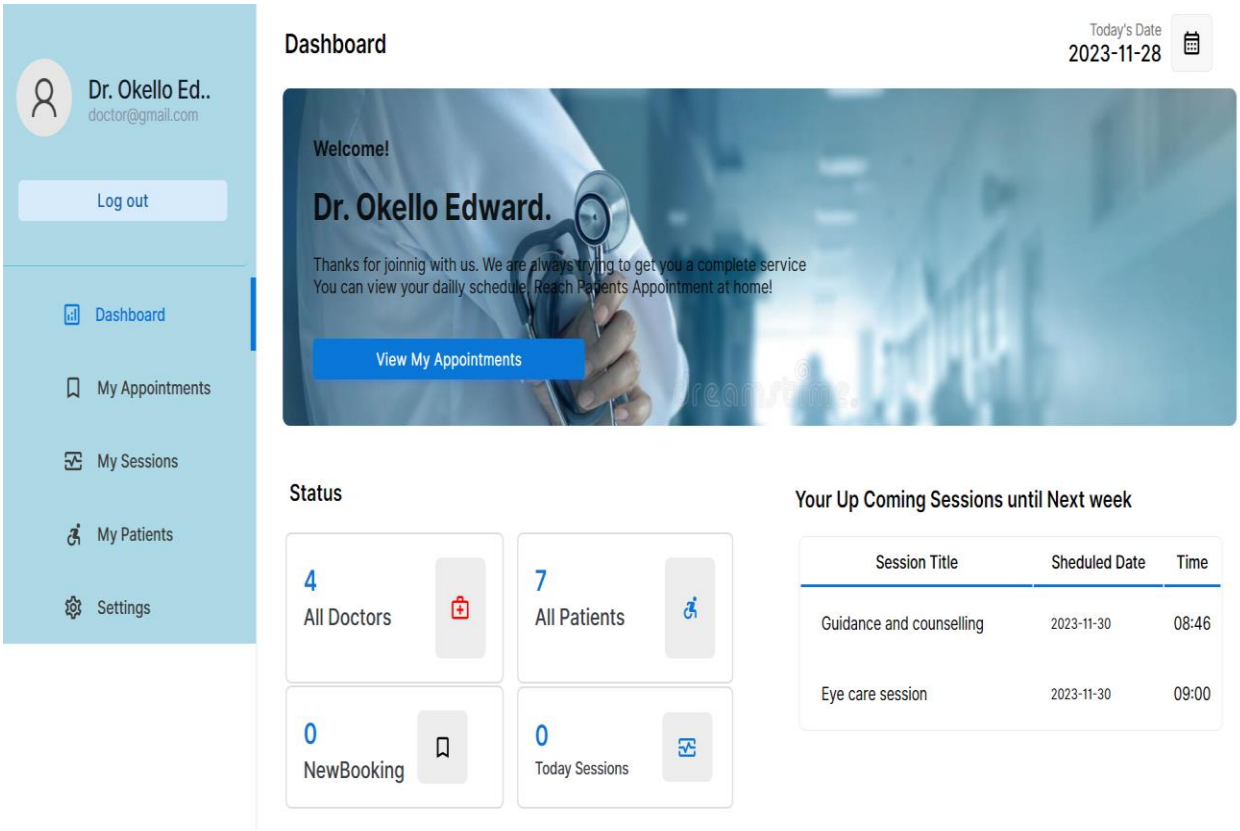

Figure 11: Doctor's Dashboard

5.5 System testing

The entire system was tested using codes, class modules and modules. This stage of implementation ensured accuracy and efficiency operation of the system before it was given to the users. It required a series of different tests which varied at different system levels. The system tester assumed that if all parts of the system were correct then the goal would have finally been achieved. Testing is the process of executing the program in order to identify errors or bugs. Testing shows the software errors. Therefore, testing was done after completion of the system. This was done in two formats including Unit testing and Integration testing.

5.5.1 5.5.1 Unit testing.

Unit testing was done on individual codes of the system to ensure that they fully yield the functional units. This was done by examining each unit, for example the code for placing an order. This was done to ensure that the order was delivered as it was ordered without errors.

Successfully achieving that encouraged me to go ahead with integration testing after all the identified errors were worked on individually.

5.5.2 Integration testing.

This was done after all the different modules had been put together to make a complete system. Integration aimed at ensuring that all the modules of the system worked hand in hand and that they could be integrated to form a complete working system.

CHAPTER SIX:

6.0 Introduction

This chapter discusses the output/result of the study in relationship with the existing knowledge presented in chapter two, Literature Review.

Conclusion is derived from the discussions and recommendations stated. Limitations and future work are also presented in this chapter.

6.1 Discussion

The discussion of this chapter is based on the theme of objectives stated in chapter one. Objective (1): To review the literature and determine the requirements for developing the cloud-based health access information system. The requirements of the study were got from two sources. These include; Library research and field research. Under Library research, the study was conducted on the previous done projects about the similar topic. This guided me on the alignment of my project work. The library research generated requirements that were used in the design of the DFD database design and a few others which led to the fulfillment of functional and non-functional requirements. The field research helped me get to know how the manual system works, the respondents' view and perception towards the cloud-based health access information system which also generated the requirements that were used for designing the interfaces.

Objective (2): To analyze the requirements and design a health access information system. The system was designed depending on the requirements followed by the RAD from the SSADM. The stage of design included Architecture, Context Flow Diagram and Data Flow Diagram, Use-case diagram and database design, which enabled the smooth flow of data.

Objective (3): To implement the cloud-based health access information system. The implementation of the system design was carried out using the implementation tools which included; Visual Studio code editor, Google Chrome, MySQL, HTML, XAMPP server and windows to fulfill the implementation where I came up with the interfaces in chapter 5, which interfaces include: "login, logout, dashboard, home, add new doctor, doctors list, patients,

scheduled sessions. The tool was implemented using parallel implementation to enable users to use the manual system as they got used to the new system.

Objective (4): To test and validate the cloud-based health access information system. The tool was tested during and after implementation. Each component was tested (Unit testing) and the whole system was also tested (system testing). Unit testing was used to test individual parts of the code whereby every part of the interface was as well tested to check whether it works properly. This was essential during the identification of errors in specific units of the code thereby making debugging quite an easy task. Integration testing was done after all the different parts had been put together to make a complete system. Integration aimed at ensuring that all the parts of the system worked hand in hand and that they could be integrated to form a complete working system.

6.2 Conclusion

The study was set to develop a cloud based health access information system for NHC IV. The results show that this system is ready for use and it brings effective results.

6.3 Recommendation

The system developed is effective when used shall solve the problem of doctors accessing the records of patients manually. However, I recommend that databases for different health centers to be included in the system with their patients and doctors so that when patients are referred to another health Centre, the health facility(ies) or health Centre(s) where the patient has been undergoing treatment is (are) known.

6.4 Limitation and future work

The researcher encountered a number of constraints which to some extent slowed the success of the study. These include the following;

6.4.1 Financial Constraints

There was a problem of financial support since study was self-sponsored. This made some of the activities to delay in the study.

6.4.2 Power Constraint

The unstable electric power supply was another problem that was not favorable to the researcher during research study. This resulted into improper planning and progress for the system development.

6.4.3 Busy Schedules

The healthcare providers at NHC IV were always busy all the time and this made the collection of data for the current system to delay for some time.

References:

Allin, S., & Rudoler, D. (2019). The Canadian health care system. *International profiles of health care systems*, 27-35.

Alturki, A., Gable, G. G., & Bandara, W. (2011). *A design science research roadmap.* Paper presented at the Service-Oriented Perspectives in Design Science Research: 6th International Conference, DESRIST 2011, Milwaukee, WI, USA, May 5-6, 2011. Proceedings 6.

Bhuiyan, M. Z. A., Zaman, A., Wang, T., Wang, G., Tao, H., & Hassan, M. M. (2018, May). Blockchain and big data to transform the healthcare. *In Proceedings of the international conference on data processing and applications* 62-68.

Cyr, J. (2019). *Focus groups for the social science researcher*: Cambridge University Press.

Dalal, A. K., Dykes, P. C., Collins, S., Lehmann, L. S., Ohashi, K., Rozenblum, R., . . . Ravindran, S. (2016). A web-based, patient-centered toolkit to engage patients and caregivers in the acute care setting: a preliminary evaluation. *Journal of the American Medical Informatics Association, 23*(1), 80-87.

Drury, M., Conboy, K., & Power, K. (2012). Obstacles to decision making in Agile software development teams. *Journal of Systems and Software, 85*(6), 1239-1254.

Hyppönen, H., Reponen, J., Lääveri, T., & Kaipio, J. (2014). User experiences with different regional health information exchange systems in Finland. *International Journal of Medical Informatics, , 83*(1), 1-18.

Kavitha, R., Kannan, E., & Kotteswaran, S. (2016). Implementation of cloud based Electronic Health Record (EHR) for Indian healthcare needs. *Indian Journal of Science and Technology, , 9*(3), 1-5.

Lambert, S. D., & Loiselle, C. G. (2008). Combining individual interviews and focus groups to enhance data richness. *Journal of advanced nursing, 62*(2), 228-237.

Matsuda, R. (2020). The Japanese health care system. *International profiles of health care systems*, 127.

Mishra, B. S. P., Das, H., Dehuri, S., & Jagadev, A. K. (2018). *Cloud computing for optimization: foundations, applications, and challenges*: Springer.

Nutley, T., & Reynolds, H,. (2013). Improving the use of health data for health system strengthening. *Global health action, 6*(1).

Rahman, M. S. (2020). The advantages and disadvantages of using qualitative and quantitative approaches and methods in language "testing and assessment" research: A literature review.

Rothman, B., Leonard, J. C., & Vigoda, M. M,. (2012). Future of electronic health records: implications for decision support. Mount Sinai Journal of Medicine. *A Journal of Translational and Personalized Medicine,, 96*(6), 757-768.

Sultan, N. (2014). Making use of cloud computing for healthcare provision: Opportunities and challenges. *International Journal of Information Management, 34*(2), 177-184.

Thorlby, R., & Arora, S. (2020). The English health care system. *International profiles of health care systems*, 59.

Tracy, S. J. (2019). *Qualitative research methods: Collecting evidence, crafting analysis, communicating impact*: John Wiley & Sons.

Wang, L., Ranjan, R., Chen, J., & Benatallah, B. (2017). *Cloud computing: methodology, systems, and applications*: CRC press.

Watson, H. J., & Frolick, M. N. (1993). Determining information requirements for an EIS. *MIS quarterly*, 255-269.

Zhang, P., Schmidt, D. C., White, J., & Lenz, G (2018). Blockchain technology use cases in healthcare. *In Advances in computers 111*, 1-41.

APPENDICES

APPENDIX I: QUESTIONNAIRE (Data Collection Tool)

I am LOKEE MICHAEL conducting academic research which is one of the fundamental requirements that will lead to the award of a Bachelors degree of science and education in computer department in the faculty of science and education in Busitema University. I therefore request for your utmost cooperation in this exercise. I assure you that this study is bound by research ethics, so your responses will be treated with maximum confidentiality and will be used for academic purposes only. Thus, you can freely share your experiences and knowledge in this insightful exercise. Thank you!

1. What is your name (*optional)

……..

2. What is your age? (Tick)

18-24☐ 25-39☐ 40-49 ☐

3. What is your gender? (Tick)

MALE☐ FEMALE ☐

4. Are you employed?

YES☐ NO ☐

5. If YES, what is the title of your job? (Tick/write)

DOCTOR☐ WATCHMAN ☐

NURSE☐ OTHERS ☐

(Specify……..

APPENDIX 2: INTERVIEW GUIDE

1. Why is it important to access patient records?
2. Discuss the challenges that you have registered as a result of patients and health care providers accessing patient information manually?
3. Which measures can be taken to curb the challenges you have cited above?
4. Which features can be included in the cloud based health access information system to make your work more satisfying to its needs?
5. How do you rate the services of the manually accessing the patients' information with the electronic way?