

A WEB-BASED MEDICAL RECORDS MANAGEMENT SYSTEM FOR NIGERIA

(A CASE STUDY OF PILGRIMS WELFARE AGENCY)

BY

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1153-04156-02165

**A THESIS REPORT SUBMITTED TO THE COLLEGE OF HIGHER DEGREES
AND RESEARCH IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR
THE AWARD OF THE DEGREE OF MASTER OF SCIENCE IN
COMPUTER SCIENCE**

AT

KAMPALA INTERNATIONAL UNIVERSITY

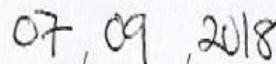
SEPTEMBER, 2018

DECLARATION

I declare that this thesis report is my original work and has not been presented for a degree or any other academic award in any University or Institution of learning.



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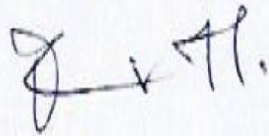


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APPROVAL

I affirm that the work presented in this thesis report was carried out by the candidate under my supervision.

Dr. Shamsudeen Samri



.....
Name & Signature of Supervisor

11 / 09 / 2018
.....

Date

DEDICATION

- My Parents who nurtured me well in the field of academic, for their support and encouragement throughout my studies and with their constant prayers to be successful in life.
- Late Mallam Umar Musa Yar'adua for your openness, due process and zero tolerance to corruption policies during your lifetime as the President of the Federal Republic of Nigeria.
- My Brothers and Sisters for your continuous, heartening financial support and constant prayers, that has sustained me to this end. Having all of you in my life is a blessing.
- Madam and Children for yours patience, understanding and prayers during the course of this study and life generally.
- Hajjat Amina Namakula for your benevolence and understanding when Naira crashed against the dollar and some students were served with quit notice for not able to settle their rent on time. I was fortunate to have stayed at your compound and this has helped in no small measure in my academic achievement during the course of my study.
- Last but not the least Yan Kanana (whom I refer as *Young Shall Grow*) I am delighted whenever I see you.

ACKNOWLEDGEMENT

I give praise and thanks to the Lord of Mankind for supporting me with the strength, good health, and knowledge to complete this research.

Undertaking this Master's Thesis has been a truly life-changing experience for me and the support and guidance that I received from many people contributed to this achievement. I would like to express deepest appreciation and gratitude to my Supervisors DR. Maryam Ahmad and DR. Sanni Shamsudeen for their untiring effort in making suggestions and corrections throughout the entire period of this research.

I extremely appreciate DR Olutola Fagbolu (H.O.D. Computer Science), Mr. Chine Umezurike, DR Yakubu Ajiji and DR Ramadhan Malinga for their valuable guidance and suggestions towards the completion of this thesis. Moreover, I would also like to take this opportunity to thank the Chairman of the Doctoral Committee (Prof. Vincent Gonzalez) and the Dean SCIT (DR. Margaret Kareyo) as well as each and every member of the Committee in School of Computing and Information Technology towards their academic contributions to the completion of this thesis.

Similarly, the efforts of Muhammad Babagana must also be acknowledged.

I acknowledge the management and staff of Sokoto State Pilgrim Welfare Agency and Specialist Hospital Sokoto for allowing me to conduct this research in their domains. Similarly, I acknowledge everyone who spared his time to participate in this research.

I acknowledge former College Registrar of FCE (T) Bichi DR Muhammad Ali and Mr. Felix Olubo (Co-operative Chairman). Likewise, I sincerely appreciate the College management of FCE (T) Bichi for given me the opportunity to study at this great University.

Last but not least, I am grateful to all those who have contributed in diverse ways towards the successful completion of this study,

May the Merciful Lord of Mankind reward you all abundantly.

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LIST OF ABBREVIATIONS/ACRONYMS

CSS	Cascade Style Sheet
EHR	Electronic Health Record
FGN	Federal Government of Nigeria
FMCT	Federal Ministry of Communication
FMoH	Federal Ministry of Health
HIS	Health Information System
HIT	Health Information Technology
HMIS	Health Management Information System
HTML	Hyper Text Mark Up Language
IT	Information Technology
NHID	National Health Identification
OPD	Out-Patient Department
RBAC	Role-Based Access Control
SHS	Specialist Hospital Sokoto
UHC	Universal Health Coverage

ABSTRACT

*The state of service delivery in Nigeria's health sector has come under persistent criticisms due to the poor quality of services rendered to its citizens. The daily newspapers reveal that Nigeria loses more than \$1bn annually to medical tourism due to loss of confidence in the nation's health care system. Therefore, this research is a contribution to the body of knowledge in support of Universal Health coverage for effective and efficient healthcare service delivery in Nigeria. Hence, a secured web-based platform for proper management of medical records amongst the healthcare providers was developed. Authentication and Authorisation techniques were also considered for security and privacy of the patients' medical records. After requirement analysis, system architecture was defined, followed by design, implementation, and testing. In addition, the web-based platform was implemented using **WAMP SERVER 3.0.6** as developing tool, in which **HTML & CSS** served as technologies for the designed at the front-end, whereas **MySQL** served at the back-end. The result obtained from the implementation evaluation conducted at the hospital conference hall with the participants of the survey demonstrates that majority of the users are satisfied with the security and privacy features incorporated into the System. Moreover, they show their readiness to move to the Web-based platform as soon as it is implemented. Therefore, the study concluded that Nigerian public sectors need to fully utilize Web-based platforms to make services widely available and accessible which will prompt to better quality delivery in an efficient and effective manner. Some recommendations were proffered such as: a law mandating the use of the web based platforms be promulgated across all healthcare providers in Nigeria, to ensure optimum security of the Web-based platform, the State Ministry of Health should have the overall administrative privilege on users' accessibility of the system. Similarly, for meaningful and successful implementation of the Web-based platform, all computer rooms in healthcare providers should be upgraded to a full fledged ICT center.*

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Healthcare Service Providers in Nigeria face a problem of poor management of Patients' Medical Records, despite the technological advancement attained at this age of globalization. Such problems include delay tracking of patient records or even worse missing documentation. Hence, vital information that will support quality service delivery across healthcare providers can't easily be exchanged. Kabiru (2016) argued that sensitivity of medical records has brought several challenges to managing institutions. The commonest relates to storage, access, safety, and security. Poor record management has been singled out partly responsible for the poor quality of healthcare services delivered to all Nigerian citizens. Kelly (2013) reported that healthcare services in Nigeria are not serving the people; they are inaccessible, poor in quality and indifferent to customers' needs. As a result of this, public confidence/ trust in the health system is poor, inequality level is high and institutional arrangements are confusing and wasteful.

Ayangbekun and Ameenah (2014) noted that most healthcare providers in Nigeria lack access to the data needed to convey most ideal healthcare with available resources. In a comparative view Yaya, Asunmo, Abolarinwa, and Onyenekwe (2015) observed that health records in most Nigerian health institutions especially in hospitals are affected by a number of challenges which affect the accessibility and utilization of health information in the treatment of people as information needed for each patient is not accessible on time or totally unavailable. Fatemeh (2011) observed that coordination and exchange of clinical information across various healthcare levels are reported to be a major challenge. Furthermore, existing evidence indicates that healthcare providers face difficulty in accessing clinical information on time especially when patients are transferred from one healthcare provider to another. Lack of timely access to patient information often results in very low turn-around time, poor patients monitoring leading to the creation of redundant medical records and medical errors.

Web-based information system creates a transparent system which ensures effective monitoring and management of organizational activities. It also improves efficiency and eliminates unnecessary paperwork. This contributes to the widespread use of the Web

from entertainment to commercial purposes, education, health, and research purposes. Both private and public organizations begin to utilize the internet and the Web to launch a new and enhanced information system to promote and accelerate their daily transactions. This shows that Web-based application has forever transformed the way businesses are conducted, services delivered and the way information is transferred among service providers across the globe. With respect to healthcare institutions Piyamas, Wisarut, and Prasong (2017) commented that Web-based technologies allow the system to become available virtually from everywhere at any time, a critical factor for medical applications where a few hours could correspond to the difference between a late diagnosis and saving a life. Despite the numerous advantages of the Web-based technologies towards enhancing speed, efficiency, transparency in the delivery of services and dissemination of knowledge in this generation, Bhatnagar (2014) observed that governments are the largest providers of information and services required by the poor but unfortunately, the methods used in the delivery of these services have not changed for decades, therefore, making them inefficient, costly and prone to corruption.

Available studies clearly indicate that implementation of a Web-based System can enhance quality healthcare although some challenges of concern in its implementation especially with regards to security issues. Aldajani (2012) reported that one of the main challenges of implementing e-healthcare systems is the concern about privacy and security of patient medical records. In a similar view, Mugo and Nzuki (2014) revealed that privacy, confidentiality and security concerns have not been much addressed in previous studies and these concerns affect implementation of e-Health systems amongst developing countries, however, acknowledged that these issues are not limited to developing countries alone. In a study conducted in Nigeria by Obotu, Uganneya and Ogezi (2018) revealed that implementation of clinical information systems in general and electronic health records, in particular, has had limited success; attributes poor system usability, deficiency in important functionalities, low levels of interoperability, low levels of customizability, and high levels of system vulnerability with regard to security and privacy as factors contributing to the low level of success recorded in clinical information system.

1.1.1 History of Medical Records

The history of medical records could be traced back to many decades when individuals' medical records such as laboratory reports were kept on paper. Later, basic electronic

health record system emerged using a word-processing program or spreadsheet applications initiated and maintained by individuals to manage lifelong personal health information. Mass storage devices such as CD ROMs, smart cards, or USB flash drive were used for the storage of personal health information. The first generation web-based PHRs were promoted as a means of providing patients and healthcare providers access to medical information through the internet anywhere in the world. An example of early web-based health records is the online emergency medical records that contain short medical history, medications, immunizations, allergies and care providers' information available to emergency room clinicians (Lin, 2014).

1.1.2 Medical Record

According to Ontario College of Physicians and Surgeons (2012), a medical record is a powerful tool that allows Physicians to track a patient's medical history and identify problems or patterns that may help determine the course of illness. Also, the primary purpose of the medical record is to enable Physicians to provide quality healthcare to their patients. It is an existing document that tells the story of a patient and facilitates each encounter they have with health professionals involved in their care. Sule (2013) define Medical Record as a record containing patient health information. It indicates doctor's diagnostic statement and the prescribed treatment. Nael, Ayman, and Mohamad (2015) reported that medical records of patients comprised of personal details and health information such as medical history, treatment received, any test done before, diagnoses, and medications were taken. However, in many places, such record is still paper-based and is susceptible to lose or damage.

1.1.3 Healthcare Service Delivery

Oyibo (2010), Opined that health service delivery is diverse which comprised of; diagnosis and treatment of disease, promotion, maintenance and restoration of health. Mutiara, Oswari, and Miharja (2012) posited that to provide health services with a broad and comprehensive scope, it is needed to build an integrated system like Health Information System (HIS). Technology provided by HIS is beneficial for enhancing the quality of care that can elevate the performance of the healthcare providers, such as auditable and accountable documentations, integrated medical records to accelerate the access and exchange of patient's medical history across hospitals, community health

centers, and clinics. Dixon (2016) forward in Raine, *et al.*(2016) commented that providing healthcare is among the most complex and risky undertakings carried out in the world because each person and his/her circumstances is unique. Open Text Corporation (2015) reported that at the point when physicians work with incomplete information, patient's safety or quality of care may be compromised while inefficiency and redundant efforts may be common. Ryan (2015) noted that patients have very little information or knowledge about their medical records hence, the need to become more involved in their health care. Prashila, Norman, Ethan, and Michael (2014) noted that when patients access their medical information they are likely to have questions, identify inaccuracies, or have information that may have an impact on their health records data, incorporating these patient contributions has the potential to improve the quality and safety of patient care by creating a feedback loop between patients and their multiple providers

1.1.4 Web-based System

According to Amarjeet (2014), the term Web-Based system refers to those applications or services that are resident on a server that is accessible using a Web browser and is therefore accessible from anywhere in the world via the Web. In a similar view Piyamas *et al.*, (2017) reported that Web-based Technologies allow the system to become accessible virtually from everywhere at any time and does not require any client-side computer software installation or customization. Furthermore, as an online databank, it could be accessed through any operating system and allows multiple user access in real time.

1.2 Contextual Perspective

Report released by Sokoto State Ministry of Health (2010) detailed that, health status indices of the state are among the worst in Nigeria due to various reasons ranging from poor health data recording and management among others. FGN and United Nations Foundation, (2015) reported that the electronic stock management system was the only application system used in Sokoto State. This system is being used for stock management of drugs amongst different healthcare providers in the State, however, the state lacks an efficient system to deal with the effective management of patients' medical records as well as its accessibility. Hence, the likelihood of emerging errors and challenges are inevitable in healthcare services being delivered in the state. This could be one of the reasons for the poor health status indices reported by the State Ministry of Health.

1.3 Problem Statement

Available studies reveal to the poor or at least questionable quality of effective health care delivery across all levels of healthcare providers in the country (Nasiru, Haruna, Idris, Suleiman, and Bashir, 2016). One of the factors contributing to the wide criticism on the quality of healthcare service delivery in Nigeria is poor record management amongst healthcare providers. This manifests through incomplete records, issues with regards to security and privacy, delays in the tracking of patients records or even totally unavailable in some instances. The absence of complete and remote access to patients' medical records may result in substantial risks to patients, delays in diagnosis, the high cost and inefficient treatment to mention but few. Tiro (2015) among others is the concern on the improper use of medical records that states that

“When patient records are not properly managed, without proper security measures, they can be misused, which can lead to possible violations of privacy and confidentiality of patient records.” McWay (2003) as quoted by Tiro (2015) mentioned some security measures necessary for ensuring that medical records serve their intended purpose and these are: authentication, timeliness, and completeness.

Consequently, poor record management which hinders the provision of proper and adequate medical services amongst healthcare providers in the country, constituted a problem upon which this study aims to develop Web-Based Medical Records Management System that can help service providers to respond on time to medical needs of Nigerian citizens which can support the attainment of Universal Health Coverage hence an effective healthcare service delivery in Nigeria.

1.3 General Objective

The main objective of this study was to develop secure Web-based System for proper management of medical records to support attainment of Universal Health Coverage (UHC) in Nigeria.

1.3.1 Specific Objectives

- i. To evaluate the current medical record system in Sokoto State with the aim of determining how to achieve privacy and security of patients medical records among healthcare providers in the State.

- ii. To Design and Implement a Secure Web-based Medical Records Management System.
- iii. To Test and evaluate the System based on User Acceptance.

1.4 Main Research Question

How is a secure Web-based System develop for proper management of medical records towards the realization of Universal Health Coverage (UHC) in Nigeria?

1.4.1 Sub Questions

- i. What is the current Medical Records System in use in Sokoto State and how does privacy and security of patients' medical records could be achieved among healthcare providers in the state?
- ii. How can a working prototype Web-Based Medical Record Management System be implemented?
- iii. How can a prototype of Web-Based Medical Records Management System be tested and evaluated?

1.5 Scope of the study

1.5.1 Geographical scope

The study was conducted at Sokoto State (The Seat of the Caliphate) located in the North-Western part of Nigeria. It is important to note that Specialist Hospital Sokoto (SHS) is amongst the healthcare providers serving the State Pilgrims Agency therefore, staff and patients of the SHS were considered to participate for the survey.

1.5.2 Content scope

This study was restricted to only study the current system being used and develop a secured Web-based platform for effective management of medical records that support universal health coverage in health care service delivery in the State.

1.5.3 Theoretical Framework

This study was underpinned by Privacy Protection Model proposed by Yuan (2001) which pinpoints the main actors viz: privacy subject, privacy collector, information protector and privacy violator as well as their roles in the context of privacy violation and protection. It suggested that these actors interact with one another through three interrelated activities:

information collection activities; privacy violation activities; and privacy protection activities. The model is used in different fields of studies.

Furthermore, once the patient information is gathered, it is the collector's legal responsibility to maintain its security and privacy. Kayode, Joseph, and Joshua (2016) argued that information collector (hospital) is required to provide patients with services. Hospitals hold a large amount of information about their patients, much of their documentation is still paper-based and is not electronically shared but sharing of patients' information will be a major issue as soon as patient records become computerized.

This study was also guided by Role-Based Access Control (RBAC) Security Model proposed by David Ferraiolo and Rick Kuhn (1992) as cited in Hassaan (2013), the RBAC model attempted to meet the requirements of the scope and created a full-fledged RBAC solution that evolved to overcome the shortcomings of Mandatory Access Control and Discretionary Access Control. The RBAC is now the broadly utilized model among all other existing models because of its dynamic nature and simplicity of organization. Moreover, in RBAC, the access to organizational resources is granted on the basis of the user assigned the role. When a role is assigned to a user all the privileges associated with that role are accorded to the user. The basic concept of RBAC consists of the Session (S), Permission (P), User (U) and Role (R). In an RBAC model, a user can play several roles, and a role can be assigned to several users. Permission assignments are not allocated to users but rather to their roles (Mei-Yu and Ming-Hsien, 2013). Commenting on the RBAC Shin, Heung, Lee, and Jeong (2015) noted that it is useful and flexible. Because of its usability, expressiveness, and extension, it is applied by various levels of governments to develop a security model for secure healthcare services.

1.5.3.1 Relevance of the Theoretical Framework to the Study

Privacy Protection Model proposed by Yuan's (2001) is consider relevant to this study because once a patient medical record is initiated by the privacy subject (Hospital), it is the Information Collector's (Hospital) legal responsibility to maintain its security and privacy so as to protect it from unauthorized access, modification or destruction. However, it is important to note that privacy subject (hospital) that initiated the patient medical records can share it with other healthcare providers on account of referral cases.

Also, the choice of RBAC Security model is on the grounds that it is widely accepted by numerous organizations and has robust security features, therefore, is regarded as the best practice security model. In like manner, Rozario (2016) opined that RBAC is among the suitable models for securing Web Applications. Therefore, RBAC model is adopted in this study. This Model considered pertinent to this study because it emphasizes on securing resources and grant only privileges based on the roles for the user to perform the required tasks. The system is only recognized useful in health sector if the system can guarantee the security and privacy of patient medical records.

1.6 Significance

This study will contribute to the body of knowledge on challenges of medical records management amongst the healthcare providers, it is anticipated that the results of this study will shed more light in a gray area of medical records management through the aspect of computer technology in order to support attainment of UHC in Nigeria. It is expected that this study will provide a direction for the remedy to the problem of records management in the Hospitals so as to improve the healthcare services delivery. The study also provides techniques to both private and public healthcare providers on proper management of medical records through the secure Web-based platform. In addition, it presents a more effective and reliable tool for improving the management of records in the hospitals. Furthermore, it enables healthcare providers to be well-informed about Patient's medical records and to make better decisions on diagnosis and treatment. This will improve the quality of healthcare delivery, ensure patient's safety, improve their satisfaction and at the same time ease the tasks of the medical doctors. Moreover, by improving patients' satisfaction it will save the economy of the country from high cost incurred through medical tourism, as part of the exploring measures in addressing the fallen of the foreign reserve account. Finally, to the research world, the developed system can be researched and enhanced with the aim of making it more applicable towards achieving UHC across the country.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

This chapter reviewed related literature based on the study topic on what previous scholars and authors have written on Paper-based, e-Health and Web-based Health Information System in Healthcare Services Delivery across the globe. It's also discussed the current practices of medical records management, probe challenges and the needs for proper management of medical records in Nigeria.

2.1 Theoretical Review

This study was underpinned by Privacy Protection Model proposed by Yuan (2001), this model pinpoints the main actors viz: privacy subject, privacy collector, information protector and privacy violator as well as their roles in the context of privacy violation and protection. It suggested that these actors interact with one another through three interrelated activities: information collection activities; privacy violation activities; and privacy protection activities. The model is used in different fields of studies. Thus, the components of the model are described as follows: **The Privacy Subject:** Refers to the individual or organization that has the responsibility to control the sharing of information in its custody. For example, a hospital that initiated the patient medical records has the right to control sharing of patient medical records to other healthcare providers. **Information collector:** can be an individual (Medical Record Officer) or organization (Hospital) that collects information such as Patient Bio-Data and medical data concerning diagnosis and treatment were given to a patient. In this case information collector (hospital) collects information from the privacy subject (Patient). **Privacy Protector:** Individual or organization that aims to protect the privacy of patients, which can be achieved through government legislation, standard and policies, professional ethical rules, services and tools to enhance privacy awareness and protection. **Privacy Violator:** The model describes the privacy violator as an individual or organization that illegally or un-ethically collects, distributes and uses patients' medical records.

Furthermore, once the patient information is gathered, it is the collector's legal responsibility to maintain its security and privacy. Kayode, Joseph, and Joshua (2016) argued that information collector (hospital) is required to provide patients with services.

Hospitals hold a large amount of information about their patients, much of their documentation is still paper-based and is not electronically shared but sharing of patients' information will be a major issue as soon as patient records become computerized.

Privacy Protection Model proposed by Yuan's (2001) is consider relevant to this study because once a patient medical record is initiated by the privacy subject (Hospital), it is the Information Collector's (Hospital) legal responsibility to maintain its security and privacy so as to protect it from unauthorized access, modification or destruction. However, it is important to note that privacy subject (hospital) that initiated the patient medical records can share it with other healthcare providers on account of referral cases.

This study is also based on the Role-Based Access Control (RBAC) Security Model proposed by David Ferraiolo and Rick Kuhn (1992) as cited in Hassaan (2013), the RBAC model attempted to meet the requirements of the scope and created a full-fledged RBAC solution that evolved to overcome the shortcomings of Mandatory Access Control and Discretionary Access Control. The RBAC is now the broadly utilized model among all other existing models because of its dynamic nature and simplicity of organization. Moreover, in RBAC, the access to organizational resources is granted on the basis of the user assigned role. When a role is assigned to a user all the privileges associated with that role are accorded to the user.

In RBAC security model, access to data is based on a user's roles and position within an organization or company. RBAC is a security model for controlling user access to resources based on roles, and it can significantly reduce the cost of access control policy administration and is increasingly widely used in large organizations. The procedure of designating roles is usually based on evaluating the basic needs and configuration of an organization and is usually coupled with a security policy. Furthermore, RBAC has five noteworthy components; The **user** or the person attempting to get access, **role** that configures what permissions the user has, the **permissions** themselves that grant access to objects, **operations**, for example, read, write, update and delete, and finally the **objects** which are the data or information that are needed to be accessed (Sergio, 2015).

The choice of this security model is on the grounds that it is widely accepted by numerous organizations and has robust security features. Hence, regarded as the best practice security model. In like manner, Rozario (2016) opined that RBAC is among the suitable

models for securing Web Applications. Therefore, RBAC model is adopted in this study. This Model considered pertinent to this study because it emphasizes on securing resources and grant only privileges based on the roles for the user to perform the required tasks. The system is only recognized useful in health sector if the system can guarantee the security and privacy of patient medical records.

2.2 Review of Related Literature

2.2.1 The Indices of Nigeria Health System

According to Olusoji (2016) indicators of Nigeria's health outcomes and coverage of basic health services show underperformance, both in absolute terms and relative to other countries at similar levels of economic development. Thus, the state of service delivery in Nigeria's health sector has come under persistent criticisms due to the poor quality of services rendered to its citizens. No wonder reports in the daily newspapers reveal that Nigeria loses more than \$1bn annually to medical tourism due to loss of confidence in the nation's health care system (Abdullateef, 2017). The federal government was worried about the development and exploring measures to contain the foreign exchange drain. A onetime President of Nigeria Goodluck Ebele Jonathan educated that the scale of capital flight lost to medical tourism is enormous, not justifiable and needs to be speedily addressed for the survival and development of our local health practitioners and industry.

The working document released by the Federal Government of Nigeria (2016) National Health ICT Strategic Framework 2015-2020 through the Federal Ministry of Health (FMoH) confirmed that health services delivery in the country is predominantly based on traditional or paper-based approaches. Sule (2013) argued that with the present system of record management in Nigeria, many patient records became damaged, lost and deteriorated. Furthermore, he stressed that until serious action is taken to remedy these shortcomings the proper management of patient health records will keep on suffering a setback which will hamper an ineffective health care services delivery. Kabiru (2016) conducted a research on significance and challenges of medical records it was reported that Hospitals which use primarily manual based medical records systems experience storage problems. Access to medical records is another challenge that users and custodians face. Sometimes there is conflict on the ownership and the right of access to a patient record.

A report released by Sokoto State Ministry of Health (2010) detailed that, health status indices of the state are among the worst in Nigeria due to various reasons ranging from poor health data recording and management among others. Umar, Oche, and Umar (2011) conducted a study to assess patient waiting time in a tertiary health institution at Usmanu Danfodio University Teaching Hospital (UDUTH) Sokoto state, Nigeria; the study demonstrated that majority of the patients were dissatisfied with services offered and the primary cause of the dissatisfaction was the long waiting time. Similarly, the study also recommended the need for health care institutions and providers to set up measures aimed at reducing waiting time and ensuring patient satisfaction.

Many factors contribute to the poor state of the medical sector in Nigeria. In fact, in many developing countries, two of the most critical challenges are record keeping and accessibility. Nigeria still operates a Paper-based Healthcare Delivery System hence, meeting the demands of citizens have been increasingly difficult due to her large population, understaffed hospitals, and apathy towards embracing ICTs among other issues (Kolawale and Ofoegbu, 2014).

2.2.2 Medical Record Management

According to Obotu, Uganneya, and Ogezi, (2018) the purpose of Medical Record Management is to ensure quality, accuracy, accessibility, authenticity, and security of information either in paper format, electronic or both. Medical Records are among the most critical tools that health care providers need in order to effectively deliver its services to the citizens of any nation across the globe. Therefore, Medical Record Management practice is imperative in any health service providing institution in ensuring quality service delivery. As pointed out by Obotu, Uganneya, and Ogezi, (2018) Medical service delivery does not only depend on the knowledge of clinical staff but also records-keeping processes in the hospital. Samuel (2013) reported that available studies indicated that most hospitals have embraced the aspect of implementing health record management system. Many hospitals are incorporating ICT into health record management due to the high level of the shortcomings of manual processes, such as misfiling of patients health records, enormous amounts of space, illegibility of doctors handwriting, transfer of medical records or files from one department to another.

2.2.2.1 Types of Record Management in Healthcare delivery

2.2.2.1.1 Paper-based Record Keeping System

Nolwazi and Louwrence (2016) observed that most medical records are kept on paper which makes available information for management of care, measuring the quality of care and improving care delivery very difficult to use. Furthermore, the healthcare industry is mostly data-driven and depends wholly on the accuracy and availability of data. When data is in paper format, there is limited access to it by healthcare providers and can act as a hindrance to effective healthcare delivery. This is in agreement with the World Health Organization (2012a) based on findings of the second global survey on e-Health which discovered that, majority of patients information is still being collected on paper in over 90% of countries indicating that there is a very high adoption of traditional method of data storage in most of their organizational settings. Zenebech (2014) conducted a study in Ethiopia on Assessment of the Current Paper Based Medical Record System. The problems identified in the paper-based medical record system were illegibility, incompleteness, difficulty in accessing data, misplacing of patient cards among others. He further emphasizes that most of the problems identified in the paper-based medical system at Multi-Drug Resistance Tuberculosis Department (MDR-TB) are typical of those problems faced in any paper-based system.

A study conducted by Alfred (2013) on sharing of patient health records in public and private hospitals in South Africa, it was revealed that Patient health information created in these hospitals are stored, managed and transmitted in paper or electronic form exclusively for use within that hospital alone which makes it impossible to be shared with other hospitals.

Exchange of information within healthcare system is plagued with several challenges especially in developing countries like Nigeria because data collection is majorly done manually. Therefore, there is significant fragmentation and duplication in the data collection and storage hence, healthcare organizations find it difficult to effectively manage information as it flows within or across the continuum of care resulting in an untimely exchange of information. Consequently, this result into inappropriate decision-making and care management, inept research, inadequate quality assessment, ineffective

planning, increase in medical errors, treatment costs as well as a decline in the quality of patient's care (Ojerinde and Iroju, 2015).

2.2.2.1.2 Electronic Health System

Ayangbekun and Ameenah (2014), electronic system stores, updates, retrieves and even verifies information keyed into it. It is linked to a database which is a repository of data from where information or data can be retrieved after being stored.

Certainly, constraints of Paper-Based Record System are impacting changes towards Electronic Health Records (EHRs) and in general electronic health (e-Health) system across the globe. Regardless of the much-achieved advantages of e-Health adoption particularly in developing countries, sharing medical records electronically still remains a significant challenge. The Nigerian government has recognized e-Health as a feature of e-government, however, as of now there is no incorporation of a multiple and wide variety of health information systems in the country instead, stand-alone systems do exist to support patient care (Mugo and Nzuki, 2014).

Africa has made remarkable progress in enhancing the well-being of its populace in spite of the challenges posed by pervasive poverty, epidemic diseases, and food insecurity. There remains an evident need to establish more robust health systems and to improve the availability and quality of healthcare services (African Development Bank, 2014).

Developing countries employ traditional method of Healthcare delivery with limited application of e-health which if strategically adopted will improve health care systems in many countries. A well-functioning Health Information System (HIS) no doubt enhances accurate, timely and reliable information on health status and health care determinants required for an efficient and effective clinical and managerial decision-making. Furthermore, e-health if well adopted can provide efficient and effective comprehensive healthcare services for the geographically dispersed people within both urban and rural areas of the community (Umar, 2015).

2.2.2.1.3 Web-based Health Information System

In today's information age, paper-based medical records are viewed as incomplete, hard to read and fragmented in the sense that different information is found in different parts which are not centrally organized. As a result, there is an increasing need to design and

establish a standard EMR model based on web technology that offers a centralized, shareable, accurate, and up to date record which is potentially available at any location at any time through a rapidly retrievable information source (Nasser, 2016). In addition, Piyamas *et al.*, (2017) commented that Web-based technologies allow the system to become available virtually from everywhere at any time, a critical factor for medical applications where a few hours could represent the difference between a late diagnosis and saving a life.

2.3 Comparative analysis of Healthcare System delivery among the developed and developing countries

More often, traditional approach is predominantly used for healthcare delivery in most of the countries across the globe. Quek and MZain (2016), reported that in most hospitals or clinics, patients' medical records are still recorded manually and kept locked in shelves or cabinets and not saved electronically thus, involving high risks as these records can get lost, be stolen or destroyed. Kola, Shoewu, and Segun (2013), commented that in this era of advanced technology, manual systems are becoming obsolete and are being replaced by e-platforms for enhanced efficiency and better productivity. However, Mugo and Nzuki (2014), revealed that privacy, confidentiality and security concerns have not been much addressed in previous studies and these concerns affect implementation of e-Health systems amongst developing countries. Nonetheless, they acknowledged that these issues are not limited to developing countries alone. This assertion is further confirmed by the study findings of Ojerinde and Iroju (2015), which examined information flow amongst the developed and developing countries as indicated in the table below.

Table 2.1: Comparative analysis of Healthcare system amongst the Developed and Developing Countries

Nigeria Healthcare system	Ethiopia healthcare system	Sweden healthcare system	USA healthcare system
Information flow is majorly paper based	Information flow is majorly paper based	Information flow is largely electronic	Information flow is both paper based and electronic
Data flow is fragmented	Data flow is fragmented	Data flow is fragmented	Data flow is fragmented

interoperability is a major challenge	interoperability is a major challenge	interoperability is a major challenge	interoperability is a major challenge
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Source: Ojerinde and Iroju (2015)

2.4 Improving Delivery of Healthcare Services

How can healthcare delivery be enhanced around the world and especially in developing countries? Health Information Systems are one of the key instruments created in order to achieve the goal of making people's medical records accessible on a global scale. Health Information System creates and manages service delivery mechanisms in order to ensure effective healthcare service delivery. According to Diana and Andrew (2013) in a world characterized by rapid social changes and technological innovations, citizens' expectations of what government ought to deliver are enormous and keep on rising. Against this background, innovative governments make it easier for their citizens to access public services on an online platform so as to boost government productivity.

A study conducted by Gregory and John (2013) to examine the impacts of HIS implementation on service delivery, user adoption and organizational culture within two hospitals in South Africa, it was found that through automation of processes there is reduction in inefficiencies of manually driven processes, lowers transaction costs, improves access to healthcare as well as streamlining operative efficiency in health system. Ayodele (2011) commented that in a heterogeneous society like Nigeria with a significant disparity in accessibility of health care facilities between urban and rural communities, Hospital Information Systems may help to improve the situation. Similarly, effective management and preservation of health records is an integral part of medical service delivery as it goes a long way in enhancing better services as well as serving as a basis for tracking patient health trends over time. It also acts as a basis for effective referral service. Hence, efforts should be made to ensure regular preservation and management of hospital records (Yaya *et al.*, 2015). Through the implementation of web-based platform it could improve the response time so as to address emergency situations amongst the healthcare providers. Madison (2014) stated that with the use of Health Information System (HIS), mistakes are kept at bay, information quality is enhanced, treatment response times improve and optimal decision-making is attained. This is consistent with the findings of Grace (2013), that Health information systems that are

successfully developed and implemented can improve healthcare efficiency and effectiveness.

2.5 Relationship between Web-based Technology and Healthcare Service Delivery.

Over the years, information required for evidence-based decision making in health care institutions has kept on expanding while its organization and accessibility diminishes. This has led to inappropriate decision-making resulting in medical errors thus calling for Electronic Health Information Management Systems (EHIMS) in order to enhance accessibility and management of patient medical data. Furthermore, without doubt, the healthcare sector is an information demanding institution; consequently, there's a need to have in place an organized Information System to guarantee the quality of care delivery (Ojo, 2013). A report from World Bank (2015), summarized the uses of information technology in public-sector (government) thus, technologies can serve as a variety of different ends, effective execution of public services, enhanced communication, citizen empowerment through access to information as well as efficient government management. The result benefits can reduce corruption, increase transparency, greater convenience, revenue growth and cost reductions.

Amina, Ibrahim, Mike, and Kuhu (2014), conducted a study in Nigeria on Health Management Information Systems (HMIS) for improved service delivery, revealed that HMIS ensures timely availability of data for decision-making, increased reporting rates from 36% to 80% and improved speed and quality of data reporting in deprived resource settings from 54% in 2009 to 74% in 2013. Moreover, it also enhanced data management capacity, empowered facilities and LGAs to take action on their health care needs at the local level. Besides, Ojo and Popoola (2015) conducted a study on aspects and elements that contribute to the success of Electronic Health Information Management System (EHIMS) in Nigerian tertiary hospitals. The discoveries of the survey demonstrated that significant positive relationship exists between technical factors and EHIMS success in Nigerian Teaching Hospitals. Such technical factors considered in the study among others comprised of appropriately designed software serving its intended functions and easy to use software which requires little or no training.

Kolawole and Ofoegbu (2014) disclosed that, the benefits to be gained by implementation the Electronic Health System include: patient information portability, efficient storage of patient data and its availability upon request, less demanding and speedy access to patients' records. More importantly, it enables efficient correspondence among Doctors and Patients as well as better diagnosis and quick administration.

According to United Nations (2014) report, it was observed that utilizing the economic model for quality service delivery is essential particularly in times of financial crises. As Nigerian government declared economic recession in the year 2016, employing Information Technology towards reducing costs of governance and better service delivery cannot be overemphasized.

2.6 Implementation of the Web-based Health Information System across the globe

There has been growing trend regarding the use of Web-based Health Information Systems towards improving the quality of healthcare service delivery. The growing popularity of these online systems are as a result of their flexibility, easy to access and convenience to the users. For example, the Web-Based Integrated Public Healthcare Information System of Korea which was planned and developed from 2005 to 2010 is being used in 3,501 regional health organizations. It has been found to enhance the quality of policy decision-making about regional healthcare at the local government level. This System contributed to the improvement of local health services of Korea (Seewon *et al.*, 2013).

Nasser (2016) conducted a research to explore the use of a unified central database repository and access through a web-based service for physicians, patients and hospital employees using web technologies. The platform was to establish a national EMR system in the Kingdom of Saudi Arabia through which an approved healthcare provider and patients can access therapeutic records at any time and in any healthcare facility. The government of Singapore deployed the Web-Based Information System to control cost and to ensure transparency. On the Ministry of Health website, there is the availability of hospital bills for the treatment of common illness and prices of different classes of wards. A patient can also check for the costs of specific surgeries, tests, drugs etc (Elias, Martin, Robin, and Dana, 2016).

Yoshiura *et al.*, (2017) reported that Web-based Information System for psychiatric admissions and discharges was developed and implemented in Brazil. The system overcame the fragmentation of medical records in healthcare systems and addressed service-specific needs enabling detailed patients' information sharing, active coordination of psychiatric admissions and discharges processes, real-time monitoring and the generation of patients' status reports. Fraser *et al.*, (2012) carried out a study on tuberculosis epidemiology in Peru which made use of a Web-Based Information System to manage data from a target goal of 16,000 subjects. The findings of the study revealed that Web-based Information System is an effective and efficient tool in clinical care as well as research.

2.7 Nigeria Experience towards Implementation of Health Information System

According to the report of the Federal Ministry of Health (2016), Nigeria has equally advanced in her use of Information and Communication Technology (ICT) for citizen services. However, the health benefits of these applications have not been realized due to the uncoordinated Health-ICT environment resulting in duplication and waste of resources and in some cases adverse health outcomes. It is important to note that the District Health Information Software Version 2 (**DHIS2: dhis2nigeria.org.ng**) is the most recognized service and application used for national health information reporting in Nigeria; no other Health ICT applications have achieved such scale in Nigeria. However, case studies exist in selected states such as Kano for the management of human resources and routine immunization planning and coverage, electronic stock management in Sokoto and Lagos states, for tracking antenatal care attendance, patient appointments and managing HIV patient data in Abuja (FGN and United Nations Foundation, 2015). Nevertheless, in a study conducted in Nigeria by Obotu, Uganneya and Ogezi (2018) revealed that implementation of clinical information systems in general and electronic health records, in particular, has had limited success; attributes poor system usability, deficiency in important functionalities, low levels of interoperability, low levels of customizability, and high levels of system vulnerability with regard to security and privacy as factors contributing to the low level of success recorded in clinical information system. Thus, the need to find ways to strengthen overall health systems becomes vital. According to Omole (2015), the use and knowledge of Health Information System in Nigerian hospitals are still below what it should be. As technology seems to be advancing each day, information

generation within the health sector does not progress. In addition, no doubt, the absence of the implementation of HIS in most African countries particularly in Nigeria has deteriorated affecting some vital and crucial aspects of patients' safety as well as the quality of healthcare delivery.

2.8 Security issues in Web-based System design

While the adoption of Electronic Health Record (EHR) systems promise a number of substantial benefits, including better care and decreased healthcare costs, serious unintended consequences from the implementation of these systems have emerged. Poor EHR system design and improper use can cause EHR-related errors that jeopardize the integrity of the information in the EHR which could eventually lead to errors dangerous to patients' safety or decreased care quality. Besides, such unintended consequences may likely lead to increased fraud and abuse which attract serious legal implications (Bowman, 2013).

Security is considered a core aspect in designing a web-based system. Naveed and Adam (2012), stressed that in designing secure systems that people can actually use, the designers should take into account security measures in the early stages of software development in order to get an optimized, usable and secure design. It's not the product or service that a user interacts with first but the design of the web site. If the user finds the design of the web site user friendly, he or she stays on the web site or otherwise leaves immediately.

Wekesa (2014) Meanwhile, it is worthy to mention that the success of any designed Web-based application system largely depends on the effectiveness of security measures inherent with it i.e. system security effectiveness indicates the success of the design and the overall quality of the software application.

2.9 Challenges of Web-based System Implementation

The roles of Web technologies towards achieving good health care quality cannot be overemphasized, however, due to various reasons, current Information Systems in various healthcare facilities are not so efficient. One of these reasons is that existing information systems do not support the seamless flow of information with regards to treatment processes. Due to interoperability issues, healthcare practitioners cannot easily exchange

patient information from one healthcare practitioner to another (Hanife, 2015). The use of Electronic Patient Record/Health Information System (HIS) is increasing worldwide due to development and availability of electronic technologies. Similarly, the awareness of the perceived importance of Health Information System and its role in improving quality of health services also led to the widespread usage of HIS. Nonetheless, one of the main challenges of employing electronic information in healthcare systems is the concern about privacy and security of patient medical records (Aldajani, 2012).

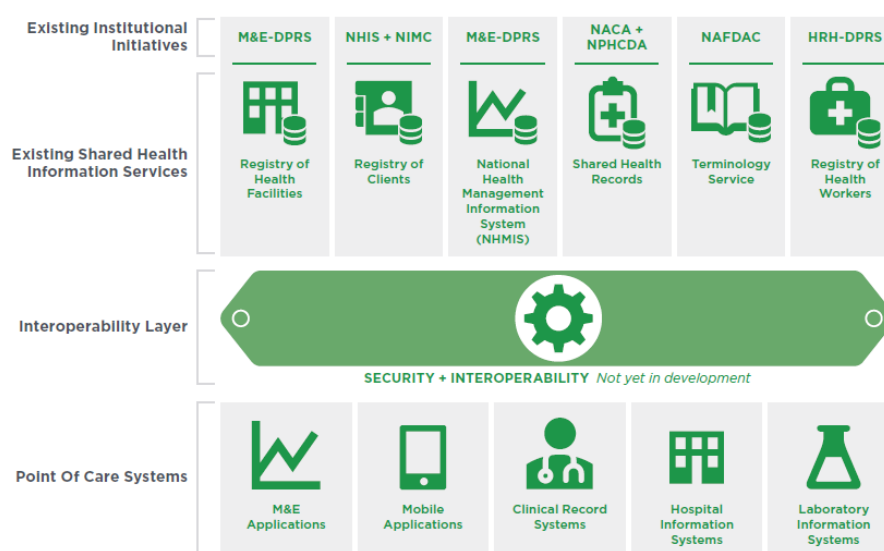
American Hospital Association (2015) reported that, as the adoption of Electronic Health Records continues, the ability of these technologies to support sharing of information across different healthcare facilities still remains limited. In addition, there are increased cases of Information System (IS) attack and stealing of personal information. Hence, maintaining a balance between sharing information and keeping it secured remains a global challenge. In addition, Mugo and Nzuki (2014) revealed that privacy, confidentiality and security concerns have not been much addressed in previous studies and these concerns affect implementation of e-Health systems amongst developing countries, however, acknowledged that these issues are not limited to developing countries alone.

Having recognized the importance of standards and interoperability in its health sector, the Federal Government of Nigeria has mandated their use in several policies including the National Health Policy, e-Health Policy, Strengthening Secondary Health Care Service Delivery Policy, among others. However, these mentioned policies have other challenges such as lack of national guidelines and requirements for privacy, security, and auditing of Health Information Systems (FGN and United Nations Foundation, 2014). In a comparative view, Amina *et al.*, (2014) identified the absence of a robust centralized coordinated framework for sharing patient medical records as one of the key challenges affecting sharing medical data among the healthcare providers in Nigeria.

The more recent report indicated that the Government of Nigeria has begun to prepare and introduce the necessary building blocks to facilitate digitization of its health system. The Federal Ministry of Health (FMOH) and the Federal Ministry of Communication Technology (FMCT) have collaboratively led an inclusive effort to set-up strategic framework for Health ICT as well as a guiding Architecture, Health Information Exchange

(HIE) and supportive policies, plans and budgets to improve health and well-being for all citizen through technological advancements and innovation (FGN, 2016). However, Interoperability and security layer as identified in the National Health ICT Architecture has not been developed yet.

Figure 2.1: A National Health Information System Architecture



Adapted from FGN (2016)

It is important to note that poor system design can cause improper use that jeopardizes the integrity of the information in the system leading to security concern issues with respect to the safety and privacy of patients' records. Such defects can greatly affect the quality of the healthcare services rendered. HealthIT.gov (2015) reported that the promise of digital health information to achieve better health for all, healthcare providers and individuals alike must accept that an individual's health information is private and must be secured. If patients lack trust in the Health Information System feeling that the confidentiality and accuracy of their electronic health information are at risk, they may not want to disclose such information to the medical practitioner and withholding it could have life-threatening consequences to the patients.

2.10 Software Testing

Johan (2013), defined software testing as the process of validating and verifying that a computer software meets the requirements that guide its design and development, ensure that it works as expected and can be implemented with the same characteristics to satisfy

the needs of stakeholders. Shivkumar (2012), opined that software testing provides a means to reduce errors, cut maintenance and overall software costs. In addition, Mohd & Farmeena (2012) opined that software testing can provide an independent view of the software to allow the business to appreciate and understand the risk of software implementation. Hence, the testing of software is an important means of accessing its quality.

System testing has been classified into several categories, however, software perspectives are grouped into three; Unit testing, Integration testing, and System testing. According to Johan (2013), Unit testing which is the testing of a single unit of source code, tests a small function of the source code for example, individual units of code, function/class level etc. Besides, Shivkumar (2012), further contended that integration testing involves building a system from its parts and testing it for issues that can emerge from component interactions. Moreover, it also serves to technically check legitimate interfacing amongst modules, and within sub-modules. According to Jeff and Paul (2015), system testing is targeted towards eliminating faults as early as possible, improve quality, reduce cost and preserve customer satisfaction. Mohd & Farmeena (2012) commenting on the main techniques for software testing in which Black box testing is based on external exceptions, no proved edge of internal working and performed by end users and also by tester and developers (user acceptance testing), whereas White box: full knowledge of internal working , it is performed by developers and testers.

2.11 Phases in Evaluating Health Information System (HIS)

Previous studies indicated that evaluating Health Information System during implementation phase is difficult but may be necessary because of its complex nature. Bossen, Jensen, and Udsen (2013) reported that evaluation is a recommended part of the development and implementation of Information System/Electronic Health Record (EHR) in order to ensure that system functionality fits with work processes and decisions regarding future design and development.

Kuipers (2016), reported that phases involved in the evaluation of HIS are pre-implementation, during implementation and post-implementation however, the overall aim of these stages is usually different: A Pre-implementation Criterion- is concerned with the need, feasibility and expectations of users on the system qualities to be implemented,

During-implementation Criterion- it provides feedback on the implementation process and first experiences using the system, and Post-implementation Criterion- is usually concerned with the final outcomes or impact of the intervention (summative).

Similarly, George (2014) disclosed that, in designing a Health Information System, there is the need to integrate the three sets of Evaluation Criteria which should be used in a phased manner. Pre-implementation Evaluation Criteria should be used to evaluate the system's viability before more resources are committed to it. Concurrent (Operational) - Implementation Evaluation Criteria should be used to monitor the process, and Post-implementation Evaluation Criteria should be applied to assess the system's effectiveness.

2.12 Gaps Identified in the Literature

In spite the numerous advantages offered by the Web-based Health Management Information System towards efficient records keeping and its accessibility, existing literature proved that few research studies were conducted that attempted to address secure web-based platforms for effective management of patients records in the various healthcare institutions in Nigeria. Most of the studies such as those of Ogbobe (2011) amongst others were focused on computerized record storage only. However, Sule (2013) conducted a study on Management of Medical Records in Primary Health Care Centres in Zamfara State. Findings of the research revealed that as a result of the manual mode of operation being used (paper based record keeping system) many patients' records were damaged or lost. Similarly, few research studies at technology level that addressed security and privacy of Web-based platforms for proper management of patient records (accessibility) in Nigeria were found. Thus, a content gap was identified which this study aimed to fill. It was also noted that, no study conducted on Web-Based Medical Records Management System that supports the attainment of a Universal Health Coverage in any state of Nigeria was found hence creating a contextual gap as well which this study tried to fill.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This Chapter describes the research methodology that was used to identify the problems, and gather requirements towards system design and development so as to achieve the stated objectives. It, therefore, includes the approaches, method of data collection, design tools, data analysis, system modeling and ethical considerations.

3.1 Research Methodology

Research methodology refers to systematic and scientific steps taken in resolving an identified researchable problem. In it we study the various steps that are generally adopted by a researcher in studying his research problem along with the logic behind them. Aklilu (2012) such question are usually answered when we talk of research methodology concerning a research problem or study are why a research study has been undertaken, how the research problem has been defined, what data have been collected and what particular method has been adopted, why particular technique of analyzing data has been used and a host of similar other questions.

3.2 Research Approach

Bossen, Jensen, and Udsen (2013) noted that evaluating Health Information System during implementation phase is difficult but may be necessary because of their complex nature; therefore, mixed methods approaches are recommended. Thus, in mixed research methods, investigators use both quantitative and qualitative data because they work to provide the best understanding of a research problem (Creswell, 2015). Therefore, this study adopted mixed-mode approaches involving qualitative and quantitative methods.

3.3 Research Design

The Design Science Research is fundamentally a problem-solving paradigm and not only endeavors to understand how the world is, but also how to improve it. According to Vaishnavi (2017) Design Science Research is primarily research using design as a research method or technique. It can be in many disciplines and fields such as the fields of education, healthcare, computer science, and engineering

3.3.1 The main activities in design science research comprise of

- i. **Problem investigation:** - the objectives of this stage were to identify the existences of problems, describe the problem and possibly identify the predicted consequences if identified problems not been address.
- ii. **Requirements definition:-** detail software descriptions which can serve as a tool for a design or implementation. It set out what a system should do and define constraints on its operation and implementation.
- iii. **Development:-** this stage concern about development tools and methodology, the creation of software system, testing the system and maintenance
- iv. **Demonstration and Evaluation.** Has to do with system evaluation for its fitness to adapt and survive within an environment. **Demonstration** to the user on the use of the software developed to solve one or more instances of the problem. While **Evaluation** has to do with observation and measuring how well the prototype supports the solution to the identified problem.

As this study involved requirements gathering, modeling, and developing a working prototype. Also, due to the academic nature of the project (*Web-based Medical Record Management System for Nigeria*) where the goal was to produce a working prototype according to the stated research objectives. Hence, this study employed design science research combine with Prototype technique. The methodology was chosen because it makes system development easy and faster, quick user feedback is available that prompt to better solutions and missing functionalities can be identified easily. Likewise, changes during the development process are easier, and it is also suitable for developing web-based systems.

Therefore, the selection of Design Science Research combines with prototype technique could be justifiable in order to provide an appropriate basis to conduct the overall research process with logical coherence.

3.4 Tool Selected for the Design

The tools chosen for the design are Windows, Apache, MySQL, and PHP (WAMP Server 3.0.6). Paul (2014) contended that MySQL database management system is popular for

many reasons; it's fast and easy to set up, use and administer. Besides, it runs on many operating system platforms such as Windows and UNIX. Also, MySQL based programs can be written in many languages.

Romil (2014) reported that, in 1994, Rasmus Lerdorf invented PHP; a server-side scripting language designed for web development but also used as a general-purpose programming language. The reference implementation of PHP is now produced by The PHP Group while PHP originally stood for Personal Home Page, it now stands for PHP: Hypertext Preprocessor, a recursive acronym. Furthermore, PHP is the most prevalent general-purpose scripting language that is particularly suited to web development. Fast, flexible and pragmatic, PHP powers everything from blog to the most popular websites in the world. Sites like Facebook, Yahoo, Wikipedia and numerous others use it.

3.5 Research Population and Sampling

The target population of this research was sixty-eight (68) participants comprising of eleven (11) physicians, three (3) medical records personnel, five (5) ICT staff and forty-nine (49) patients who report to the Out Patient Department (OPD) on the routine medical checkup. Due to the small size of the population, all the respondents were considered.

Table 3.1: Population and Sample Size

Participants	Population and Sample size
Physicians	11
Medical Records Personnel	03
ICT Staff	05
Patients	49
Total	68

3.6 Research Instrument

A close-ended questionnaire using Likert's four rating scale thus; 1= Strong Disagree, 2= Disagree, 3=Agree, and 4=Strongly Agree was used for quantitative data collection which was distributed among the respondents. The questionnaire was divided into Parts I, II, III and IV. With the first part composed of questions about the Demographic

Characteristics of the respondents having (3) number of questions, the second part evaluates users on security requirements (4) number of questions, privacy requirement having (6) number of questions, and user satisfaction having (5) number of questions.

The research instrument for qualitative data focused on the face –to- face interview conducted with the staff of Special Hospital Sokoto to access the procedure for filling, storage and securing, and retrieval of Patient's medical data. The interview was guided by a set of structured questions and was conducted in English while the responses were recorded in writing. The interview lasted for two hours fifteen minutes for questioning, responses, and further clarification. Due to the nature of this research pertaining to the management of medical records, the Heads of Record Unit and Computer participated in this study; their selection was because of management position held in this organization. It's important to note that Specialist Hospital Sokoto (SHS) is amongst the healthcare providers serving the State Pilgrims Agency. Therefore staff and patients of the SHS were considered to participate for the survey.

3.7 Method of Data Collection

For the purpose of problem identification, interview was conducted with Heads of the Units from the selected departments of the SHS on the management of patients' medical records in the hospital. This was done in order to study and clearly understand the challenges of the current record keeping system, so as to offer solutions to the organization.

3.8 Validity

Experts were used to test the content validity of the research instrument; the questionnaire was given to the Supervisor and one member of the academic staff in the same department to judge the relevance of each question in the questionnaire. Their comments and suggestions led to the adjustment of the items in the instrument thereby ensuring its content validity. The result obtained from the content validity index is 0.86 since CVI > 0.70 this indicates the instrument has been judged valid.

3.9 Reliability

SPSS (Version 16.0) was used in obtaining Chronbach's Alpha Reliability Coefficients to determine the consistency of the instrument. The reliability test on each construct yielded

the following results as indicated in **Table 3.2**. It was found that the value of α on each construct was greater than **0.70** thus demonstrated that the instrument was reliable and accepted for the research.

Table 3.2: Reliability of the Instrument

Security Requirement	
Cronbach's Alpha	N of Items
.723	4
Privacy Requirement	
Cronbach's Alpha	N of Items
.785	6
User Satisfaction	
Cronbach's Alpha	N of Items
.720	5

3.10 Data Analysis

The thematic analysis employed in analyzing qualitative data which was done manually, through note taking, analysis and drawing a conclusion from the coded data in line with a formulated research question (1), while descriptive statistics was used for analysis of quantitative data collected using SPSS (Version 16.0).

3.11 Interpretation of the Responses

The results from the respondents were summarized from the Frequency Tables (see Table 5.4, Table 5.5, Table 5.6, and Table 5.7) and grouped into two categories, thus:

- Agree (A) & Strongly Agree (SA) = Positive Response
- Strongly Disagree(SD) & Disagree(D) = Negative Response

3.12 System Modelling

Use Case Modeling approach was used in modeling the system, the selected modeling approach was used to translate the requirements needed then the expected system functionalities were predicted. It also guided the coding of the developed system. Howard

(2015) commented that modeling approach is needed when designing a database system so that interested parties can check that the design will satisfy the requirements.

3.13 Ethical Considerations

An Introduction letter from the College of Higher Degrees and Research of Kampala International University introduced the researcher to the organization. All respondents were informed of the subject matter and nature of the research and were given the choice to either participate or otherwise. Data collected was treated with utmost confidentiality and respondent's comments were reported anonymously.

CHAPTER FOUR

REQUIREMENTS GATHERING, ANALYSIS, SYSTEM DESIGN & IMPLEMENTATION, TESTING AND EVALUATION

4.0 Introduction

In this Chapter, system investigation findings from the interviews conducted on the management of patients' medical records in Sokoto State, Nigeria were presented. It examined the need for Web-Based Medical Records Management System, requirements for the design of the proposed system, as well as expected benefits that will be derived from implementing the system, were discussed. Moreover, it presents the implementation of Web-Based Medical Record Management System together with the testings' in which the Unit, Integration, and System were carried out. Also, the discoveries from demonstration show conducted with the hospital staff and patients based on the implementation evaluation of the proposed Web-based platform were presented.

4.1 Presentation of Findings

Interviews were conducted with the Heads of Computer and Record Units which had to do with the evaluation of the system during the Pre-implementation Stage. Wilson and George (2014) disclosed that in designing a Health Information System, there is the need to have built-in these three sets of Evaluation Criteria which should be used in a phased manner. Pre-implementation Evaluation Criteria should be used to evaluate the system's viability before more resources are committed to it. Concurrent (Operational) - Implementation Evaluation Criteria should be used to monitor the process, and Post-implementation Evaluation Criteria should be applied to assess the system's effectiveness.

STAGE 1: THE PROBLEM INVESTIGATION STAGE:

4.1.1 Interview Findings

Based on the findings made, the whole process of patients' medical records is manually done.

The whole medical record registration, storage, and retrieval process are done manually using paper-based record keeping system (Interviewee 1).

The whole process with regards to the management of patients' medical records is purely done on paper-based concerning registration, recording, storing and retrieval (Interviewee 2).

The findings also revealed that security and privacy of patients' medical records are necessary for the healthcare operations. Therefore, if it does not properly manage the quality of care and safety of patients can be compromised.

Yes, security of patients' medical records is necessary with regards to this organization's operations. Actually, the record office couldn't implement the proposed ICT in the management of medical records because of issues of security and privacy were not addressed by the system designers (Interviewee 1).

However, the hospital couldn't transform to digitalized medical centre due to concern on security and privacy of patients (Interviewee 2).

On challenges that an organization can face with regards to the Paper-based Recording Keeping System, the respondents' commented thus:

"I can just say that Paper-based Record Keeping System is cheaper and the process is simplified, but challenges associated with it outweigh its benefits when compared with the Web-based Information System. In an example, issue of misplacement of patient's records resulting from putting the folder in wrong code is extremely challenging and its retrieval takes a lot of time. In such circumstances, security of the stored folders cannot be guaranteed. Besides, there are also issues with regards to patient's privacy which do arise as a result of the manual mode of transmitting patients' medical records" (Interviewee 1).

Although the Paper-based record keeping system seems to be more advantageous because it is easy to fill in the needed information, it can only be so in a situation dealing with few numbers of people. Hence, it is not easy to manage a large number of individual records using the Paper-based Record Keeping System (Manual Record Keeping System). Also, there are issues with regards to storage, backup, security, and privacy of patients' medical folders (Interviewee 2).

The most pressing challenges identified with paper-based record keeping system are:-

With regards to the Paper-based record keeping system, the most serious problem is the time taken in locating misplaced folders of patients' records. In addition to the issue regarding patients' security and privacy, the result of the manual mode of transmission process from record office to the physicians can be tampered with. Also, there is serious challenge and difficulty in accessing and sharing the medical history of a patient among different healthcare providers (Interview 1).

On problems with regards to security and privacy of medical records, the issue of concern is that once patient's folder is lost, there can be no guarantee for its backup. Similarly, Sharing of records among different healthcare providers becomes an issue of concern considering the manual mode of transmitting patients' folders (Interviewee 2).

The respondents also revealed the following benefits that could be achieved by successful implementation of the Web-based Platforms in the management of patients medical records towards the realization of UHC in Nigeria

There is a lot to be gained with successful implementation of Web-based Application Systems as it benefits sharing of health records as well as security and privacy of patients. It is also efficient, saves time and effort, reduces patients' waiting time and brings overall satisfaction to the patients as well which will restore their confidence in Nigeria Health Sector (Interviewee 1).

Benefits inherent with the Web-based Platforms include ease of sharing patients' records across different healthcare providers this is the most important reason behinds UHC, better quality of data reporting which improves the quality of service delivery and supports data storage and backup that guarantee the security of medical records in hospitals. Also, timely availability of patients' records reduces patient waiting time. I also perceive that the introduction of the Web-based medical record management system will increase the overall satisfaction of the citizens, restore their confidence and make universal health coverage a realistic healthcare project in Nigeria (Interviewee 2).

As regards to the Universal Health Coverage (UHC), the respondents revealed that

If this new technological innovation is to be incorporated into the management of medical records amongst the healthcare centres, it will confer a better quality of output regarding service delivery and of course support the attainment of Universal Health Coverage

across the country. This would improve the economy by bringing to an end to medical tourism. I 'am in support of the idea 100% (Interviewee 2).

Moreover, the two interviewees welcomed the idea of incorporating the Web-based platforms into the management of patients' medical records.

Integrating information technology in managing patients' medical records is a welcome development considering the country is the most populous black nation. I believe it will improve the quality of service delivery (Interviewee 1).

If this new technological innovation is to be integrated into the management of medical records amongst the healthcare centres, it will confer a better quality of output regarding service delivery. I 'am in support of the idea 100% (Interviewee 2).

4.2 Requirements Gathering & Analysis of the Current Medical Records Keeping System

4.2.1 Patients Medical Registration

According to the respondent information, after a patient reported to the OPD, the register will be open to that patient and the visiting card will be given to the patient. In summary, the whole medical record registration, storage, and retrieval process are done manually. In summary, the whole process of patient's medical registration, storage, and retrieval are done manually using Paper-Based Record Keeping System.

4.2.2 Current Record Keeping System in the State

The findings revealed that the entire process of patient medical records in the hospital under investigation is purely manual with regards to recording, storing and retrieval of their records.

4.2.3 Knowledge about Web-Based Information System

Findings from the field study showed that all the respondents' interviewed had an idea on the Web-Based System. Furthermore, they recommended for the implementation of the Web-Based Medical Records Management System at that healthcare provider.

4.2.4 The Need for Web-Based Medical Records Management System

It was reported that in the Nigerian Healthcare sector, only a few had adopted the use of electronic health record systems. The conventional technique of keeping patient records which includes the utilization of paper and files is the system that is currently being used. This Paper-Based System had been useful but no longer adequate as a result of some possible errors that occur such as the illegibility of some handwritings by the medical practitioners, improper care of patients, poor accessibility rate to patients medical data, as well as wrong diagnosis due to inaccurate diagnostic decision made (Taiwo, Awodele, and Kuyoro, 2016).

Considering a large number of citizens demanding medical attention on a daily basis, the treatment process turns out to be more complex using the Paper-Based System resulting in delays, errors, and inefficiency. In this manner, all respondents recognize the need for integrating Web-based technology into the management of medical records as an appreciated advancement. According to Ahlan and Barroon (2015), Health Information System has the potential to improve healthcare quality, efficiency, and effectiveness. In addition, it provides up-to-date information to healthcare providers and consumers to ensure the minimization of medical errors and reduction of health care costs.

4.2.5 Benefits of Web-Based Medical Records Management System

- Benefits as far as sharing of patient records across different healthcare providers for the realization of UHC in Nigeria.
- Reduction in the cost of treatment.
- Improve healthcare quality by minimizing medical errors.
- Better quality of data reporting which will also improve healthcare quality.
- Timely and up-to-date availability of data for decision-making leading to better service delivery.
- Empowerment of citizens through prompt accessibility to therapeutic data which result in more comforts and greater convenience.
- Data storage and backup that guarantees the security of patients' medical records in case of disasters.
- Increase response time particularly amid emergency cases.

- A web-based information system is a more effective tool in comparison with Paper-based record keeping system.
- Improve access to patient records by both healthcare providers and patients.
- Timely accessibility of patient record that can decrease persistent holding up time.
- Job performance and productivity will increase, which will result in decreased patient waiting time.
- Increase overall patient satisfaction.

4.2.6 Analysis of the existing system

According to the respondent information, after a patient reported to the OPD, the register will be open to that patient and the visiting card will be given to the patient. The medical Doctor examines the patient and documents the diagnosis and treatment provided into the patient medical form and attached all the documents into the patient folder. On any subsequent visits to the hospital, patient presents the card containing details such as ID, Surname, Other Name, and Age to the record office. The record officer collects the card and check on the patient folder base on storage index and present it to the physician on duty.

In summary, the whole process of patient's medical registration, storage, and retrieval are done manually using Paper-Based Record Keeping System.

4.2.7 Problems Identified with the Existing System

Some of the problems identified with the Manual Record Keeping System currently in operation were challenges in sharing patients' records among healthcare providers, difficulty and time-consuming in locating patient's folders when placed in a wrong code, security issue in the case of disaster because once the patient folder is lost there will definitely be no guarantee for any backup. Also, there is the issue regarding privacy of patient considering the mode of transmission of the patients' folders.

This implies that the current Paper-based Record System in operation is no longer effective due to the large population of Nigerian demanding medical attention on a daily basis, as a result, provision of healthcare services becomes complicated.

STAGE 2: REQUIREMENT DEFINITION

4.3 Requirement Analysis for the Web-Based Medical Records Management System

Requirements are categorized into two broad categories namely; Functional and Non-functional requirements. Functional requirement describes the behavior of the system as it is related to the system's functionality, in other words, functional requirement specifies a function or service that a system must be capable of performing from user's point of view. On the other hand, Non-functional requirement specifies the criteria that judge the operation of a system rather than a specific behaviour (Ericksson, 2012).

4.3.1 Functional Requirement

Based on the categories of Users, the Users are the Patient's, Medical Doctor's and Administrator.

4.3.1.1 Patient's Requirements

Patients need to check their medical records from different healthcare providers and print out copies.

4.3.1.2 Doctor's Requirements

For the Doctors, the system should permit access to hospital records previously visited by the patient, create a new medical record and be able to modify the records of the patients they treated. However, Doctors are only allowed to modify records of their own patients.

4.3.1.3 Administrator's Requirements

The administrator is to manage the hospital lists, activate and deactivate user's confirmation status, and perform general system maintenance.

4.3.2 Non-functional Requirement

Non-functional requirement specifies criteria that judge the operation of a system rather than a specific behaviour (Ericksson, 2012). The following are the Non-functional requirements of the system.

4.3.2.1 Security Requirement

There is a need for securing patient health records due to its sensitivity. Security is a necessary part of the Non-functional requirement. Avizienis, Laprie, Randell and

Landwehr (2004) as cited in Elmer (2011) opined that security is a composite of several attributes namely confidentiality, integrity and availability (CIA). These are the primary attributes, whereas secondary attributes such as accountability, authenticity, and non-repudiation refine the primary ones. Fateemeh (2013) contended that electronic patient records' privacy and security is the primary concern that needs to be preserved because of the sensitive nature of the information.

Rozario (2016) described that a way of securing the system by restricting access to the users of the system using authentication and authorization is called Role-Based Access Control. RBAC security model was adopted in this study whereby a Citizen plays the role of a Patient, a Physician plays the role of a Doctor, and every user is assigned different privileges to perform various functions on the Web-Based Medical Records Management System. Also, the staff of the SHS assumes the role of Administrator.

Access management is a fundamental element of cybersecurity since access to resources exposes them to deliberate or accidental misuse. In order to ensure that those resources are protected from exploitation, in most of the organizational settings many systems validate a user's identity with some form of ID management before granting access to certain resources. RBAC is a scheme for describing what a user is authorized to do (Jackson, 2011).

4.3.2.2 Usability Requirement

System documentation manual is essential so as to ease the system operations for the users through the help options integrated into the system menu. For each session logging, the system should provide guidelines on how the user should go about operating the system. This will ease the likely challenges newly users might experience with the developed Web-Based Medical Records Management System.

4.3.2.3 Expansion Requirement

The system should be designed in such a way that it allows for changes, modifications and improvements to cater for future changes in the proposed Web-Based Medical Records Management System.

4.4 Use Case Modelling

The Use Case is a powerful modeling technique that can be used at different stages of system and software development. It's understandable by technical and non-technical people alongside its simplicity, high flexibility and readability have made it a first choice to capture and organize requirements. It can likewise be utilized in the analysis, design and testing processes. Moreover, it can be used as a user guide and even in user training process (Hosseini, 2012).

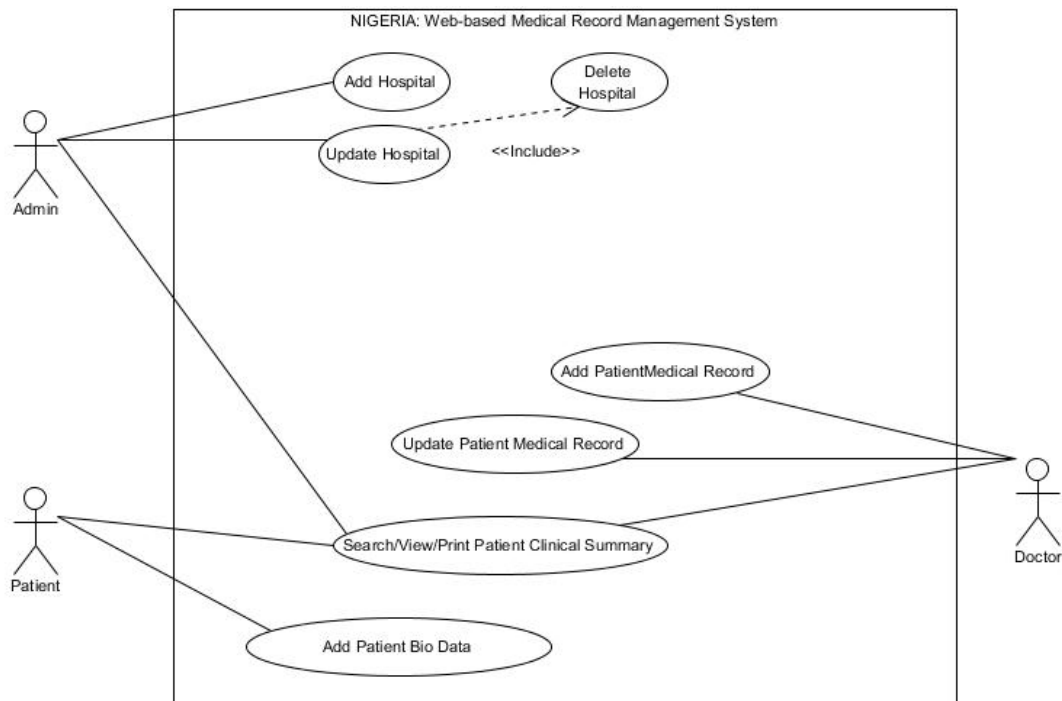


Figure 4.1: Use case diagram

The actors as identified in figure 4.1 are:-

4.4.1 Actor 1: System administrator - Staff of the SHS responsible for securing and maintaining the Web-Based Platforms.

4.4.2 Actor 2: Medical Doctor – Physician working in government or private establishment providing healthcare services to people, checks on patients' Biodata to add new medical records. The Doctor will only update medical records of patients treated by him. In situations whereby a patient visits another physician, medical records previously recorded at different healthcare services in various locations can be viewed.

4.4.3 Actor 3: The patient - is also an actor and can carry out the functionalities of adding demographic information. Besides, can view and print own clinical summary.

After identifying the major actors and their operations in the relation to the proposed Web-based Medical Record Management system; then, system architectural layers were also defined. This is to ensure that the system design, development and its maintenance are in conformance with the requirement definition.

4.5 Architectural Layers of the Web-based Medical Records Management System

Based on the requirements analysis obtained from the interviews conducted with staff of the Specialist Hospital Sokoto, the system architectural layer was defined which comprised of five distinct Layers for various functions. The Layers are namely: Interface Layer, Checking Layer, Operational Layer, Database Layer, and Termination Layer.

4.5.1 The Interface Layer (Physical Layer)

The Physical Layer is at the top of the system architecture and is the minimal layer in terms of the functionalities it performs. The Interface Layer accepts the login details and passes it to the Checking Layer. In an event where the User is new to the System, it provides a login to register the new user with a unique ID identifier and Password. Only registered Users are permitted to log into the System and carry out tasks based on the assigned privileges. Every user must be identified by his/her category so as to be assigned a role/privilege to perform. For an existing user, it is only required to give a remarkable ID and Password to be effectively enrolled with a specific end goal to grant access to the system.

4.5.2 The Checking Layer

At this stage, Authentication of the attempted User login is performed in order to verify that the user is the person he/she claimed to be. In an event whereby the provided ID (Username) and the Password (Secret Code) don't match with any information in the database, the user ID and the Password will be dismissed and redirected back to the Interface Layer in order to supply the correct entries for logging in again. A new user will need to create an account first before he/she can log in. Next, once the ID and the Password match with that of the registered ID and Password in the database, the user will be assigned session and be automatically taken to the User Dashboard.

4.5.3 The Operational Layer

This is where the User performs many tasks (activities) with regards to the Web-based Medical Record Management System. It permits a legitimate User to perform operations based on the assigned role(s). In this, the User sends a request to the Server and the Server responds back. Different categories of users and their roles are identified below:

4.5.3.1 Citizen (Patient):- A patient can add biodata and only active patient should be able to view and print own clinical summary.

4.5.3.2 Physician (Medical Doctor):- A Physician can only update records of patients he/she had treated, add a new patient record into the database. The Doctor can only view patients' medical records from other healthcare providers but cannot modify it.

4.5.3.3 Administrator (Staff of the SHS):- The Administrator is only able to manage Users' accounts, hospital lists, activate and deactivate users' privileges.

4.5.4 Database Layer

It stores users' accounts, citizen demographic information as well as their medical records into the database tables in MySQL Server.

4.5.5 Termination Layer

When an authorized user ends operations and logs out from the system, this layer terminates the session for that particular user. At subsequent logins by the same user, the same process of authentication and authorization will be carried out in order to ensure the security of patient records in the database server.

Ryan (2015) posited that creating and implementing an authorized access model for exchanges of health information across healthcare providers will proactively protect patient data and ensure the continued growth of interconnected health networks.

STAGE 3: DEVELOPMENT

4.6 Development Tool and Technologies used in Implementation of the System

WAMP Server version 3.0.6 an integrated development tool was selected for the implementation of the system.

- Windows (Windows 7 Ultimate Service Pack 1)
- Apache

- MySQL and
- PHP.

At the front end, HTML and CSS are the most important technologies used in implementing the system for developing Web pages, while MySQL was used for implementing the system at the back end for the design of various tables into MySQL (version 5.7.14) of the WAMP Server (version 3.0.6).

4.7 Prototype Implementation and User Interface Snapshot

The implementation of the working prototype system starts with backend followed by the front end. SQL statements for the creation of the tables were provided. Moreover, MySQL Console was used to describe the tables' structures'. At the completion of interface design than PHP scripting language was used for the actual coding of the developed Web-based platform. A samples source code and user interface snapshots were also presented. PHP is amongst the most prevalent scripting languages used for the development of Websites and Web applications in this era of web technologies.

4.7.1 Database Layer Implementation

Although, the Database Layer is the fourth layer based on the proposed system architecture, however, the implementation process will have to start from this layer. This is based on the fact that, for the returning user, the system will need to confirm the existence of his/her record in the database before the user can be authenticated. Therefore, if the record supplied by the user matches the record in the Database, that is a proof that the user is a legitimate user and authentication phase is passed successfully.

At this point, the system creates a session for the user and accord access to the Dashboard in view of the user role. The user can only perform tasks based on the assigned privileges. For example, the Patient can only view his own medical records, the Doctor can only edit own treated patients' records.

After data gathering process, entities, attributes, and their relationships are identified through Entity Relationships Model (ER Model), then back-end implementation starts with designing tables into MySQL WAMP server. **Figures 4.2 – 4.7** represent the Structural Tables Viewed in MySQL Console.

```

c:\wamp64\bin\mysql\mysql5.7.14\bin\mysql.exe
Enter password:
Welcome to the MySQL monitor.  Commands end with ; or \g.
Your MySQL connection id is 2
Server version: 5.7.14 MySQL Community Server (GPL)

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affiliates. Other names may be trademarks of their respective
owners.

Type 'help;' or '\h' for help. Type '\c' to clear the current input statement.

mysql> use mrms_db;
Database changed
mysql> show tables;
+-----+
| Tables_in_mrms_db |
+-----+
| citizens            |
| diagnosis           |
| doctors             |
| hospital_setup      |
| users               |
+-----+
5 rows in set (0.00 sec)

mysql>

```

Figure 4.2: Database Tables View in MySQL of the Web-based Platform

4.7.1.1 Table: Citizens

Stores details about a citizens demographic information which includes Stores details about a citizen's demographic information which include Citizen_id, first_name, second_name, middle_name, sex, dob, reg_date, nationality, phone, address, status, user_id, and nhid into MySQL WAMP server as represented in **Figure 4.3**

```

mysql> desc citizens;
+-----+-----+-----+-----+-----+-----+
| Field          | Type          | Null | Key | Default | Extra          |
+-----+-----+-----+-----+-----+-----+
| citizen_id     | int(10)       | NO   | PRI | NULL    | auto_increment |
| first_name     | varchar(25)   | YES  |     | NULL    |                |
| second_name    | varchar(25)   | YES  |     | NULL    |                |
| middle_name    | varchar(25)   | YES  |     | NULL    |                |
| sex            | varchar(10)   | YES  |     | NULL    |                |
| dob            | date          | YES  |     | NULL    |                |
| reg_date       | date          | YES  |     | NULL    |                |
| nationality     | varchar(25)   | YES  |     | NULL    |                |
| phone          | varchar(15)   | YES  |     | NULL    |                |
| address        | varchar(125)  | YES  |     | NULL    |                |
| status         | int(2)        | YES  |     | NULL    |                |
| user_id        | int(10)       | NO   | MUL | NULL    |                |
| nhid           | varchar(25)   | YES  | UNI | NULL    |                |
+-----+-----+-----+-----+-----+-----+
13 rows in set (0.09 sec)

mysql>

```

Figure 4.3: Structural view of citizens table in MySQL Console

4.7.1.2 Table: Diagnosis

This table stores detailed information about citizens' health status such as diagnosis_id, treatment_date, description, treatment, status, citizen_id, doc_id, attestation, and comment as indicated in **Figure 4.4**.

```
mysql> desc diagnosis;
```

Field	Type	Null	Key	Default	Extra
diagnosis_id	int(10)	NO	PRI	NULL	auto_increment
treatment_date	date	YES		NULL	
description	varchar(225)	YES		NULL	
treatment	varchar(25)	YES		NULL	
status	int(2)	YES		NULL	
citizen_id	int(10)	NO	MUL	NULL	
doc_id	int(10)	NO	MUL	NULL	
attestation	varchar(225)	YES		NULL	
allergy	varchar(125)	YES		NULL	
comment	varchar(225)	YES		NULL	

10 rows in set (0.08 sec)

```
mysql>
```

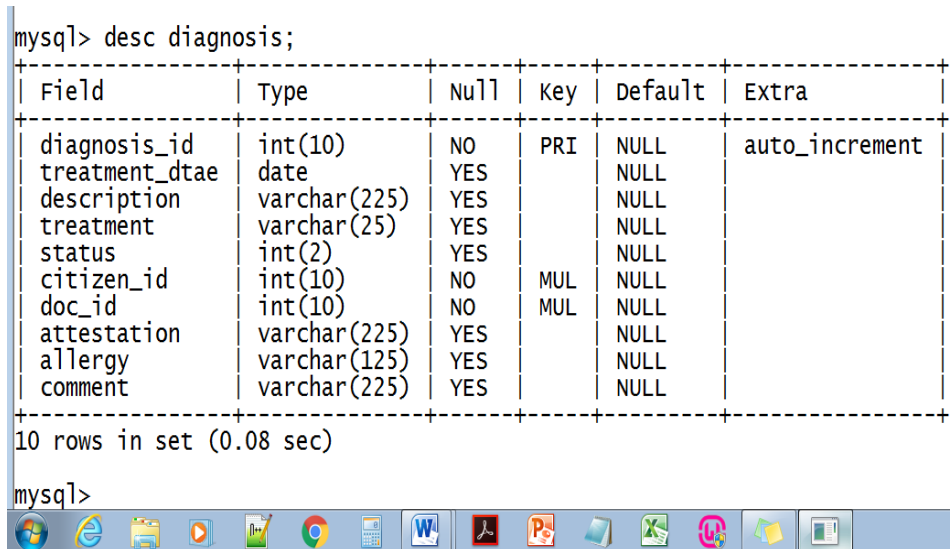


Figure 4.4: Structural view of Diagnosis Table in MySQL Console

4.7.1.3 Table: Doctors

Maintains data about doctors which comprised of doc_id, first_name, second_name, middle_name, sex, dob, phone, reg_date, nationality, address, status, user_id, hospital_id into the server as illustrated in **Figure 4.5**

```
mysql> desc doctors;
```

Field	Type	Null	Key	Default	Extra
doc_id	int(10)	NO	PRI	NULL	auto_increment
first_name	varchar(25)	YES		NULL	
second_name	varchar(25)	YES		NULL	
middle_name	varchar(25)	YES		NULL	
sex	varchar(10)	YES		NULL	
dob	date	YES		NULL	
phone	varchar(25)	NO		NULL	
reg_date	date	YES		NULL	
nationality	varchar(25)	YES		NULL	
address	varchar(125)	YES		NULL	
status	int(2)	YES		NULL	
user_id	int(10)	NO	MUL	NULL	
hospital_id	int(10)	NO	MUL	NULL	

13 rows in set (0.09 sec)

```
mysql>
```

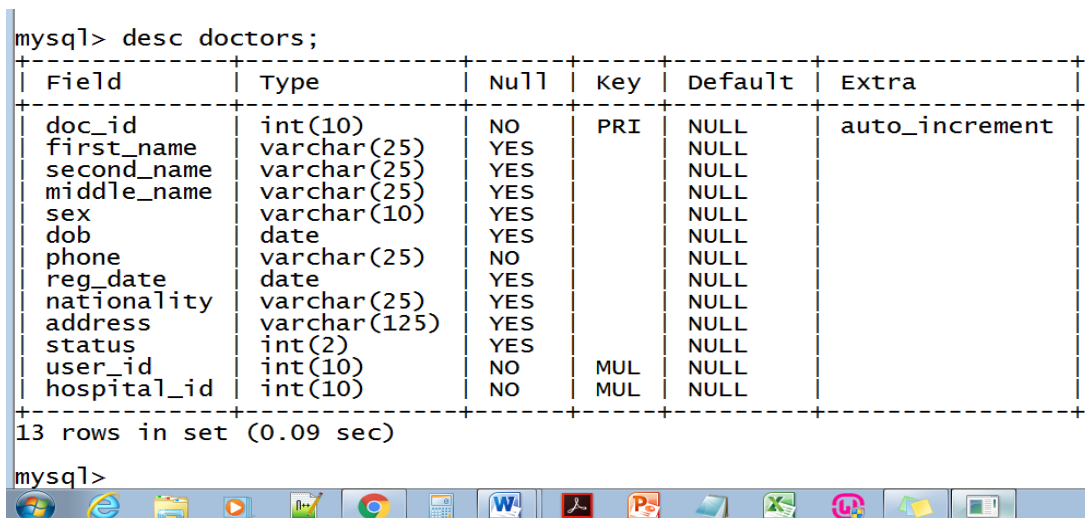


Figure 4.5: Structural view of Doctors Table in MySQL Console

4.7.1.4 Table: Hospital_setup

Holds details about the registered hospitals in the state and the data captured are hospital_id (which is an auto_increment), hosp_name, logo, hospital address, hospital_code, status. These are stored into the MySQL WAMP server.

```
mysql> desc hospital_setup;
```

Field	Type	Null	Key	Default	Extra
hospital_id	int(10)	NO	PRI	NULL	auto_increment
hospital_name	varchar(25)	YES	UNI	NULL	
logo	varchar(225)	YES		NULL	
hospital_address	varchar(125)	YES		NULL	
hospital_code	varchar(25)	YES	UNI	NULL	
status	int(2)	YES		NULL	

6 rows in set (0.06 sec)

```
mysql>
```



Figure 4.6: Structural view of Hospital_setup Table in MySQL Console

4.7.1.5 Table: Users

Stores the User's login details which consist of user_id (auto_increment), username, password, category, and status as indicated in Figure 4.7.

```
mysql> desc users;
```

Field	Type	Null	Key	Default	Extra
user_id	int(10)	NO	PRI	NULL	auto_increment
username	varchar(25)	YES	UNI	NULL	
password	varchar(15)	YES		NULL	
category	varchar(25)	YES		NULL	
status	int(2)	YES		NULL	

5 rows in set (0.09 sec)

```
mysql>
```



Figure 4.7: Structural view of Users Table in MySQL Console

4.7.1.6 SQL Statements for the Tables Creations

--- Database: `mms\_db` ---

-- Table structure for table `citizens`--

```
CREATE TABLE IF NOT EXISTS `citizens` (  
  `citizen_id` int(10) NOT NULL AUTO_INCREMENT,  
  `first_name` varchar(25) DEFAULT NULL,  
  `second_name` varchar(25) DEFAULT NULL,  
  `middle_name` varchar(25) DEFAULT NULL,  
  `sex` varchar(10) DEFAULT NULL,  
  `dob` date DEFAULT NULL,  
  `reg_date` date DEFAULT NULL,  
  `nationality` varchar(25) DEFAULT NULL,  
  `phone` varchar(15) DEFAULT NULL,  
  `address` varchar(125) DEFAULT NULL,  
  `status` int(2) DEFAULT NULL,  
  `user_id` int(10) NOT NULL,  
  `nhid` varchar(25) DEFAULT NULL,  
  PRIMARY KEY (`citizen_id`),  
  UNIQUE KEY `nhid` (`nhid`),  
  KEY `FKcitizens832480` (`user_id`)  
) ENGINE=MyISAM DEFAULT CHARSET=latin1 AUTO_INCREMENT=3 ;
```

-- Table structure for table `diagnosis`--

```
CREATE TABLE IF NOT EXISTS `diagnosis` (  
  
```

```

`diagnosis_id` int(10) NOT NULL AUTO_INCREMENT,

`treatment_dtae` date DEFAULT NULL,

`description` varchar(225) DEFAULT NULL,

`treatment` varchar(25) DEFAULT NULL,

`status` int(2) DEFAULT NULL,

`citizen_id` int(10) NOT NULL,

`doc_id` int(10) NOT NULL,

`attestation` varchar(225) DEFAULT NULL,

`allergy` varchar(125) DEFAULT NULL,

`comment` varchar(225) DEFAULT NULL,

PRIMARY KEY (`diagnosis_id`),

KEY `FKdiagnosis311135` (`citizen_id`),

KEY `FKdiagnosis884125` (`doc_id`)

) ENGINE=MyISAM DEFAULT CHARSET=latin1 AUTO_INCREMENT=2 ;

```

-- Table structure for table `doctors`--

```

CREATE TABLE IF NOT EXISTS `doctors` (

`doc_id` int(10) NOT NULL AUTO_INCREMENT,

`first_name` varchar(25) DEFAULT NULL,

`second_name` varchar(25) DEFAULT NULL,

`middle_name` varchar(25) DEFAULT NULL,

`sex` varchar(10) DEFAULT NULL,

`dob` date DEFAULT NULL,

```

```

`phone` varchar(25) NOT NULL,

`reg_date` date DEFAULT NULL,

`nationality` varchar(25) DEFAULT NULL,

`address` varchar(125) DEFAULT NULL,

`status` int(2) DEFAULT NULL,

`user_id` int(10) NOT NULL,

`hospital_id` int(10) NOT NULL,

PRIMARY KEY (`doc_id`),

KEY `FKdoctors199752` (`user_id`),

KEY `FKdoctors554906` (`hospital_id`)

) ENGINE=MyISAM DEFAULT CHARSET=latin1 AUTO_INCREMENT=3 ;

-- Table structure for table `hospital_setup`--

CREATE TABLE IF NOT EXISTS `hospital_setup` (

`hospital_id` int(10) NOT NULL AUTO_INCREMENT,

`hospital_name` varchar(25) DEFAULT NULL,

`logo` varchar(225) DEFAULT NULL,

`hospital_address` varchar(125) DEFAULT NULL,

`hospital_code` varchar(25) DEFAULT NULL,

`status` int(2) DEFAULT NULL,

PRIMARY KEY (`hospital_id`),

UNIQUE KEY `hospital_name` (`hospital_name`),

UNIQUE KEY `hospital_code` (`hospital_code`)

```

```
) ENGINE=MyISAM DEFAULT CHARSET=latin1 AUTO_INCREMENT=4 ;
```

-- Table structure for table `users`--

```
CREATE TABLE IF NOT EXISTS `users` (
```

```
  `user_id` int(10) NOT NULL AUTO_INCREMENT,
```

```
  `username` varchar(25) DEFAULT NULL,
```

```
  `password` varchar(15) DEFAULT NULL,
```

```
  `category` varchar(25) DEFAULT NULL,
```

```
  `status` int(2) DEFAULT NULL,
```

```
  PRIMARY KEY (`user_id`),
```

```
  UNIQUE KEY `username` (`username`)
```

```
) ENGINE=MyISAM DEFAULT CHARSET=latin1 AUTO_INCREMENT=6 ;
```

4.7.1.7 PHP Code for Connection to the database /connection.php

This is the connection string that connects to the database, all other scripts refer to this connection string in order to connect to the server and manipulate the database. The connection string is separated from other scripts in the PHP files to enhance the system security and performance.

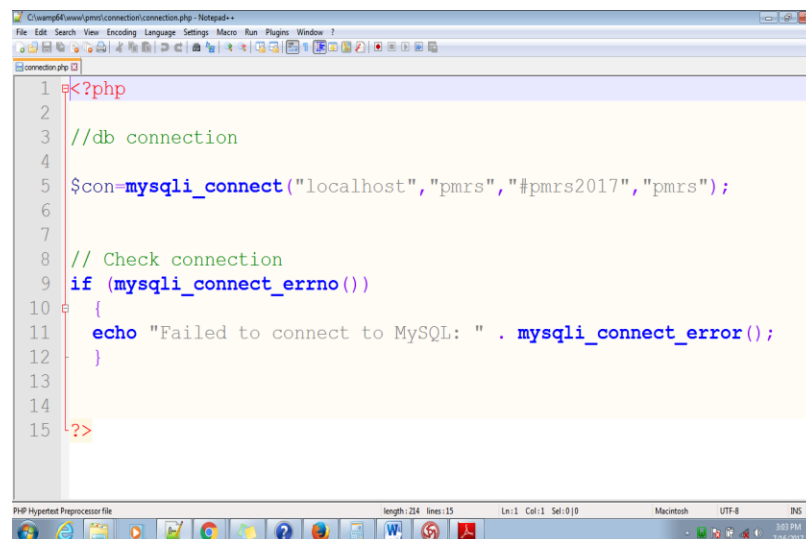


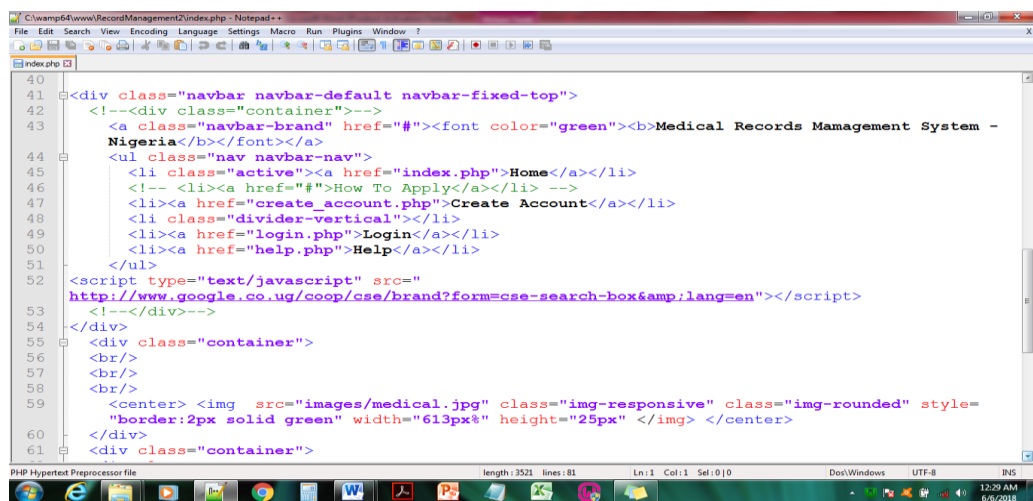
Figure 4.8: Sample Source Code for Connection to the Database

4.7.2 Interface Layer Implementation

The Interface Layer presents to the user the login page. The admin login page is separated from the user login page for security purpose. Any user having the organizational website address can reach this level and on accomplishing this stage, there a need to supply the correct username and password to complete the authentication and authorization processes. If correctly done, the system directs the user to the Dashboard based on the identified role.

4.7.2.1 Web-Based Medical Records Management System Homepage

This code was used to implement Homepage for the Medical Records Management System; **Figure 4.9** shows a sample code for actualizing the homepage.



```
40
41 <div class="navbar navbar-default navbar-fixed-top">
42 <!--<div class="container">-->
43 <a class="navbar-brand" href="#"><font color="green"><b>Medical Records Management System -
44 Nigeria</b></font></a>
45 <ul class="nav navbar-nav">
46 <li class="active"><a href="index.php">Home</a></li>
47 <!-- <li><a href="#">How To Apply</a></li> -->
48 <li><a href="create_account.php">Create Account</a></li>
49 <li class="divider-vertical"></li>
50 <li><a href="login.php">Login</a></li>
51 <li><a href="help.php">Help</a></li>
52 </ul>
53 <script type="text/javascript" src="
54 http://www.google.co.ug/coop/cse/brand?form=cse-search-box&lang=en"></script>
55 <!--</div>-->
56 </div>
57 <div class="container">
58 <br/>
59 <br/>
60 <center>  </center>
62 </div>
63 <div class="container">
```

Figure 4.9: Sample code for Homepage

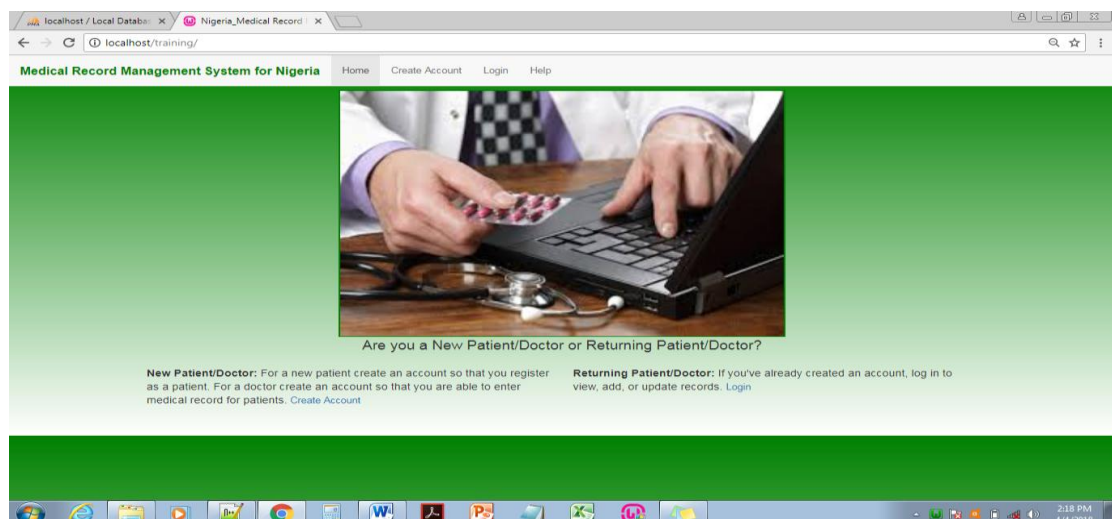
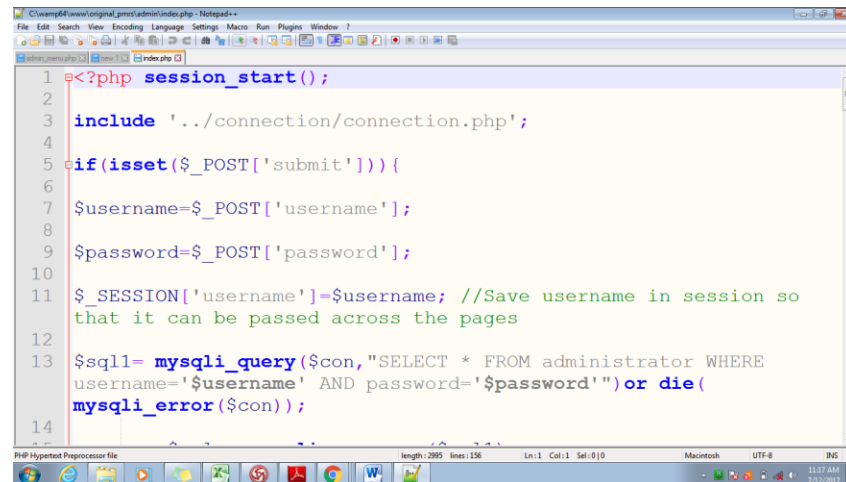


Figure 4.10: Home Page Snapshot

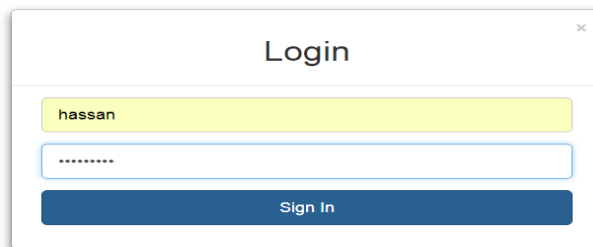
4.7.2.2 Administrator Login Page: admin/index.php

This PHP source code provides a secure login for the system administrator in which the correct username and password secret to the Admin officer must match with the records stored in the database. Administrator login page is separated from those of the patient and the doctor. This code saves username in session so that it can be passed across the pages for the user to perform the assigned roles as authorized by the system. **Figure 4.11** shows a sample code for implementing the administrator login page.



```
1 <?php session_start();
2
3 include '../connection/connection.php';
4
5 if(isset($_POST['submit'])){
6     $username=$_POST['username'];
7     $password=$_POST['password'];
8
9     $_SESSION['username']=$username; //Save username in session so
10    that it can be passed across the pages
11
12    $sql=mysqli_query($con,"SELECT * FROM administrator WHERE
13    username='$username' AND password='$password'") or die(
14    mysqli_error($con));
```

Figure 4.11: Sample code for Administrator Login Page



Login

hassan

Sign In

Figure 4.12: Administrator Login Page Snapshot

4.7.2.3 User Login Page: thesis/index.php

This PHP source code is used to implement a secure login for the Doctor as well as the patient. Whereas, for a new user, either a patient or doctor must create an account and supply all the required information before getting access to the system. Returning user should click on login and type in the correct username and password officially enrolled with the system. **Figure 4.13** shows a sample code for actualizing the Doctor/Patient Login page.

```

1 <?php session_start();
2
3 include 'connection/connection.php';
4
5 if(isset($_POST['submit'])) {
6
7     $username=$_POST['username'];
8     $password=$_POST['password'];
9
10    $_SESSION['username']=$username; //Save username in session so
    that it can be passed across the pages
11
12    $sql1= mysqli_query($con,"SELECT * FROM user WHERE username='
    $username' AND password='$password'") or die(mysqli_error($con));
13
14    $value=mysqli_num_rows($sql1);
15    $category=mysqli_fetch_array($sql1);

```

Figure 4.13: Sample code for User Login Page

Login

[Go to Home](#)

Figure 4.14: User Login Page Snapshot

Once the user supplies data that matches the one stored in the MySQL Server, the system saves the username in session and automatically moves to the Dashboard so as to perform assigned roles based on privileges. In any case, the Doctor Dashboard is separated from the Patient Dashboard keeping in mind the end goal to uphold the system security.

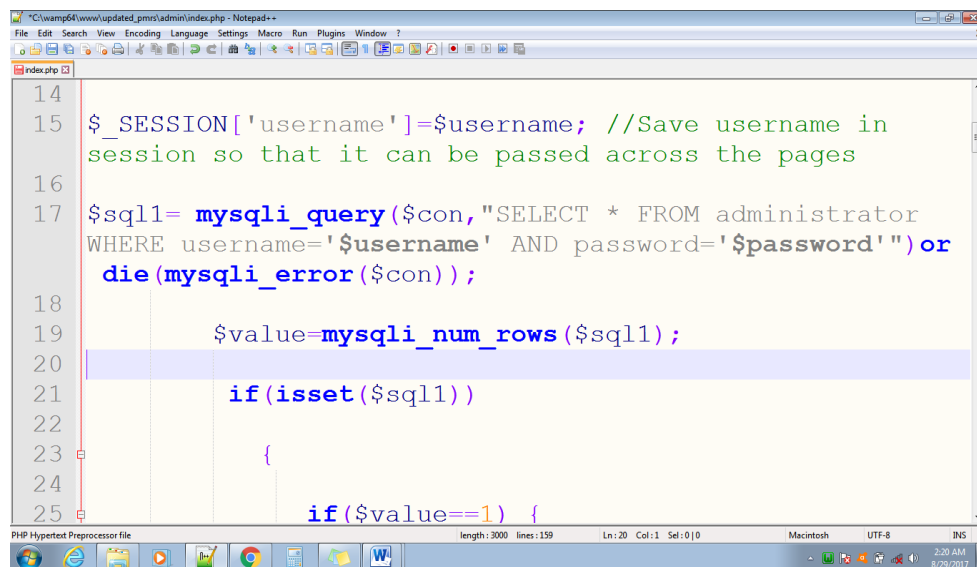
4.7.3 Checking Layer Implementation

In this layer, the system is actualized to check for the Username and Password to ensure that it matches with the stored records in the database server. This is an indication that authentication stage has been passed and takes the User to the Dashboard based on the user role (authorization stage). Once the user successfully signs in at this layer, the system saves the username in session so that it can be passed across the pages for the user to perform assigned tasks/activities based on the role. **Figure 4.15 and 4.16** shows a sample source code for implementing the administrator authentication and authorization process at the level of checking layer respectively.

4.7.3.1 Administrator Authentication: admin/index.php

This PHP code provides a secured login for the System Administrator who must provide the correct Username and Password secret to him/her and must match with the records

stored into the database server. Administrator login page is separated from Patient/Doctor Login page keeping in mind the ultimate objective of maintaining system security.

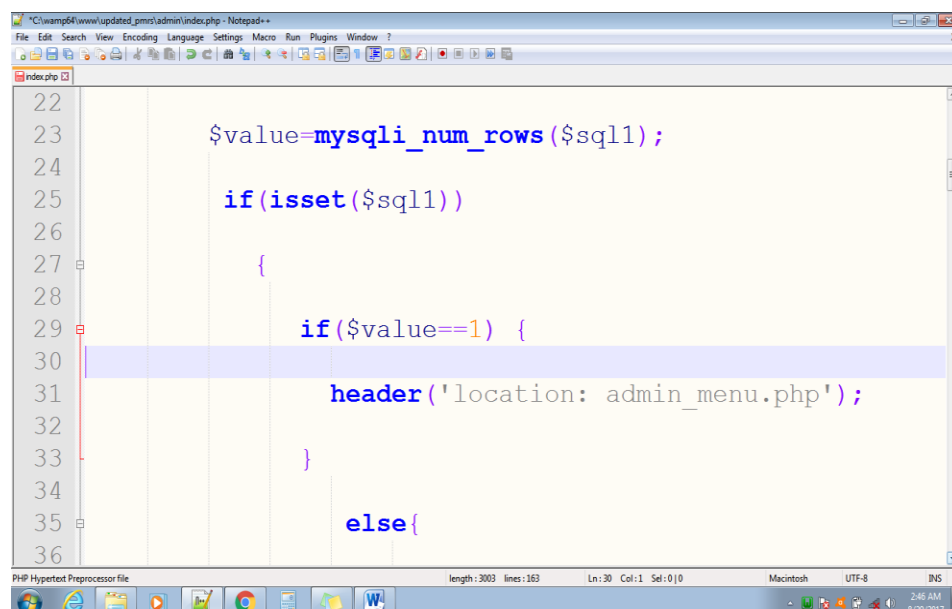


```
14
15 $_SESSION['username']=$username; //Save username in
    session so that it can be passed across the pages
16
17 $sql1= mysqli_query($con,"SELECT * FROM administrator
    WHERE username='$username' AND password='$password'") or
    die(mysqli_error($con));
18
19 $value=mysqli_num_rows($sql1);
20
21 if(isset($sql1))
22
23 {
24
25     if($value==1) {
```

Figure 4.15 Sample Code for Admin Authentication

4.7.3.2 Administrator Authorization: admin/index.php

After the successful process of authentication verifying that administrator is the right person as he/she claims to be, then access is granted to the verified Admin. This is to ensure that the Admin performs control operations that are permitted in the system during web services execution.

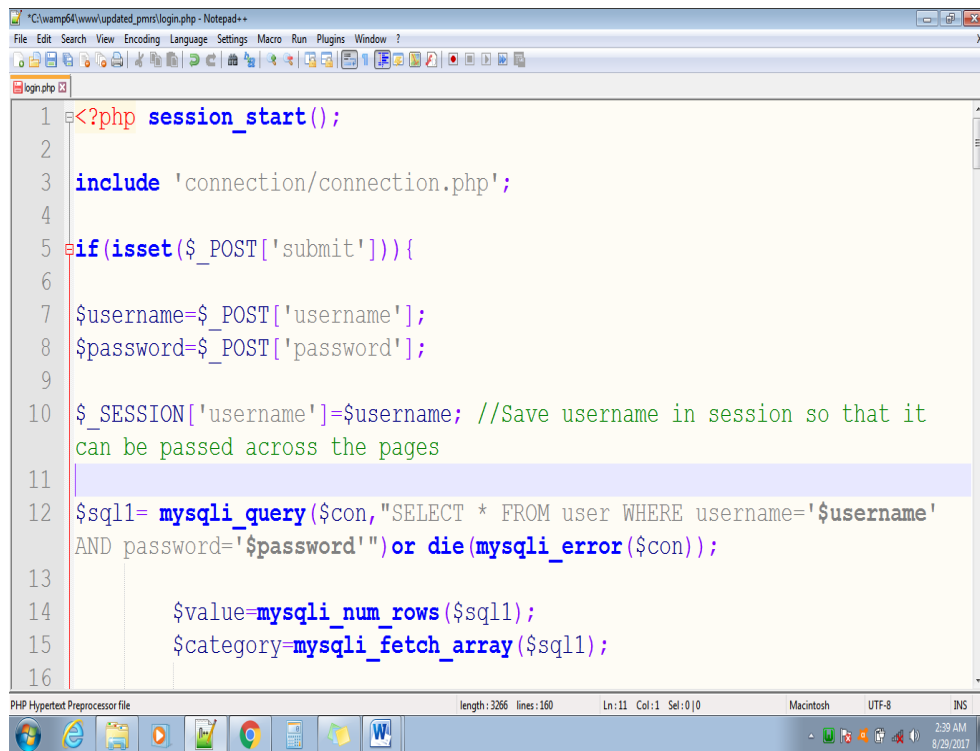


```
22
23 $value=mysqli_num_rows($sql1);
24
25 if(isset($sql1))
26
27 {
28
29     if($value==1) {
30
31         header('location: admin_menu.php');
32
33     }
34
35     else{
36
```

Figure 4.16 Sample Code for Admin Authorisation

4.7.3.3 User Authentication: thesis/login.php

This is the PHP source code that provides a secured login for Doctors and Patients. For a new user, either a Patient or a Doctor, an account must be created and supplied with all the required information before getting access to the system. The returning user should click on login and type in the correct Username and Password already registered in the system. **Figure 4.17** shows a sample code for implementing the authentication of user attempted login while **Figure 4.18** illustrates sample code for the implementation of the authorization process.



```
1 <?php session_start();
2
3 include 'connection/connection.php';
4
5 if(isset($_POST['submit'])){
6
7     $username=$_POST['username'];
8     $password=$_POST['password'];
9
10    $_SESSION['username']=$username; //Save username in session so that it
    can be passed across the pages
11
12    $sql1= mysqli_query($con,"SELECT * FROM user WHERE username='$username'
    AND password='$password'") or die(mysqli_error($con));
13
14    $value=mysqli_num_rows($sql1);
15    $category=mysqli_fetch_array($sql1);
16
```

Figure 4.17: Sample code for user Authentication

4.7.3.4 User Authorisation

After the successful process of authentication that the user is the right person as he/she claimed to be, access is then granted. This is to ensure that the user performs control operations that are permitted in the system during web services execution. For example, a Doctor can view medical records from other hospitals but is not allowed to alter patients' records of another physician. Patients are only permitted to view their own medical records from different healthcare providers they attend but are not allowed to alter any of their medical records data recorded into the web server.

```

13
14 $value=mysqli_num_rows($sql1);
15 $category=mysqli_fetch_array($sql1);
16
17
18 if(isset($sql1))
19 {
20
21     if($value==1 && $category['category']=="Patient") {
22         header('location: menu.php');
23     }
24     else if($value==1 && $category['category']=="Doctor") {
25         header('location: doctor_menu.php');
26     }
27 }
28
29
30

```

Figure 4.18: Sample code for user Authorisation

Once a user supplies data matching with that of the data stored in MySQL Server, the system saves the username in session and automatically opens the Dashboard so as to perform assigned roles.

4.7.4 Operational Layer Implementation

Operational layer enables a legitimate user to perform tasks based on the assigned privileges. After successful login, the system consequently appoints the session to the user and automatically moves to the dashboard.

4.7.4.1 Administrator Dashboard: /admin_menu.php

This source code is used to implement administrator Dashboard for an official of the SHS to manage hospitals lists, user's accounts as well as activate/deactivate the user account.

Figure 4.19 shows sample code for implementing Admin Dashboard.

```

34 Medical Record System</b></font></a>
35 <ul class="nav navbar-nav">
36 <li class="active"><a href="admin_menu.php">Home</a></li>
37 <li><a href="manage_hospital.php">Manage Hospital</a></li>
38 <li><table class="pure-table pure-table-horizontal" width="70%"
39 ><tr><td>
40 <form class="pure-form pure-form-stacked" action="" method="post">
41 <input class="span2" type="text" name="searchitem" size="20"
42 placeholder="Search by NHID"> </td><td>
43 <button type="submit" value="Search" class="pure-button
44 pure-button-primary" name="Submit1">Search</button>
45 </form></td><tr></table></li>
46 <li><a href="logout.php">Log Out</a></li>
47 </ul>

```

Figure 4.19: Sample Code for Implementing Admin Dashboard

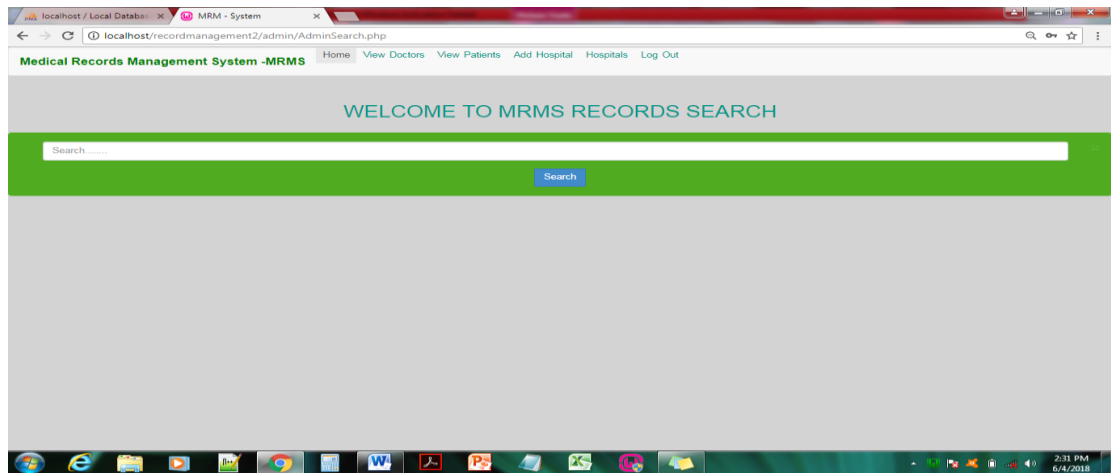


Figure 4.20: Administrator Dashboard Snapshot

4.7.4.2 Set Approval by Administrator: /admin/patient_approval.php

This permits the hospital administrator to set approval for the user to be able to access his/her medical records through the web-based platform.

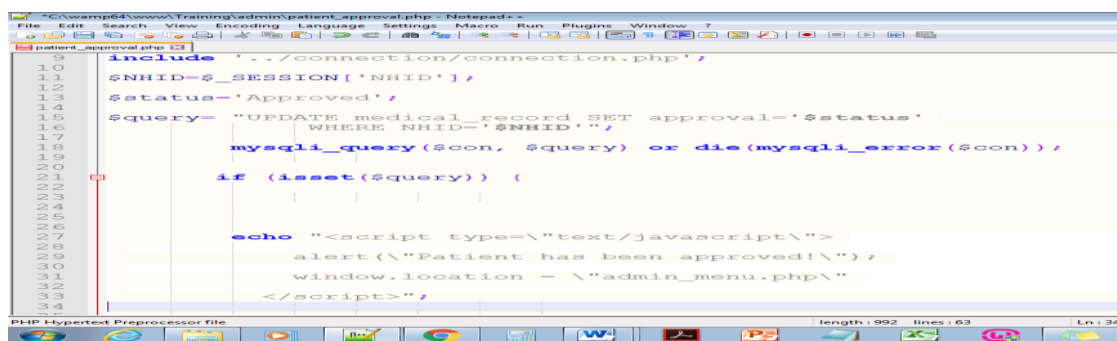


Figure 4.21 Sample code for setting user approval



Figure 4.22: Snapshot for Activation/Deactivation of User account by the Administrator

4.7.4.3 Doctor Dashboard: doctor_menu.php

Figure 4.23 shows HTML sample code for implementing of Doctor's Dashboard. It allows a physician to add a new medical record into MySQL server, search and view patient's records from other hospitals.

```
34 <ul class="nav navbar-nav">
35 <li class="active"><a href="doctor_menu.php">Home</a></li>
36 <li><a href="add_patient_medical_record.php">Add Patient
    Medical Record</a></li>
37 <li><a href="other_patients.php">Patients' Records from
    other Hospitals</a></li>
38 <li><table class="pure-table pure-table-horizontal" width
    ="70%"><tr><td>
39 <form class="pure-form pure-form-stacked" action="" method
    ="post">
40 <input class="span2" type="text" name="searchitem" size=
    "20" placeholder="Search by NHID"> </td><td>
41 <button type="submit" value="Search" class="pure-button
    pure-button-primary" name="Submit1">Search</button>
42 </form></td><tr></table></li>
43 <li><a href="logout.php">Log Out</a></li>
```

Figure 4.23: Sample code for implementing Doctor Dashboard

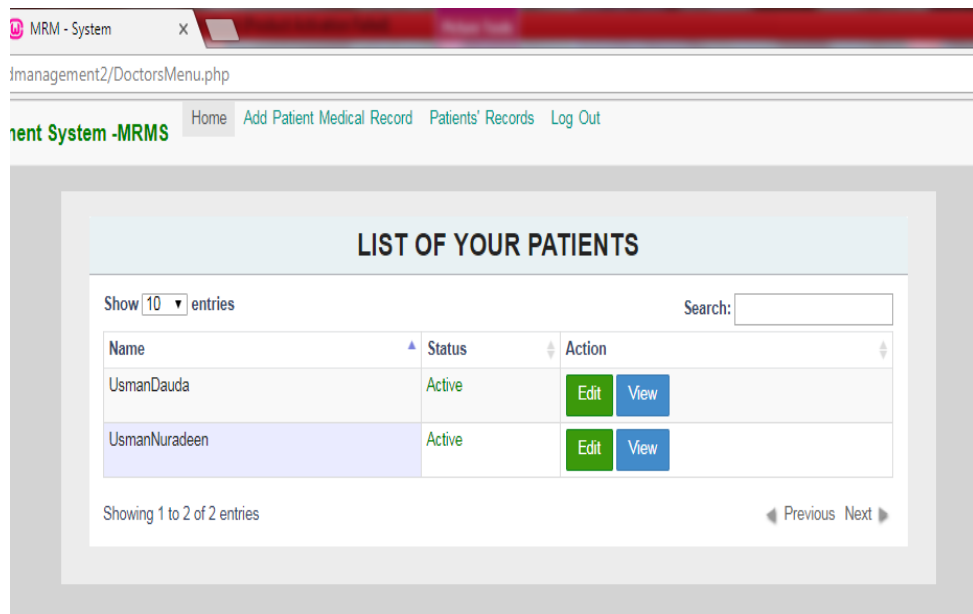


Figure 4.24: Doctor Dashboard Snapshot

4.7.4.4 Encryption of Patient ID

In order to enforce privacy of patient records over the World Wide Web, NHID has been encrypted using **One way function (MD5)** specifically. The implementation of the code as indicated in the **Figure 4.25**.

```

50
51 <?php
52
53 $NHID=$_REQUEST['who'];
54
55
56
57 //echo $var_value;
58 //decrypt id
59
60 $decrypt_query=mysqli_query($con,"SELECT NHID from citizen");
61
62 while($real_NHID = mysqli_fetch_array($decrypt_query)) {
63
64     if(md5($real_NHID['NHID'])== $NHID) {
65
66
67         $NHID=$real_NHID['NHID'];
68
69
70     }
71
72
73
74
75

```

Figure 4.25: Sample Code for Encryption of NHID of a Patient



Figure 4.26: Showing Encrypted patient NHID over the World Wide Web

4.7.4.5 View Patient Medical Record by Doctor

This permit a medical doctor whose status is set to active to view a medical of patient

```

79
80
81
82
83
84
85 <table class="pure-table pure-table-horizontal" width="100%">
86 <tr>
87 <th>NHID:</th><td colspan="4"><font color="red"><?php echo $row['nhid']; ?></font></td>
88 </tr>
89 </tr>
90 <tr>
91 <th bgcolor="#e6ffe6">Patients Name</th>
92 <td><?php echo $name; ?></td>
93 <th bgcolor="#e6ffe6">Given Name</th>
94 <td><?php echo $row['middle_name!']; ?></td>
95 </tr>
96 <tr>
97 <th bgcolor="#e6ffe6">DoB</th>
98 <td><?php echo $row['dob']; ?></td>
99 <th bgcolor="#e6ffe6">Nationality</th>
100 <td><?php echo $row['nationality!']; ?></td>
101 </tr>
102 <tr>
103 <th bgcolor="#e6ffe6">Gender</th>

```

Figure 4.27: Sample code for viewing patient medical record

Generated Patient Clinical Summary (Medical Record) through the developed Web-based Medical Records Management System for Nigeria

MRM-System X

management2/check_medical_records.php?id=a87ff679a2f3e71d9181a67b7542122c&key=1&status=c81e728d9d4c2f636f067f89cc14862c&name=c

Home Print

ment System - MRMS

PATIENT MEDICAL RECORD

NHID:	7/NGN/673		
Patients Name	Usman Dauda	Given Name	Danlami
DoB	1993-02-13	Nationality	Nigeria
Gender	Male	Phone	08033335579

MEDICAL DATA

Allergy	Cold Weather	Diagnosis	Cold and Catarr
---------	--------------	-----------	-----------------

ATTESTATION by Medical Doctor

I Hauwa Usman of Usmanu Danfodio University Teaching Hospital do attest and affirm that information given about Usman Dauda are to the best of my knowledge true and correct in both form and content.

I shall be held liable and responsible for any false declaration on the above information.

Figure 4.28: Medical Record of a Patient

4.7.4.6 Patient Dashboard: /patient_menu.php

This presents a Dashboard for the Patient based on the assigned roles. The Citizen (Patient) can add demographic information and enrolled to any registered hospitals for a

treatment. After that he/she can view their own medical report (clinical summary). **Figure 4.29** shows sample code for implementing of the Patient Dashboard.

```

68 </ul>
69 </div>
70 <div class="col-sm-9">
71 <div class="lead text-center" ><font color="green">Welcome to Medical
Records Management System For Nigeria</font></div>
72 <p>Through this platform you can register yourself and view your
medical record. Below are the steps you must take to register and use
the system:
73 <ol>
74 <li>Click on the Link patient registration</li>
75 <li>Go to a registered hospital and carryout a test</li>
76 <li>View medical record</li>
77 </ol>
78 </p>
79 </div>
80
81 </div>
82

```

Figure 4.29: Sample code for Implementing Patient Dashboard

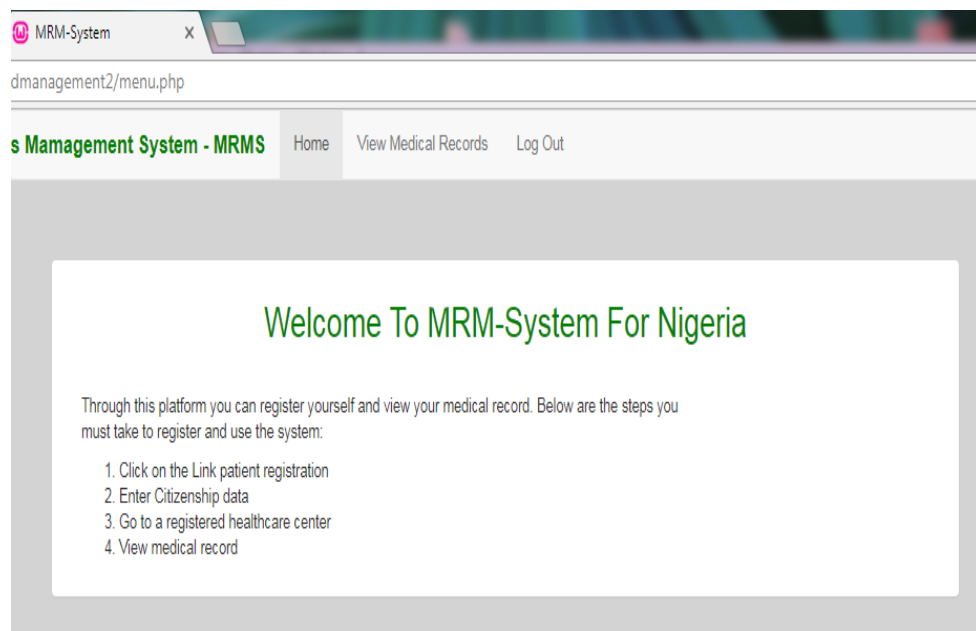


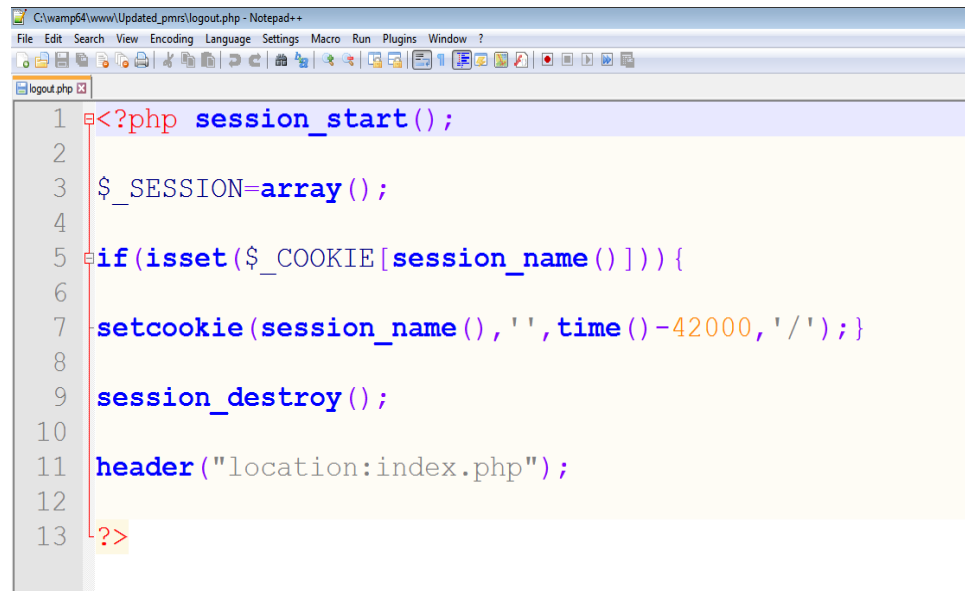
Figure 4.30: Patient Dashboard Snapshot

4.7.5 Implementation of Termination Layer

Once the user is authenticated and the session allocated, he/she can perform tasks based on the assigned privileges.

4.7.5.1 Termination of Session: /logout.php

This PHP source code terminates the session and enables the user to successfully log out of the system. **Figure 4.31** demonstrates the sample code for termination of the Session.



```
1 <?php session_start();
2
3 $_SESSION=array();
4
5 if(isset($_COOKIE[session_name()])){
6
7     setcookie(session_name(), '', time()-42000, '/');
8
9     session_destroy();
10
11     header("location:index.php");
12
13 >
```

Figure 4.31: Sample code for Destroying Session & Logging Out of the System

4.8 Software Testing

Johan (2013) defined software testing as the process of validating and verifying that a computer software meets the requirements that guide its design and development, ensure that it works as expected and can be implemented with the same characteristics to satisfy the needs of stakeholders. Shivkumar (2012) opined that software testing provides a means to reduce errors, cut maintenance and overall software costs. In addition, the testing of software is an important means of accessing the software quality. System testing has been classified into several categories, however, software perspectives are grouped into three and thus: Unit testing, Integration testing, and System testing were identified. Therefore, software testing was adopted for testing the developed Web-Based Medical Records Management System. Programmer conducted the Unit testing, Integration testing, and System testing. Furthermore, system testing was also conducted by an independent tester to validate the functionalities of the developed Web-based platform before finally conducting the system demonstration show at the conference hall of Specialist Hospital Sokoto (SHS).

4.8.1 Unit Testing

White box technique was employed in conducting the Unit testing which was utilized as a part of testing solitary unit of source code. According to Johan (2013), Unit testing tests a small function which is testing a single unit of source code, for example, individual units of code, function/class level.

Table 4.1: Unit Testing

No	Function	Expected outcome	Remark
1	Tests connection to the database.	To connect to the database.	Pass
2	Creation of User Account (new user)	It takes the new user to the creation of account form.	Pass
3	Creation of User Account (existing user)	If existing User logs into the system with the purpose of creating another account, prevent the user from doing so.	Pass
4	Tests the privileges.	The returning user should be automatically directed to the Dashboard based on the identified user role.	Pass
5	Logs out	Terminate the user session and log out	Pass

4.8.2 Integration Testing

After performing the Unit Testing, Integrating Testing was conducted on the developed system in which White and Black Box Techniques were applied. Shivkumar (2012) contended that integration testing involves building a system from its parts and testing it for issues that can emerge from component interactions. Moreover, it also serves to technically check legitimate interfacing amongst modules, and within sub-modules.

Table 4.2: Integration Testing

No.	Function	Expected outcome	Remark
1	New patient registration.	The system displays [<i>create_account.php</i>] form, once the data is entered and click on submit button. [A <i>pop-up Congratulatory Message Box</i>] appears in which user can click [OK] to log into the system or [Cancel] for a later time operation.	Pass

2	Insert patient data into the database	Once a patient is registered with the system, it should automatically take him/her to the patient dashboard upon successful login. By clicking [<i>Patient Registration</i>], the patient can fill up all required information and data should be saved into the database.	Pass
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4.8.3 System Testing

Shivakumar (2012) reported that System Testing is geared towards functional requirements of an application in order to verify that the system components perform a control function, to perform the inter-system test and demonstrate that the system does both functionally and operationally as specified. Moreover, Jeff and Paul (2015) contended that system testing is targeted towards eliminating faults as early as possible, improve quality, reduce cost and preserve customer satisfaction.

Table 4.3: System Testing

No.	Function	Expected outcome	Remark
1	Activate/Deactivate User by the Administrator	Provided that Admin logs into the system with the right login details, the system should automatically take the Admin to the [<i>Dashboard</i>], and enables him to activate/deactivate user permission to access patients' medical records.	Pass
2	View record from another hospital by the Doctor.	Once a Doctor logs into the system with the right login details, the system should save the Doctor's session and redirects the user to the [<i>Doctor's Dashboard</i>]. If the doctor access permission is activated, the records should be displayed else [<i>Access Denied Pop-up Menu</i>] appears.	Pass
3	View medical record by the patient.	Once the Patient logs into the system with the right login details, the system should save the patient's session and redirects him/her to the [<i>Patient's Dashboard</i>]. If the patient access permission is activated, the records should be displayed else [<i>Access Denied Pop-up Menu</i>] appears.	Pass

STAGE 4: SYSTEM DEMONSTRATION & EVALUATION

4.9 System Evaluation during Implementation Phase

Bossen, Jensen, and Udsen (2013) reported that evaluation is a recommended part of the development and implementation of Information System/Electronic Health Record (EHR)

to ensure that system functionality fits with work processes and decisions regarding future design and development.

4.9.1 Acceptance Testing

System demonstration show was conducted at the hospital conference, to validate on the security and privacy of the developed Web-based Medical Records Management System towards the attainment of UHC in Nigeria. Data for testing was given by the healthcare provider which was kept secret in accordance to international standard and also in conformance with the healthcare provider ethical committee i.e Data supplied for testing must not reveal.

The outcomes of the findings were summarise and presented in table 4.4, 4.5, 4.6 and 4.7.

4.9.2 Demographic characteristics of respondents

Table 4.4: Demographic characteristics of respondents (n=68)

	Frequency	Percentage
1 Gender		
Male	50	73.5
Female	18	26.5
Total	68	100
2 Age		
20 – 29	17	25.0
30 – 39	26	38.2
40 – 49	12	17.6
50 – 59	10	14.7
60 – 69	03	4.4
Total	68	100
3 Occupation		
Physicians	11	16.2
Medical Record Officers	03	4.4
ICT Staff	05	7.4
Patients	49	72.1
Total	68	100

Table 4.4 According to participants' gender, 50 respondents (73.5%) who evaluated the system during the implementation phase were male while 18 respondents (26.5%) were female. The age distribution from **Table 4.4** indicates that, majority of the respondents were within the age range of 30 – 39 years who were represented by 26 respondents (38.2%) followed by 17 respondents (25.0%) within the age group of 20 -29 years, 12

respondents (17.6%) within the age group of 40 – 49 years, 10 respondents (14.7%) in the age group of 50 – 59 years while only 3 respondents (4.4%) were within the age group of 60-69 years. Distribution of participants amongst occupation status demonstrates that 11 respondents (16.2%) were medical doctors, medical records officers 3 respondents (4.4%), ICT staff 5 respondents (7.4%) and patients which constituted the highest percentage having 49 respondents (72.1%).

4.9.3 Security Requirements

Table 4.5: Security

A:Security Requirements	- Response			+ Response			Total
	SD	D	Freq. & Perc.	A	SA	Freq. & Perc.	Freq. & Perc.
a1: Information is available and reliable in the case of a natural disaster	6	9	15 (22.1%)	3	50	53 (77.9%)	68 (100%)
a2: Information is secured from accidental modification by authorize user (i.e the Doctor can only update medical records of Patients treated).	-	-	0 (0%)	18	50	68 (100%)	68 (100%)
a3: Information is secured from unauthorized User from disclosure, modification, or destruction (deletion).	11	3	14 (20.6%)	45	9	54 (79.4%)	68 (100%)
a4: You are confident with data stored on the web server (system integrity).	6	12	18 (26.5%)	32	18	50 (73.5%)	68 (100%)

On the issue of availability of information forming part of the security requirement, 53 respondents (77.9%) agreed or strongly agreed that if the system is implemented it guarantee the availability and reliability of patient medical records even in the case of natural disaster, though 15 respondents (22.1%) strongly disagree or disagree with the statement. The discoveries in **Table 4.5** also demonstrated that information is secured from accidental modification by authorize user (i.e the Doctor can only update medical

records of Patients treated) with 68 respondents (100%) in total agreement with this statement. In addition, concerning securing patient medical records from unauthorized disclosure, modification, or destruction (deletion), the participants were skeptical about their response, thus 54 respondents (79.4%) are in agreement. However, 14 respondents (20.6%) had contrary views. Responses on data stored into the Web server recorded the least ranking. The findings revealed that 50 respondents (73.5%) had confidence in the integrity of the system with regards to stored data in the Web server, while 18 respondents (26.5%) did not have confidence in the integrity of data stored on the Web server. Further scrutiny of the respondents proved that the least scoring recorded on system integrity quality is because of the fear of data loss or damage due to attacks on the Web application system.

4.9.4 Privacy Requirements

Table 4.6: Privacy B: Privacy Requirements	- Response			+ Response			Total
	SD	D	Freq. & Perc.	A	SA	Freq. & Perc.	Freq. & Perc.
b1: Only active User can have access to the Patient Medical data	-	-	0 (0%)	13	55	68 (100%)	68 (100%)
b2: I can only perform a task(s) deemed necessary as authorised by Hospital Administrator	-	-	0 (0%)	-	68	68 (100%)	68 (100%)
b3: No two Patients belongs to the same NHID (National Health Identification Number)	5	8	13 (19.1%)	18	37	55 (80.9%)	68 (100%)
b4: Patient can only view own clinical summary report	2	8	10 (14.7%)	19	39	58 (85.3%)	68 (100%)
b5: Ensures automatic session login	-	-	0 (0%)	-	68	68 (100%)	68 (100%)
b6: National Health Identification is encrypted over the WWW	-	-	0 (0%)	18	50	68 (100%)	68 (100%)

The discoveries in **Table 4.6** revealed that only active user can have access to the Patient Medical data this is represented by 68 respondents (100%) in total agreement with this statement. Likewise, the user can only perform a task(s) deemed necessary as authorised by Hospital Administrator recorded 100% in total agreement with this statement. With regards to the duplication of patient medical number (NHID), 55 respondents (80.9%) confirmed that no two Patients belong to the same NHID (National Health Identification

Number). Besides, 13 respondents (19.1%) opposed this statement. With the security highlights incorporated into the system, safeguarding the privacy of patient record through the implementation of the Web-based platforms. 58 respondents (85.3%) were agreed or strongly agreed that patient can only view own clinical summary report. However, 10 respondents (14.7%) were strongly disagreeing or disagree with this statement. On the automatic session login, all the respondents were strongly agreed or agreed with this statement represented by 100%. Similar outcomes realized on the encryption of National Health ID (NHID) over the WWW were all the 68 respondents (100%) were in total agreement.

4.9.5 User Satisfaction

Table 4.7: User Satisfaction		- Response			+ Response			Total
C: User Satisfaction		SD	D	Freq. & Perc.	A	SA	Freq. & Perc.	Freq. & Perc.
c1: Data generated on Patients' Clinical Summary Report is always complete.		8	9	17 (25.0%)	24	27	51 (75.0%)	68 (100%)
c2: Contents represented in the patient clinical summary is clearly expressed and better understood as generated by the system.		0	2	2 (2.9%)	30	36	66 (97.1%)	68 (100%)
c3: Job performance and productivity will increase which can decrease Patients' Waiting Time (PWT).		3	2	5 (7.4%)	28	35	63 (92.6%)	68 (100%)
c4: Satisfied with the responsiveness of the system as it is displayed on the screen.		4	7	11 (16.2%)	28	29	57 (83.8%)	68 (100%)
C5: User readiness (like to move to the Web-based platforms as soon as it is implemented).		6	3	9 (13.2%)	19	40	59 (86.8%)	68 (100%)

On the completeness of Patients' Clinical Summary Report, 51 respondents (75%) agreed or strongly agreed that with the Web-Based System, contents of patients' medical records are up-to-date (complete), whereas a quarter of the respondents opposed the view representing 17 respondents (25%). Based on the clarity of output results which bring about a better understanding, 66 respondents (97.1%) agreed or strongly agreed with the statement though 2 respondents (2.9%) have contrary views. Moreover, amongst the

participants of the survey, 63 of them (92.6%) were of the opinion that the job performance and productivity will increase which can decrease Patients' Waiting Time (PWT), while 5 respondents (7.4%) had opposing views. This implies that participants were optimistic that with Web-based System if integrated into the management of patients' medical records will reduce time wasted by patients in locating their medical records. With regards to user satisfaction in the system responsiveness, 57 respondents (83.8%) were satisfied while 11 respondents (16.2%) show dissatisfaction with the developed Web-based medical record management system for Nigeria.

In addition, 59 respondents (86.8%) were of the opinion that, they would like to move to the Web-based System as soon as it is implemented while 9 respondents (13.2%) were not ready for migration to the Web-based System immediately when it is implemented. This entails that the Web-based Application System is gaining acceptance amongst healthcare providers and patients in Sokoto State, Nigeria.

CHAPTER FIVE

DISCUSSION OF FINDINGS, CONCLUSION, RECOMMENDATION, AND FUTURE WORK

5.0 Introduction

This chapter presents the summary of the research findings, conclusion, recommendation, and future work for further research.

5.1 Discussion of the findings

The major findings from the study were summarised according to the specific research objectives.

5.1.1 Objective One: the first objective of this study was to evaluate the current medical record system in Sokoto State with the aim of determining how to achieve privacy and security of patients' medical records among healthcare providers in the State.

The findings revealed that the entire process of management of patients' medical records at the Specialist Hospital Sokoto is purely manual with regards to registration, recording, storing and retrieval of their records.

Considering a large number of citizens demanding medical attention on a daily basis, the treatment process turns out to be more complex using the Paper-Based System resulting in delays, errors, and inefficiency. In this manner, all respondents interviewed recognize the need for implementing Web-based technology into the management of patients' medical records as an appreciated advancement. These findings also corroborate with the study findings of Sule (2013) argued that with the present system (manual) of record management in Nigeria, many patient records became damaged, lost and deteriorated. Furthermore, he stressed that until serious action is taken to remedy these shortcomings the proper management of patient health records will keep on suffering a setback which will hamper an ineffective health care services delivery.

Privacy and Security is the primary concern that needs to be preserved because of the sensitive nature of the medical records in the cause of treatment process.

Based on the findings of this study, security of patients' medical records can be achieved through:-

- i. Information should be available and reliable even in the cases of natural disaster; this can be done through storing patient medical records on the web server.
- ii. Information should be secured from accidental modification by authorized user, this can be achieved through defining roles and assigned privileges on what an authorised user should perform in connection to the management of patient medical records in the hospital (i.e authorisation).
- iii. Information should be protected from the unauthorized user from disclosure, modification or destruction (deletion); this can be achieved through authentication technique.
- iv. Ensure the integrity of data stored on the web- server which can be attained by putting restrictions to operations that can be performed on medical records (i.e only the physician who treats a patient can modify the patient records if the need arises).

Furthermore, the identified privacy requirements based on the outcomes of this study are:-

- i. Only the active user can have access to the patient medical data.
- ii. Users can only perform a task(s) deemed necessary as authorized by the hospital administrator.
- iii. No two patients belong to the same National Health Identity (NHID), this has achieved by making National Health Identity as Primary key in the database table.
- iv. The patient can only view own clinical summary report. This is attained by automatically directed the authenticated user to his/her Dashboard based on identified category.
- v. By ensuring automatic session login when legitimate user logs into the system.
- vi. Since Privacy limits the access of the public. Therefore, patients NHID should be encrypted while transfer over World Wide Web.

This study confirmed in the previous studies that, privacy is achieved by associating roles with each individual who might have a need to access information. With each role

defining the set of privileges and operations an individual assuming that role may perform (Adebayo and Justice, 2014; Jackson, 2011).

5.1.2 Objective Two: the second objective of this study was to implement a working Prototype Web-based Medical Records Management System

The tool chosen for the design was Windows, Apache, MySQL, and PHP (WAMP Server Version 3.0.6). At the front-end, HTML and CSS are the technologies used in implementing the system and are the most important technologies used for developing web pages. Mohammad (2015) noted that most of the front-end framework uses HyperText Markup Language (HTML), whereas CSS allows the user to separate the content of the website from its style. MySQL was used for implementation of the developed system at the back-end for the design of various tables into MySQL WAMP Server. Paul (2014) contends that MySQL database management system is popular for many reasons; it's fast and easy to set up, use and administer. In addition, it runs on many operating system platforms such as Windows and UNIX, and MySQL based programs can be written in many languages.

5.1.3 Objective Three: the third objective of this study was to test and evaluate the Prototype Web-based System

5.1.3.1 Testing the Prototype the System

White box technique was employed in conducting the Unit testing. It was utilized as a part of testing a solitary unit of source code. After every creation of PHP script, the researcher had to test its functionality and any fault detected was fixed immediately. After performing the Unit testing, Integration testing was conducted on the developed Web-based system in which White and Black box techniques were applied trailed by System testing in which Black box technique was employed. Outcomes of all the tests conducted on the security and privacy features of the developed Web-based Medical Record Management System were passed successfully and therefore presented to potential users' for evaluation purpose. Shivkumar (2012) opined that software testing is an important means of accessing the software quality. Mohd & Farmeena (2012) commenting on the main techniques for software testing in which Black box technique is based on external

exceptions, no proved edge of internal working and performed by end users and also by tester and developers (user acceptance testing), whereas White box technique full knowledge of internal working is required, and it is performed by developers and testers.

5.1.3.2 Evaluation of the Developed Web-based Medical Record Management System based on the User Acceptance

Evidence gathered from usage assessment feedback during Implementation Phase with regards to Security, Privacy, together with User Satisfactions such as system responsiveness, information completeness, clarity of information, and users' readiness to migrate to the Web-based Medical Records Management System towards the realization of Universal Health Coverage in Nigeria were discussed.

5.1.3.2.1 Demographic Characteristics of the Respondents

The findings demonstrated that the majority of the respondents who evaluated the system during the Implementation Phase were Male. The high percentage of Male recorded is because of the wide gap in regards to educational status, and economy they had in the state under the study compared to their Female countered part.

5.1.3.2.2 Evaluation on Security of Patient Medical Records in the Hospital through the Web-based Platform.

On the security of patients medical records over the Web-based platform, a reasonable percentage of the respondent agreed or strongly agreed that if the system is implemented it guarantee the availability and reliability of patients' medical records even in the case of natural disaster. By implication improvement on the access to the patient medical records will result in better service delivery and brings effective healthcare services delivery in Nigeria. This is similar to findings made by Evans (2016) that, with the advancement of computer technology, the use of Electronic Health Records made patients' medical information easier to read and available from almost any location in the world. The outcomes of this survey tally with the findings of Yaya *et al.*, (2015) that, management and preservation of health records are integral parts of medical service delivery as it goes a long way in enhancing better service delivery, serving as a basis for following patient health trend over time, and acts as a basis for effective referral service. In addition, the findings revealed that 26.5% of the respondents, indicated fear concerning the storage of their medical records on the web server. Further scrutiny of the respondent's proved that

the least scoring recorded on the integrity of medical records while stored on the web-server is because of the fear of data loss or damage due to security threats over the World Wide Web. This finding is in agreement with Jennifer and Ebru (2012) that, whenever health information is stored electronically, there are significant security concerns. Similarly, American Hospital Association (2015) reported that there are increased cases of Information System (IS) attack and stealing of personal information. Hence, maintaining a balance between sharing information and keeping it secured remains a global challenge

5.1.3.2.3 Evaluation of Privacy of Patient Medical Records in the Hospital through the developed Web-based Platform.

Outcomes from the demonstration show conducted proved that with the utilisation of a Web-based system, the user can only perform a task(s) deemed necessary as authorized by Hospital Administrator this account for 100% agreement by the respondents. This finding corroborates with the recommendations of Ngoako and Patrick (2012) that, there should be an effective plan to manage electronic health record, security or access control should be built upon to ensure that records are not deleted or access without authorization. Furthermore, the finding of this study confirmed that through the developed Web-based Medical Records Management System, only active user can have access to the patient medical data. This will ensure the privacy of patients' medical records. Tiro (2013), acknowledge that the sensitivity of patient records has brought several challenges to managing institutions. The commonest relates to storage, access, safety, and security. Large hospitals which use primarily manual based patient records systems experience storage problems. Access to patient records is another challenge that users and custodians face. Sometimes there is conflict on the ownership and the right of access to a patient record. Moreover, this study demonstrates that with the web-based platform no two patients share the same NHID. Sule (2013), acknowledge poor organization of records hinders quick accessibility to records, and duplication of patient numbers where different people were given same hospital number.

5.1.3.2.4 User Satisfaction

Outcomes of the demonstration show revealed that with the developed Web-based system, content of patients' medical records are complete this will ensures it availability while on demand. Thus, majority of the participants of this study believed that completeness of

patients' records is a mandatory quality of Web-based Systems. Open Text Corporation (2015) reported that, providing healthcare personnel with complete and accurate patient information enables them to make informed decisions and prescribe the best possible treatment, improving patient outcomes and clinical pathways. Besides, contents represented in the patient clinical summary are clearly expressed and better understood as generated by the system, majority of the respondents were in agreement to this statement. Ngoako and Patrick (2012) called attention to the drawback of the handwritten medical records as in it may be illegible, incomplete, not well organized and could sacrifice the quality of care.

Respondents' comments on system responsiveness was satisfying, implying that a greater percentage of acceptance by the respondents. In addition, 86.8% were of the opinion that, they would like to move to the Web-based platform as soon as it is implemented. This entails that the Web-based System is gaining acceptance amongst healthcare providers and patients in Sokoto State, Nigeria, though, 17.6% had some difficulties in performing the required tasks. The difficulties recorded were basically among the elderly participants. This suggests that, greater percentage of the respondents were satisfied with the designed system features. In a similar view, Biruk *et al.*, (2014) opined that, younger people normally have a tendency to have more rationale, intrigue, and preparation to accept new technological developments than aged people.

5.2 Conclusion

Conclusively, this research presented clear and feasible Web-based system architecture towards the attainment of UHC in Nigeria. Most of the attention was focused on computerized record storage only. Similarly, few research studies at technology level that addressed security and privacy of Web-based platforms for proper management of patient records (accessibility) in Nigeria were found. Hence, developing such system architecture is necessary. Therefore, after requirement gathering, architecture of Web-based system was defined, after that system design and implementation were performed.

Going by the findings made after usage assessment at the testing site, it can be concluded that majority of the users were satisfied with the developed Web-based system in terms of its measurable qualities (i.e security, privacy, and user satisfaction). However, a few users found the system difficult to use in one way or the other. These categories of participants

were found to be the elderly ones. This can presumably be attributed to the low level of IT in relation to web technologies. From these facts, a general conclusion can be made that the system really satisfied users' requirements and are ready to be deployed for usage amongst healthcare providers in Sokoto State, Nigeria.

Summarily, the use of web technologies all over the world is changing the face of how governments operate and how services are delivered to citizens thus, the Sokoto state government can't afford to take a back seat. Healthcare institutions in Nigerian need to fully utilize the Web-based platforms in order to make services widely available and accessible which will prompt better quality delivery in an efficient and effective manner. This will restore the confidence of the public on Nigerian Healthcare services. Moreover, by improving patients' satisfaction it will help in saving the economy of the country from high cost incurred through medical tourism, as part of the exploring measures in addressing the fallen of the foreign reserve account.

5.3 Contributions to Knowledge

Available literature clearly indicates that low success recorded towards implementation of Web-Based Health Information System is partly responsible for poor quality of healthcare services delivery in Nigeria. Highlighting security and privacy issues remains the major concern for implementing Web-based platforms in most of the healthcare settings across the country. These situations spur the need for this study. The main focus is on security at the technology level, and therefore comes up with the system architecture, after that a secured Web-based platform was designed and developed in support of Universal Health Coverage across the country.

5.4 Recommendations

Based on the findings made by this study as well as the conclusions drawn, the following recommendations for the successful implementation of the Web-based Medical Record Management System in order to attain a UHC in Nigeria were made:

- (i) With regards to the issues identified in the current medical record system, the legislative arm of government should promulgate a law mandating the use of a Web based medical record system and health information system across all healthcare providers in Nigeria.

- (ii) To ensure optimum security in medical records, a Web-based platform in which the State Ministry of Health has overall administrative privileges on setting activation/deactivation of users' accounts should be provided.
- For effective and successful implementation of the developed Web-based platform, all computer rooms in healthcare providers should be upgraded to full fledged ICT centers.
- On system testing and evaluation, it was recommended that, post implementation evaluation should follow immediately whenever the Web-based platform is deployed to any healthcare provider. This will enable instant assessment of its impact and identification of issues that require immediate actions.

5.5 Future work

The ideas presented in this study may be used as reference information in conducting new similar research to deliver government services through Web-based platforms therefore, it is recommended that future studies should be embarked upon:

- The development of an Algorithm that will generate NHID randomly, so that the authorised user of the system should not easily guess a patient National Health Identity.
- In order to proactively detect privacy violators, there is a need to improve on the security features of the developed system. Hence, future researchers should incorporate SMS notification alerts to be sent to patient's any time a physician alters the stored patient data.
- Future research should integrate audit log file to monitor user activities of the Web-based Medical Record Management System.

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APPENDICES

APPENDIX A1: INTRODUCTION LETTER

**KAMPALA
INTERNATIONAL
UNIVERSITY**

Ggaba Road, Kansanga * PO BOX 20000 Kampala, Uganda
Tel: 0772365060 Fax: +256 (0) 41 - 501974 E-mail:
dhrinquiries@kiu.ac.ug * Website: <http://www.kiu.ac.ug>

*Directorate of Higher Degrees and Research
Office of the Director*

Our ref. 1153-04156-02165

Tuesday 4th July, 2017

Dear Sir/Madam,

Re: Introduction Letter for Usman Nuradeen Umar.
Reg. No. 1153-04156-02165

The above mentioned candidate is a student of Kampala International University pursuing a Masters Degree in Computer Science.

He is interested in conducting a research for his dissertation titled, *"An Integrated Web-Based Pilgrim's Medical Records System for Improving Quality of Public Sector Service Delivery: A Case Study of Sokoto State Pilgrims Welfare Agency "*.

Your organization has been identified as a valuable source of information pertaining to the research subject of interest. The purpose of this letter is to request you to kindly cooperate and avail the researcher with the pertinent information he may need. It is our belief that the findings from this research will benefit KIU and your organization.

Any information shared with the researcher will be used for academic purposes only and shall be kept with utmost confidentiality.

I appreciate any assistance rendered to the researcher.

Yours Sincerely,


Dr. Claire Mack Mugasa
Director



C.c. DVC, Academic Affairs
Dean, SCIT

"Exploring the Heights"

APPENDIX A2: APPROVAL LETTER FROM THE AGENCY



SOKOTO STATE PILGRIMS WELFARE AGENCY

Office of the Executive Governor

Sultan Ibrahim Dasuki Road,
PMB 2187 Sokoto, Sokoto State - Nigeria.

Date: 19th July, 2017

The Director,
Higher Degrees and Research
Kamfala International University
Uganda.

Dear Sir/Madam

RE: INTRODUCTION LETTER FOR USMAN NURADEEN UMAR
REG. NO. 1153-04156-02165

Reference to your letter 1153-04156-02165 dated 4th July, 2017, I have the pleasure to inform attest that the above named student has conducted a research for his dissertation with the Agency

2. He reported to the agency on 19th July, 2017 and he was allowed to access all the recovery information he requested.
3. Thanks and best regards.


FARUKU UMAR
Media Assistant
For:- Director General.

APPENDIX B1: INTERVIEW GUIDE

Opening Remarks:

Welcome, this is an introduction to the study of “*Web-based Patient's Medical Record Management System for Nigeria*”. Procedures on the interview and ethical issues are briefly discussed.

a: **Introductory question**

- i. Please, can you kindly discuss how Patients’ medical records are recorded, stored and retrieved within the organisation.
- ii. The Federal Government of Nigeria mandated the use of ICT in its health sector, however, looking at the National Health ICT Strategic Framework 2015 – 2020 interoperability and security layer is yet to be developed. Do you foresee that this development could compromise the quality of healthcare delivery and put patient safety at risks, likewise could make the realization of UHC by 2020 a mere illusion?
- iii. What are the benefits and challenges of paper-based record keeping system as it relates to patients’ medical records in this hospital?

b: **Transition question**

- i. Among the challenges identified by using paper-based record keeping system, state the most serious ones?
- ii. With regard to the effective healthcare quality services delivery, can you compare efficiency and effectiveness of paper-based record keeping system with the Web-based information system?

c: **Key questions**

- i. Do you have an idea of Web-based Health Management Information System?
- ii. What functions will you like to see with Web-based Patient’s Medical Record Management System?

d: **Ending questions**

- i. What are the perceived benefits of Web-based Platforms in the management of patients medical records and realization of UHC in Nigeria?
- ii. How can you recommend a Web-based Medical Record System implementation in this healthcare centre?

e: **Any other comments or suggestions:.....**

APPENDIX B2: INTERVIEW TRANSCRIPTS

Participant's code:

Interviewee 1

Interviewee 2

----- *****-----

Interviewer

The first interview was conducted with the head of the record unit in order to assess how Patient's medical records are recorded, stored and retrieved within the organization.

Interviewee 1

According to the respondent information, after a patient reported to the OPD, register will be open to that patient and the visiting card will be given to the patient. In summary, the whole medical record registration, storage, and retrieval process are done manually using paper-based record keeping system.

Interviewer

The Federal Government of Nigeria mandated the use of ICT in its health sector, however, looking at the National Health ICT Strategic Framework 2015 – 2020 interoperability and security layer is yet to be developed. *Do you foresee that this development could compromise the quality of healthcare delivery and put patient safety at risks, likewise could make the realization of UHC by 2020 a mere illusion?*

Interviewee 1

Yes, security of patients' medical records is necessary with regards to this organization's operations. Actually, the record office couldn't implement the proposed ICT in the management of medical records because of issues of security and privacy concern. I couldn't comment much on the realization of UHC, all I can say 2020 is nearer (Interviewee 1).

Interviewer

Briefly, discuss the advantages and challenges of paper-based record keeping system within the organisation

Interviewee 1

I can just say that Paper-based Record Keeping System is cheaper and the process is simplified, but challenges associated with it outweigh its benefits when compared with the Web-based Information System. In an example, issue of misplacement of patient's records resulting from putting the folder in wrong code is extremely challenging and its retrieval takes a lot of time. In such circumstances, security of the stored folders cannot be guaranteed. Besides, there are also issues with regards to patient's privacy which do arise as a result of the manual mode of transmitting patients' medical records (Interviewee 1).

Interviewer

Among the challenges identified by using Paper-based Record Keeping System, state the most serious ones?

Interviewee 1

With regards to the Paper-based record keeping system, the most serious problem is the time taken in locating misplaced folders of patient's records in addition to the issue regarding patients' security and privacy as a result of the manual mode of transmission process from record office to the physicians. Also, there is serious challenge and difficulty in accessing and sharing the medical history of a patient among different healthcare providers (Interview 1).

Interviewer: Do you have an idea of Web-based Health Management Information System?

Interviewee 1

Yes, I have an idea of Web-based Medical Record System.

Interviewer

With regard to the effective healthcare quality services delivery, can you compare efficiency and effectiveness of paper-based record keeping system with the Web-based information system?

Interviewee 1

Absolutely no at this information technology age, to anyone with IT skills will prefer Web-based Information System unless somebody is not computer literate such stick to manual process simply because of IT skills lacking to operate web-based platforms.

Interviewer

What functions will you like to see with The Web-based platform for proper management of Patients' Medical Record System in this centre?

Interviewee 1

The functions differ from users, for example, patient's want to check for his/her medical records status, and of course, doctors too in the course of treating the patient need to check for the past medical records of a patient.

Interviewer

What are the perceived benefits of Web-based Platforms in the management of patients medical records towards the realisation of UHC in Nigeria?

Interviewee 1

There is a lot to be gained with successful implementation of Web-based Application Systems as it benefits sharing of health records as well as security and privacy of patients. It is also efficient, saves time and effort, reduces patients' waiting time and brings overall satisfaction to the patients as well which will restore their confidence in Nigeria Health Sector (Interviewee 1).

Interviewer

How can you recommend a Web-based Medical Record System implementation in this healthcare centre?

Interviewee 1

For the Web-based to be successfully implemented in this secondary healthcare centre, the staff needs to be trained and there should be regular television and radio programmes to the general public of its importance and the reasons why the hospitals need to integrate information technology in the management of patients' medical records in this State.

Interviewer: Any other comments or suggestions?

Interviewee 1

Integrating information technology in managing patients' medical records is a welcome development considering the country being the most populous black nation. I believe it will improve the quality of service delivery (Interviewee 1).

=====

Interviewer

The second interview was conducted with head of computer unit in order to assess how Patient's medical records are recorded, stored and retrieved within the organization.

Interviewee 2

The whole process with regards to the management of patients' medical records is purely done on paper-based concerning registration, recording, storing and retrieval (Interviewee 2).

Interviewer

The Federal Government of Nigeria mandated the use of ICT in its health sector, however, looking at the National Health ICT Strategic Framework 2015 – 2020 interoperability and security layer is yet to be developed. *Do you foresee that this development could compromise the quality of healthcare delivery and put patient safety at risks, likewise could make the realization of UHC by 2020 a mere illusion?*

Interviewee 2

With the current record keeping system and considering the huge number of patients demanding for medical attention, some challenges were realized such as difficulties in tracing misplaced medical record folders. This can result in a delay of treatment of a patient or probably putting patient's life at risk during emergency cases. However, the hospital couldn't transform to digitalized medical centre due to concern on security and privacy of patients. Well, 2020 is closer now but let us not gives off for the realization of UHC in Nigeria.

Interviewer

Briefly, discuss the advantages and challenges of paper-based record keeping system within the organisation

Interviewee 2

Although the Paper-based record keeping system seems to be more advantageous because it is easy to fill in the needed information, it can only be so in a situation dealing with few numbers of people. Hence, it is not easy to manage a large number of individual records using the Paper-based Record Keeping System (Manual Record Keeping System). Also,

there are issues with regards to storage, backup, and security and privacy of patients' medical folders (Interviewee 2).

Interviewer

Among the challenges identified by using Paper-based Record Keeping System, state the most serious ones?

Interviewee 2

Problems with regards to security and privacy of medical records. Another issue of concern is that once patient's folder is lost, there can be no guarantee for its backup. Similarly, Sharing of records among different healthcare providers becomes an issue of concern considering the manual mode of transmitting patients' folders (Interviewee 2).

Interviewer

Do you have an idea of Web-based Health Management Information System?

Interviewee 2

Yes, I have an idea of Web-based Medical Record System; in fact, I have seen some private clinic at Egypt operating it (Web-based Medical Record System).

Interviewer

With regard to the effective healthcare quality services delivery can you compare efficiency and effectiveness of paper-based record keeping system with the Web-based information system?

Interviewee 2

Absolutely No, to anyone with IT skills will prefer an online mode of accessing records through the organisational website.

Interviewer

What functions will you like to see with the Web-based platform for proper management of Patients' Medical Record in this centre?

Interviewee 2

I will look at it based on the perceived future users of the proposed system. Patient's need to check their medical records and view it's from different healthcare providers attended. In addition print it to have a copy with him/her and the system should protect unauthorized

access to patient's records. Considering the doctors the system should permit access to hospital records previously visited by the patient, create a new medical record of patient and edit on only the treated patient record. The administrator takes an example this organization to manage the hospitals by creating, updating and deleting the hospital lists, also all users' accounts are supposed to be managed by an administrator. The aforementioned requirements are functional requirements needed for the system to effectively manage the patients' medical records. But, there is a need for non-functional requirements?

Sir, what are the non-functional requirements?

Here there is need to consider verification and validation of all system users, for example, a patient can only check views and print his own records, the system should validate and authenticate patients/physicians before getting access to the system. Part of the non-functional requirements the system should allow for expansion to accommodate a large number of records considering the large population of citizens attending this healthcare centre. Part of non-functional requirement system documentation manual is essential so as to ease the system operations.

Interviewer

What are the perceived benefits of Web-based Platforms in the management of patients medical records towards the realization of UHC in Nigeria?

Interviewee 2

Benefits inherent with the Web-based Platforms include ease of sharing patients' records across different healthcare providers this is the most important reason behinds UHC, better quality of data reporting which improves the quality of service delivery and supports data storage and backup that guarantee the security of medical records in hospitals. Also, timely availability of patients' records reduces patient waiting time. I also perceive that the introduction of the Web-based medical record management system will increase the overall satisfaction of the citizens, restore their confidence and make universal health coverage a realistic healthcare project in Nigeria (Interviewee 2).

Interviewer

How can you recommend a Web-based Medical Record Management System implementation in this healthcare centre?

Interviewee 2

With regards to ICT infrastructure in this organization and level of ICT skills, some of our staff are computer graduate (B.Sc holders in Computer Science/IT) I can confidently tell that resistance to new technologies will not be an issue here. The most important considerations if the proposed system is to be successfully implemented, staff should be part of the system development, and there is a need for a workshop to the staff on management of medical records through the web-based platforms. Also, for the acceptance of this newly propose technological innovation in this state, regular television and radio programmes should be launch at least on weekly basis, so as to enlighten the general public on the importance of Web-based system towards improving the quality of healthcare service delivery among the citizens of this country.

Interviewer: Any other comments or suggestions?

Interviewee 2

If this new technological innovation is to be integrated into the management of medical records amongst the healthcare centres, it will confer a better quality of output regarding service delivery and of course support the attainment of Universal Health Coverage across the country. This will improve the economy by bringing to an end to medical tourism. I'm in support the of idea 100% (Interviewee 2)

APPENDIX C: EVALUATION TOOL (QUESTIONNAIRE)

RESEARCH QUESTIONNAIRE

Respondent ID:



KAMPALA INTERNATIONAL
UNIVERSITY

SCHOOL OF COMPUTING AND
INFORMATION TECHNOLOGY
DEPARTMENT OF COMPUTER SCIENCE

Dear respondent,

My names are USMAN Nuradeen Umar, I am a student at Kampala International University in Uganda, undertaking a research “***Web-Based Medical Records Management System for Nigeria***”. I humbly request your participation in this study by answering this questionnaire according to your true and candid opinion. Be assured that the data collected will be treated with a very high degree of confidentiality, the identity of respondents will be kept anonymously and it is meant for academic purpose only.

SECTION I: DEMOGRAPHIC CHARACTERISTICS OF RESPONDENTS

1: Gender

- a) Male b) Female

2: Age

- a: 20 -29
b: 30 -39
c: 40 -49
d: 50 -59
e: 60 -69

3: Occupational Status

- a: Physicians
b: Medical Record Officer
c: ICT Staff
d: Patient

SECTION II: EVALUATING USERS ON SECURITY REQUIREMENT FOR THE WEB-BASED MEDICAL RECORDS MANAGEMENT SYSTEM

(KEY: 1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree)

A: Security Requirements	SD	D	A	SA
a1: Information is available and reliable in the case of a natural disaster				
a2: Information is secured from accidental modification by authorize user (i.e the Doctor can only update medical records of Patients treated)				
a3: Information is secured from unauthorized User from disclosure, modification, or destruction (deletion)				
a4: You are confident with data stored on the web server (system integrity)				

SECTION III: EVALUATING USERS ON PRIVACY REQUIREMENT FOR THE WEB-BASED MEDICAL RECORDS MANAGEMENT SYSTEM

(KEY: 1=Strongly Disagree, 2=Disagree, 3=Agree, 4=Strongly Agree)

B: Privacy Requirements	SD	D	A	SA
b1: Only active user can have access to the Patient Medical data				
b2: I can only perform a task(s) deemed necessary as authorised by Hospital Administrator				
b3: No two Patients belongs to the same NHID (National Health Identification Number)				
b4: Patient can only view own clinical summary report				
b5: Ensures automatic session login				
b6: National Health Identification is encrypted over the WWW				

SECTION IV: EVALUATING USERS ON CONTENT REQUIREMENT FOR THE WEB-BASED MEDICAL RECORDS MANAGEMENT SYSTEM

(KEY: 1=*Strongly Disagree*, 2=*Disagree*, 3=*Agree*, 4=*Strongly Agree*)

C: User Satisfactions	SD	D	A	SA
c1: Data generated on Patient's Clinical Summary Report is always complete				
c2: Contents represented in the patient clinical summary is clearly expressed and better understood as generated by the system.				
c3: Job performance and productivity will increase which can decrease Patient's Waiting Time(PWT)				
c4: Satisfied with the responsiveness of the system as it is displayed on the screen.				
c5: User readiness (like to move to the Web-based platforms as soon as it is implemented).				

APPENDIX D: TIME FRAME

Activity Plan	Time
Identification of problems, research gaps, and formulation of Thesis Title	May 2016 – September 2016
Concept Paper Presentation	September, 2016
Corrections made and re-presentation of concept paper	31 st March, 2017
Proposal defense	5 th May 2017
Correction of proposal errors after defense and submission to the Department	25 th May 2017
Field data collection (Interview)	July, 2017
Prototype Design and Testing	July – August, 2017
Presentation and Interpretation of results	September 2017
Correction of errors suggested by Supervisor	October 2017
Work in Progress	17 th November, 2017
Corrections of errors suggested by Independent Reader	22 nd – 30 th November, 2017
Submitted for Internal and External Assessments	2 nd December, 2017
VIVA VOCE Presentation	8 th June, 2018
Compliance Supervisor	4 th September, 2018
Printing of final copy, binding as well as submission to the department	10 th September, 2018

APPENDIX E: BUDGET

Activity	Requirement	Amount (UGX)	Amount (NGN)
Internet connection	Bundle data subscription	150,000	17,045.45
Proposal correction from the Supervisor	Typing and Printing	15,000	1,704.55
Field data collection	Printing of Questionnaire	50,000	5,681.82
Data collection and analysis	Help desk assistance / tools/ consultation	50,000	5,681.82
Prototype design and testing	Tools and Consultation	100,000	11,363.64
Final thesis copies	Typing, photocopy, and binding	50,000	5,681.82
Hardware cost		900,000	102,272.73
Local runs		500,000	56,818.18
Total		1,815,000.00	206,250.00

Exchange Rate at the Parallel Market: NGN: UGX [1:8.80]