Research Article / Review Article FUPRE JOURNAL 9(1):339-363(2025)

FUPRE Journal

of

Scientific and Industrial Research

ISSN: 2579-1184(Print) ISSN: 2578-1129 (Online)

http://fupre.edu.ng/journal

Enhanced Health (Record) Information Management System Using Mobile Application Development Framework

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ARTICLE INFO

Received: 27/12/2024
Accepted: 07/04/2025

Keywords

Application, Appointment, Health record, Management, Security, Software, Web-based

ABSTRACT

An essential component of effective healthcare delivery is health record management. Although, conventional paper-based systems have long been the standard, they have a number of drawbacks, including inaccuracy, inefficiency, and a lack of accessibility. The adoption of a web-based health record management system proved to be a viable replacement for the paper-based system for handling medical records. However, there were certain obstacles along the way, including concerns about data security and privacy, data loss during the shift from paper to the web-based system, a lack of inclusivity, unauthorised access to patient records, and limited access to patient records because of inadequate internet access and facilities in Nigeria. This dissertation therefore reviewed the observable limitations of the existing system and proposed the development of a mobile patient's health record management system using mobile application development framework. The system was developed using Android Studio integrated development environment (IDE) and the Java programming language, with SQLite database and rapid application development methodology (RAD) which is an Agile method for enhanced program development especially for mobile application development. The new system outperformed the existing web-based hospital record management system in terms of speed, efficiency, robustness portability, data security and integrity as it enables both patients and doctors to access and book appointments remotely without having to go physically to the hospital saving man-hour and boosting the morale of both staff and patients.

1. INTRODUCTION

Global economic growth and stability rely on a healthy society, as a nation's strength is rooted in the well-being of its people, regardless of race or location. Health and wellness are fundamental to sustainable socioeconomic development, cultural harmony, and individual growth. Health is integral to our existence, with quality medical treatment being essential for well-being. Achieving quality healthcare requires well-designed health information systems. Healthcare is a continuous service, from birth to death (Winter et al., 2023). The World Health Organization (WHO) defines health not just as the absence of disease, but as a state of physical, mental, and social well-

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being (Raji, 2018). In all economies, health is a critical element for socioeconomic progress and poverty reduction (Thiede, 2015).

A good healthcare system depends on the effective management of healthcare information, ensuring it is accessible, accurate, and available to healthcare providers. Proper management of information in healthcare is vital for the growth and efficiency of healthcare organizations, as it can mean the difference between life and death. Healthcare institutions face the challenge of accurately maintaining patient records, which is crucial for providing effective care (Shimishi and Mupala, 2019).

Advances in healthcare are rapid, driven by the need to manage increasing health challenges. Technology has facilitated the storage, search, and access of patient records, reducing reliance on physical filing systems. However, Nigeria has been slow to adopt these technological advances, hindered by factors such as inadequate funding, training, and a perception that technology is only useful in developed countries. Many Nigerian healthcare facilities are understaffed and overcrowded, leading to delays in patient care. Patient conditions can deteriorate while searching for records, emphasizing the need for systems that store essential patient data for timely medical responses.

Since the 1990s, the healthcare sector has integrated information and communication technology (ICT) to improve service quality in areas like patient safety, efficiency, and satisfaction. The goal of ICT in healthcare is to enhance access, quality, and effectiveness for all citizens. ICT has proven to be a key tool in facilitating electronic communication, processing, and information transmission, ultimately improving health outcomes (Bates and Gawande, 2002). The role of ICT in improving healthcare and increasing the availability of health information is vital, especially in developing nations where it can enhance service quality and reduce costs (Brandrud et al., 2011).

Patient health information management systems have the potential to monitor health records and treatments over time, providing insights into the best approaches for patient care and diagnosis (Gomes and Romão, 2020). These systems are particularly valuable in managing maternal and child health, chronic diseases like diabetes and cardiovascular conditions, and other health issues that require continuous records. A robust health information system allows for a deeper analysis of a patient's medical history, offering medical practitioners—especially those unfamiliar with the patient—new insights into their health status, whether for chronic or acute conditions.

Record management is referred to as a branch of management that is in charge of effectively and systematically overseeing the production, receipt, preservation, use, and disposal of records. This branch of management also includes procedures for gathering and preserving records that serve as proof of business transactions and activities. According to Buckland (1994), there are three theoretical contexts in record management which include: functional, professional and intellectual concepts respectively.

1.1 An Overview of Record Management System

Records management supports an organization's mission by ensuring efficient access to records and aligning them with related functions like data processing, archives, and management information systems. Without this connection, records management remains ineffective. It is part of

retrieval-based information systems, similar to libraries and corporate databases, sharing common features while maintaining distinct roles (Buckland, 1982).

The concept of records management dates back to the early 20th century, when Paul Otlet classified it as "administrative documentation," alongside what is now known as management information systems. His ideas influenced European practices (Boyd, 1986). Records management also intersects with archival theory, with archivists tracing their roots to ancient record-keeping practices. Additionally, it has contributed to modern computer science ideas like hypertext and hypermedia (Duranti, 1989). A strong records management system relies on people, processes, and technology. Records differ from other information assets due to their transactional nature, requiring authenticity and trustworthiness. Digital environments pose risks, making effective records management crucial for accountability and governance (Yusuf and Adekoya, 2021). Electronic records management now serves as the standard, helping organizations and governments maintain control over record creation, use, and disposal while ensuring long-term accessibility and security.

1.2 Medical Record and Management

Medical records are essential for patient care, healthcare planning, medical research, and health statistics. They enable continuity of care by providing a reference for doctors, nurses, and other healthcare workers. If records are inaccessible, patient care may suffer, and trust in the records management system declines (WHO, 2018).

The evolution of medical records began with case history reports in antiquity. Medieval Islamic physicians expanded these records, and by the 19th century, structured clinical records emerged in Europe and the U.S. Modern health records management governs patient data throughout its lifecycle, ensuring proper storage, protection, and disposal. Mismanagement can compromise privacy and lead to data breaches, eroding patient trust. A U.S. survey found that 87% of patients hesitate to disclose full medical histories due to privacy concerns (Davis, 2022).

Medical records serve multiple purposes, including physician memory support, interdisciplinary collaboration, and legal documentation. They typically contain patient identity, history, symptoms, diagnoses, treatment, and discharge information (Dalianis, 2018). The rise of electronic medical records (EMRs) has streamlined records management but faces resistance due to learning curves and legal considerations (Jardim, 2013).

Health information systems integrate people, processes, and technology to enhance healthcare services. These systems store, process, and analyze data for healthcare planning and delivery, aiming for quality, efficiency, and security. They also eliminate redundant tasks and improve responsiveness, benefiting providers and patients (Almunawar and Ansari, 2011). As healthcare evolves, robust health information systems are crucial for managing data effectively and ensuring high-quality care (Haux, 2006).

1.3 Electronic Health Record Management and its Benefits

Electronic health record (EHR) is a developing concept that is defined as a systematic collection of electronic health information about individual patients or populations. It is a digital record that can be shared across different health care settings by being embedded in network-connected

enterprise-wide information systems. Demographics, medical history, medication and allergy information, immunization status, laboratory test results, radiology images, vital signs, personal stats such as age and weight, and billing information may all be included in such records (Habib, 2010). According to Sahney and Sharma (2018) electronic health record (EHR) systems are designed in a way that reduces paper medical records to store data accurately and legible in a digital format. Digitally, health records reduce the risk of data replication as file can be shared across the different health care systems and can be modify and update which reduce the risk of lost paperwork. EHR programs directly benefit the physicians, patients, and obviously the healthcare systems.

Electronic patient information systems, according to the WHO (2012), have the potential to enhance health by providing health professionals with more information about their patients. They can also enhance healthcare quality and help control costs through increased efficiency. Electronic health record (EHR) systems can be understood as a complete record of patient encounters that allows the automation and streamlining of the workflow in health care settings and increases safety through evidence-based decision support, quality management, and outcomes reporting. Electronic health record (EHR) and electronic medical record (EMR) are frequently used interchangeably, but there is a distinction between them. The electronic medical record (EMR) is defined as the legal patient record created in hospitals and ambulatory settings that serves as the data source for the electronic health record (EHR). It is important to note that an electronic health record (EHR) is created and maintained within a facility, such as a hospital, integrated delivery network, clinic, or physician office, to provide patients, physicians and other health care providers, employers, payers or insurers, and others with access to a patient's medical records across facilities (Wong et al., 2019).

Electronic Health Records (EHR) streamline paperwork, reducing costs related to transcription, filing, and storage. They enhance patient management, minimize medical errors, and improve disease management (Sahney and Sharma, 2018).

Cost and Storage: While initial implementation costs are high, EHR systems save money over time by reducing manpower and physical storage needs. Paper records require increasing space, personnel, and maintenance, leading to higher costs. EHRs, stored securely in the cloud, prevent decay, misplacement, or loss.

Security: Both paper and electronic records face security threats. However, EHRs provide enhanced protection through access controls, reducing risks from theft, disasters, and unauthorized access.

Access and Accuracy: EHRs offer instant access, allowing healthcare professionals to retrieve records remotely and respond to emergencies efficiently. Paper records require physical retrieval, slowing operations. Additionally, EHRs use standardized formats, ensuring readability and reducing medical errors, unlike often illegible handwritten records.

EHRs ultimately improve efficiency, security, and patient care.

1.4 Evolution Of Mobile Application In Health Information System

The evolution of mobile devices is driven by advancements in hardware and software, shaping communication and healthcare applications. Mobile apps, designed for various functions, have transformed from basic programs to sophisticated solutions catering to businesses and individuals

(Damingo and Elliot, 2022). Mobile application development involves creating installable programs that use network connectivity for backend services (AWS, 2019). Rajput (2015) notes that these apps function on mobile devices as conventional software does on computers. Progress in mobile applications has been fueled by collaboration among manufacturers, developers, and service providers (Phongtraychack and Dolgaya, 2018). The launch of Apple's iPhone (2007) and Google's Android (2008) revolutionized mobile computing. App and Play Stores provided a global marketplace, reaching one billion downloads by 2010 (Damingo and Elliot, 2022). Today, Java and Kotlin dominate Android development, with Kotlin offering streamlined coding.

Mobile health (mHealth) delivers healthcare via mobile platforms, including smartphones, tracking devices, and alert systems (Ayangbekun and Kasali, 2014). Initially called "wireless telemedicine" (Istepanian and Lacal, 2003), mHealth enhances access, quality, and affordability (Qiang et al., 2011). Its impact spans chronic disease management, telemedicine, and electronic records. Mobile technologies have disrupted healthcare, improving clinical decision-making and patient outcomes (Divali et al., 2013). However, concerns over validation and standardization persist (Ventola, 2014). Faster processors and open-source systems have further accelerated mobile integration into clinical practice (Ozdalga et al., 2012). With ongoing innovation, mobile technology continues to redefine healthcare delivery worldwide.

1.5 Types of Mobile Applications in Healthcare

Since the 2007 release of the iPhone, the technological environment has undergone a significant change. Although there were smartphones before the iPhone, Apple invented the idea of the app store, allowing users to acquire and install apps for a variety of purposes. We are currently experiencing a mobile revolution in healthcare, and it won't be long before mobile healthcare applications ("apps") transform the way we distribute, consume, measure, and pay for healthcare. This revolution has been sparked by the quick pace of innovation and the widespread applicability of mobile healthcare apps. In 2017, it is anticipated that the $4 billion industry for healthcare mobile apps will grow to $26 billion (Ramdurai, 2021).

There are many mobile applications (apps) that can be used to improve health, but before healthcare organizations or providers can suggest an app to the patients they serve, they must be confident that the app will be user-friendly and beneficial for the target illness or behaviour (Boudreaux et al., 2014). Additionally, critical areas like tele-stroke consultation, which can be fatal if not correctly and promptly diagnosed, have seen the use of mobile applications. Also, the use of smartphone apps has been crucial. The following are some of the areas and types of mobile applications currently deployed in the healthcare sector globally for patients and healthcare professionals alike;

Professional Healthcare Apps

i. Medical reference and database apps
ii. Professional networking apps
iii. Patient medical health tracking apps
iv. Doctor appointment and clinical assistance apps
v. Telehealth mobile apps (doctor-on-demand apps)
vi. Mobile Health Apps for Patients

Patient Medical Education Apps

i. Reminder apps -includes medical tracking apps or some health habit

ii. Patients records and appointment apps
iii. Diagnosis apps for preventive purposes
iv. Healthy lifestyle apps
v. Monitoring apps for chronic conditions
vi. Mental health apps
vii. Dieting apps
viii. Women's health apps

1.6 Factors to be considered for using Mobile Healthcare Application

There are certain factors that should be considered when developing and utilising mobile healthcare apps for patient and personal healthcare in any health setting of the country. According to Dike and Kabir (2020), these factors could include:

i. proportion of people with a mobile phone in a population in the region
ii. internet accessibility,
iii. power supply stability,
iv. purposes/functionality,
v. mobile healthcare application (mHealth apps) authorship and maintenance,
vi. climatic/environmental conditions,
vii. data security and,
viii. literacy level of the people.

When the population of people who own and use mobile devices is small, it makes it challenging to implement them for widespread use in healthcare delivery in the region. Poor network and internet services impede the widespread use of mobile healthcare applications (mHealth apps) for care delivery, and reliance on them may worsen people's healthcare status by jeopardizing communication links between healthcare providers and patients, as well as healthcare providers and healthcare providers.

Because the power source is stable, the garget's batteries can be charged on a regular basis to ensure proper functionality. However, when there is epileptic power supply and the garget battery runs out, the garget becomes inoperable, bringing harm to patients, healthcare providers, and the general public who may require the services. Climatic conditions frequently influence the use of mobile devices, particularly when the environment element (winter, summer, solstices, and autumn) of the country/geographical location is not taken into account during device manufacturing. Similarly, authorship, maintenance, and data security are critical for device usability and sustainability in order to accomplish the organization's goals.

Mobile healthcare (mHealth) gadgets should be evaluated for benefits to patients, healthcare providers, and the organization at all phases of development for use in practice. Mobile healthcare application (mHealth app) developers should concentrate on creating gadgets that can be used by the global population without internet connectivity or that provide an alternative source of power supply for 24 hour operation without limitations in remote areas, suburbs, and densely populated cities. Furthermore, identifying software and hardware that enforces the private preferences of the users, protect the contents of their devices, and user automation is critical.

1.7 Related Work

Gorule (2023) developed a Web-Based Hospital Management System using HTML, CSS, and PHP to streamline patient registration, appointments, billing, and medical records. It enhances coordination among hospital staff while ensuring secure remote access to patient data.

Shimishi and Mupala (2019) designed an automated patient record system with MySQL, PHP, and JavaScript, improving service efficiency and lowering costs. Dhatrak et al. (2023) highlighted inefficiencies in paper-based records, advocating for an online system to enhance data storage, retrieval, and security.

Yahaya et al. (2019) proposed a smartcard-based electronic health record system at the University of Ilorin, improving accessibility but requiring hospital visits for record retrieval. Shinde et al. (2022) developed a PHP-MySQL hospital management system focused on patient and physician data security. Pune et al. (2019) integrated disease prediction and QR code generation using Naïve Bayes and Blowfish algorithms to enhance authentication.

Anpan et al. (2020) introduced automated search functions for hospital management, optimizing workflow. Shah et al. (2022) emphasized replacing paper-based systems for improved data security but noted the lack of pharmacy notifications and asset management.

Revathy (2022) developed a secure health portal where doctors access reports via OTP authentication. Mohapatra and Bhuvana (2023) proposed an online healthcare system with appointment scheduling, online payments, and chatbot support.

Zhou et al. (2019) introduced a mobile PHR app to centralize personal health data from smart devices. Pandey et al. (2023) proposed an RFID-based Electronic Health Record System, improving patient identification.

2. METHODOLOGY

This research adopted the rapid application development methodology (RAD). This methodology is an information systems development procedure with a lifecycle designed to render speedy development and increased-quality reports. It is designed to have the maximum advantage of strong development software that has excellent quality, risk control and project delivery on time within the given frame of time budget. This can also be seen as an approach to constructing computer systems that put together computer-assisted software engineering tools and techniques, user-driven prototyping, and stringent project delivery time limits into a potent, tested, trusted formula for the best quality and productivity. This development drastically uplifts the importance of finished systems while decreasing the minutes it uses to construct them. This is achieved by accustoming sets of trusted application development tools, around a well-defined method. It is a process from which the development cycle of an application is expedited. Finally, RAD is a method of software development with an object-oriented approach to system development (Dennis, 2012).

This Rapid Application Development (RAD) methodology is flexible and adaptable to changes. The following are some of the rationale for the choice of the methodology for the development of a mobile patient's record management system;

i. reduction of the overall project risk,
ii. it is easier to transfer deliverables as scripts,
iii. high level abstractions and intermediate codes are used,
iv. it enables code generators, code reuse and reduces manual coding,
v. it is prototyping in nature; there is a possibility of a lesser defect,
vi. every phrase in the Methodology delivers highest priority functionality to client with less people and increased productivity in a short time.

2.1 Architecture of the System

The proposed mobile patient's health record management is an electronic health record management system that is designed to run on a mobile device whether tablets, smart phones and other handheld devices. The system is secure and personalized for each user making is more safe and ensuring high level of data integrity. The system architecture in Figure 3.2 shows the different components of the proposed system from the sign-up module to every of the functional module of the system. The proposed system acts as an interface between the patients and the hospital health record management system.

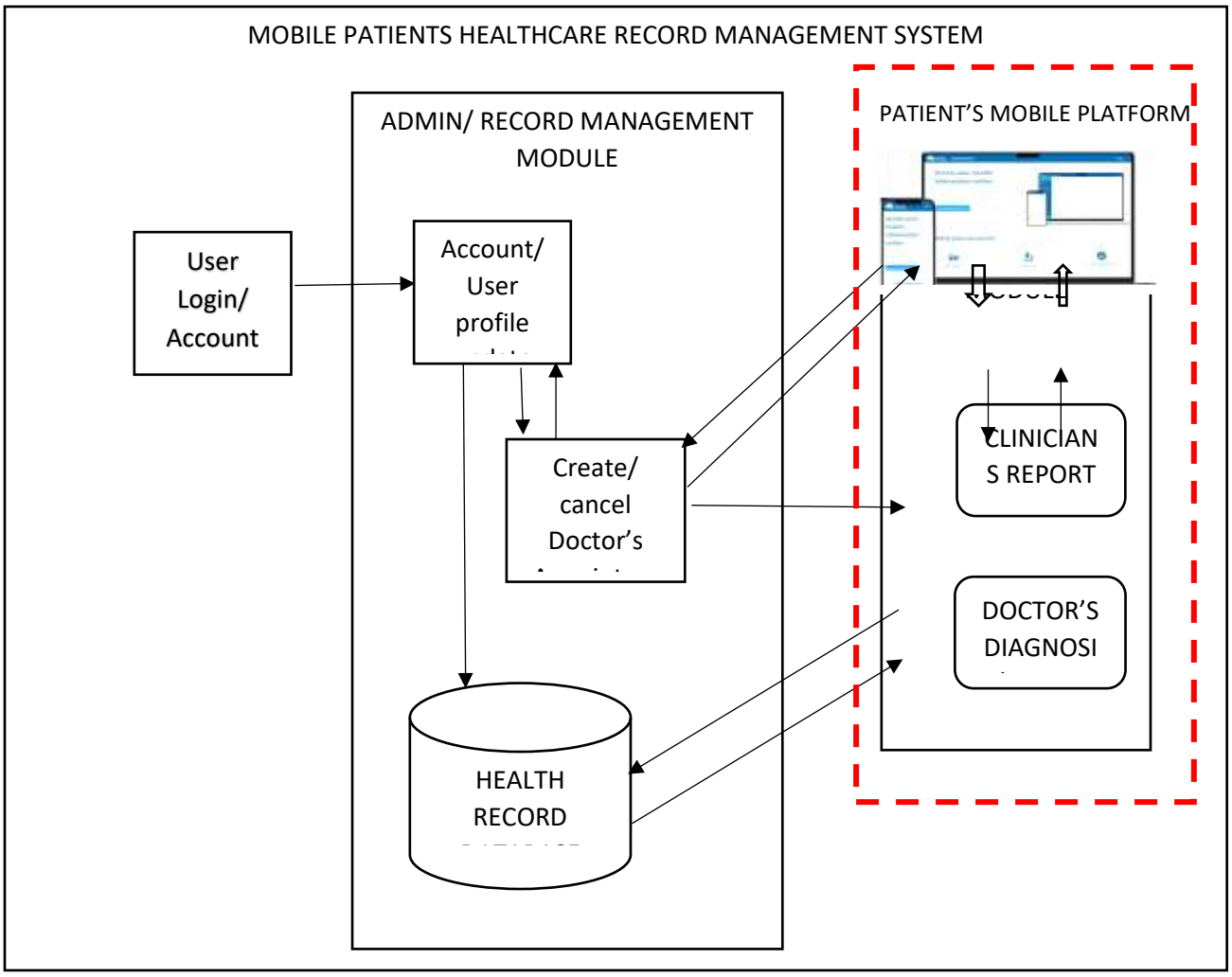

Figure 1 Architecture of the Proposed Mobile Patient's Record Management System

Description of the proposed Systems Architecture

The proposed system architecture in figure 1 comprises of three main modules which includes;

i. the login/ account creation module,
ii. patients mobile platform,
iii. admin/ record management module and
iv. physician report modules.

At the login/ account creation module, the user/ patient after getting or downloading the mobile patient management application signs up/ create a user account with a distinct username and password that will allow him gain access into the application to update his profile. If the user does not have an existing account he cannot use the application. Once the account has been created the user automatically has an electronic medical record folder created for him/her in the given healthcare institution/ hospital. Furthermore, the user also known as the patient can book or create a doctor's appointment which will be stored on the systems database to be seen only and updated by the admin and doctors respectively. It is important to note that from the appointment creation module the user can also cancel his appointment if he cannot attend. The doctors from their own end gain access to all the appointment, attends to the patients and the saves their report in the systems' database for future use. To this end, when a patient has a repeat visit or has an emergency, it is easy to access their medical history/ records by a click and medical attention given to them.

2.2 UML Diagram of the proposed System

Software modelling is an active field of research

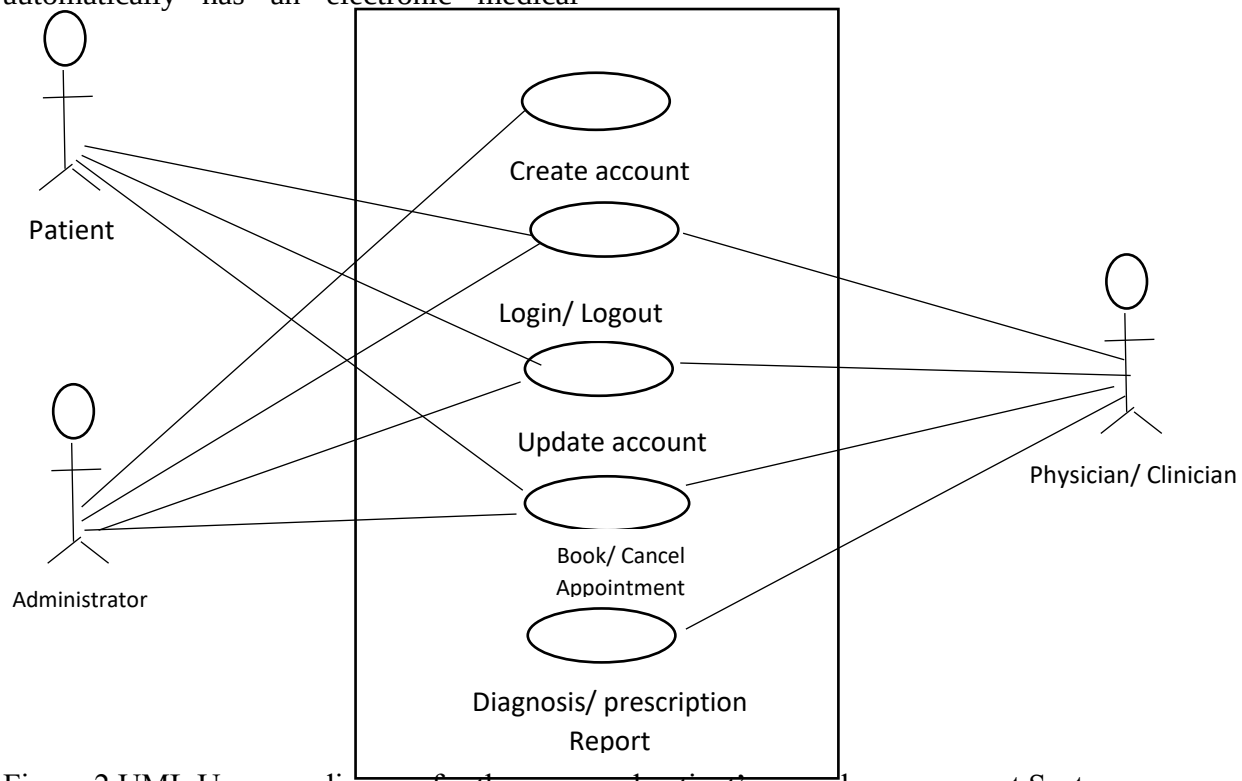

Figure 2 UML Use case diagram for the proposed patient's record management System

Flowchart of the proposed System

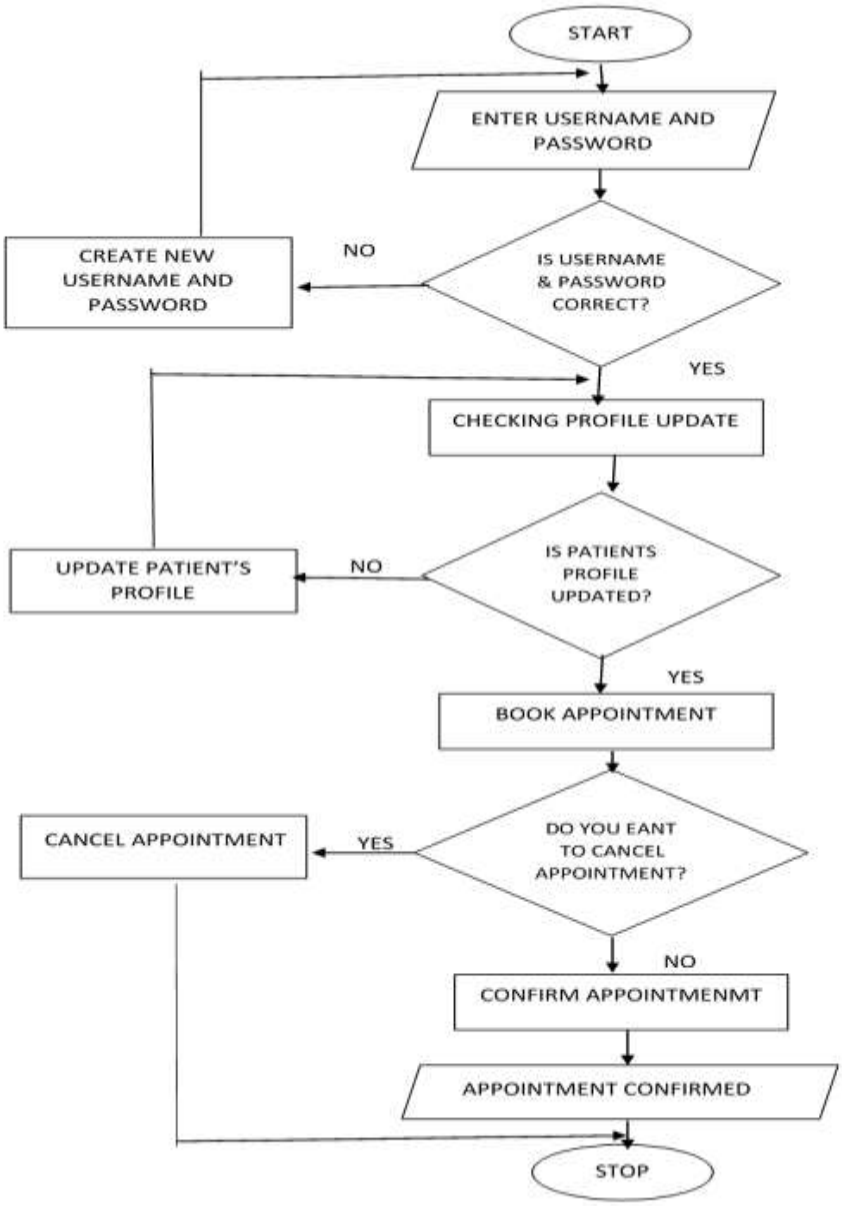

Figure 3 Flowchart of the Proposed Health Record Management System

where unified modelling language UML is considered a standard for software design. UML has played an important role in recent time to elicit the important understanding of a software and its effectiveness (Karasneh and Chaudron, 2013). UML use case diagram describes the user interaction with the system giving details of what the system should do and the role of the user from an external view point (Nayak and Samanta, 2012). It is also a good technique for gathering systems requirement for the viewpoint of the user. In the proposed system the user interaction is basically that of the patients, doctors and system administrators. It is important to note that the UML diagram will illustrate the systems activities with regards to what each actor and responsibility, activities and interaction with system will be. Figure 3.4 shows the UML use case diagram for the

proposed mobile patients record management system taking into consideration all the actors involved in the use of the system.

A flowchart is a graphical representation of the sequence of the operations and flow of a computer program or system showing how data flows from source documents through and the interaction between the different components to the final distribution to users. The propose system flowchart in figure 3 shows the flow of operation in the mobile patient record system.

2.3 System Design Specification

The various design specification for the proposed system covers both the front-end and back-end design of the system which enable for easy integration of the various system component for the smooth running of the system. These design specifications include the input, output and database design specifications respectively. The design phase stipulates the various design procedures required to efficiently implement a robust, secured dynamic information system for patients records management.

2.4 Input Design of the Proposed System

The input design entails all the required input fields and attributed of the user interface that the user would have to engage as they use the system to carry out their statutory responsibilities. Figure 4 shows the different input fields of the mobile patients' health records management system that would be stored in the database for future use.

2.5 Output Design of the Proposed System

The output design shows the output screen that will be seen when the system has been deployed as shown in figure indicating the different fields that will be displayed once the user concludes the data entry process to execute either the profile update or the doctor's appointment booking process.

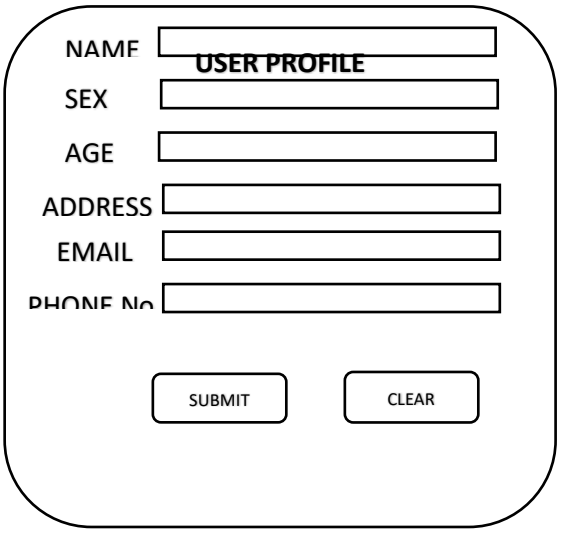

Figure 4: Input Design

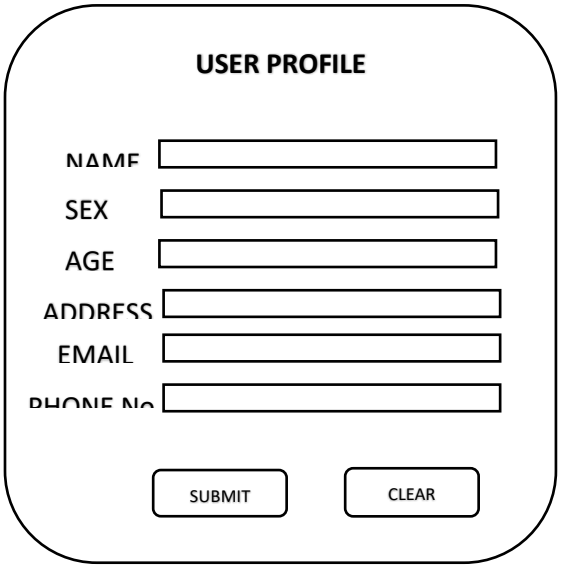

Figure 5: Output design

Entails the processes that the proposed system will undergo to perform and accomplish the design goal with respect to the dissertation aim and objectives. Software process design transform user requirements into some suitable form, which helps the programmer in software coding and implementation. Because each step in a new process represents a task performed by different modules in the program, therefore,

process design plays an important role in quality assurance of a software system. Going forward, in project management terms process design can be used to;

i. Identify weak links and potential bottlenecks in internal activities
ii. Show where automation might improve a new business procedure
iii. Enhance workflow understanding for new team members.

Some of the process design tools used in software development process include flowcharts, dataflow diagrams, algorithms, etc. The flowchart for the proposed system in figure 3.4 shows the pictorial representation of the flow of the program for the mobile healthcare records management system.

2.6 Database Design

The database design for the proposed system comprises of three database tables designed to handle the user authentication/ login and security component of the system, the patients profile/ bio-data which hold information critical to the patient's identity and the diagnosis/ treatment component which holds information relating to the patients treatment and medical history which can be referenced from time to time by the physician to ascertain the level of care delivered to the patient. The as tables 1, 2 and 3 indicates the different database tables in the proposed system.

Table 1 Login Authentication table for the proposed System

SN	FIELD NAME	DATA TYPE	DATA SIZE	STATUS
1	Username	VARCHAR	10	PK
2	Password	VARCHAR	10	
3	Secret questions	VARCHAR	20	
4	Answer	VARCHAR	20	

Table 2 Patients Profile/ Bio-data Table

SN	FIELD NAME	DATA TYPE	DATA SIZE	STATUS
1	Patient_ID	VARCHAR	10	PK
2	Name	VARCHAR	30	
3	Gender	VARCHAR	6	
4	Age	DATE	3	
4	Address	VARCHAR	100	
5	Email	VARCHAR	50	
6	Phone No.	VARCHAR	50	

Table 3 Diagnosis/ Treatment Table

SN	FIELD NAME	DATA TYPE	DATA SIZE	STATUS
1	Patient_ID	VARCHAR	10	PK
2	Doctor Name	VARCHAR	30	
3	Date	DATE	10	
4	Patient Name	VARCHAR	30	
5	Gender	VARCHAR	10	
6	Diagnosis	VARCHAR	100	
7	Prescription	VARCHAR	100	
8	Referral	VARCHAR	100	
9	Next Visit	DATE	10	

2.7 Security Design of the Proposed System

The security design of the proposed system includes the data security and privacy concern of the system. This ensure that only authorized users have access to the system to reduce the risk of data loss, theft and human error. The security ranges for the login restriction to the data type deployed for the system. The security design includes the processes put in place to manage both human and software issues that may arise in the course of the design, development and implementation of the system.

3. RESULTS ANALYSIS AND DISCUSSIONS

This dissertation is implemented using mobile application development framework with an integrated development environment (IDE) that as the application is designed to allow the user perform the basic operation as it manly an android base platform that is designed to support provision of healthcare delivery services, and allow the user to register, book appointment and check their appointment status on the healthcare facility or hospital they are registered with. It also gives the medical practitioners the opportunity to see their proposed patients for the day and also reschedule if they cannot attend to them. As stated earlier the project is an android base application and the implementation programming language is Java programming language on android studio integrated development environment (IDE).

The new system consists of various forms and activities developed to enhance the user experience and interaction with the system making it easy for the patient download the mobile App, register and create account, login, create and update their profile, book appointment to see a doctor, check booking and medical history. It also provides the modules for the medical doctor to check booking and patients' history remotely from any location not necessarily from the hospital. The various forms include;

i. **Login Form**: This is where users will sign in to use the application. It is important to note that before any user can use the system, that user must have registered/ signed-up on the application to be able to use the system. The login serves as a security check for unauthorized access into the system as it works as user authentication module of the system. The login form is indicated in Figure 6

ii. **Registration Form:** This component of the new system is the part where a user after downloading the mobile application will have to input their personal information and details to register and use the system. The registration module serves as a basic hospital register as the information entered here is stored on the Hospitals database and can be accessed remotely from anywhere in the world. This enables the patient/ user to officially register as a patient on the platform of the given healthcare institution. Figure 7 shows the registration module of the new system. After a user/ patient finish entering their details, they click on the register button to effect and commit the data into the hospital record system/ database. Then the user can click on the login button to officially login and access the various functions of the system.

Figure 6 Login Form

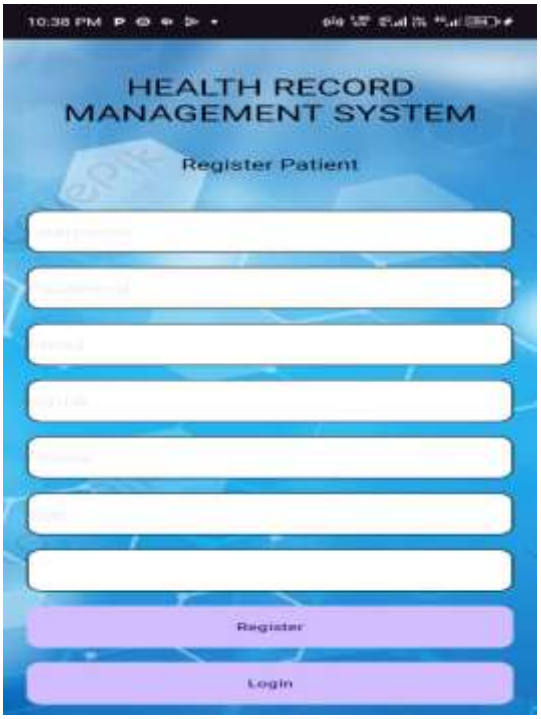

Figure 7 Patient Register

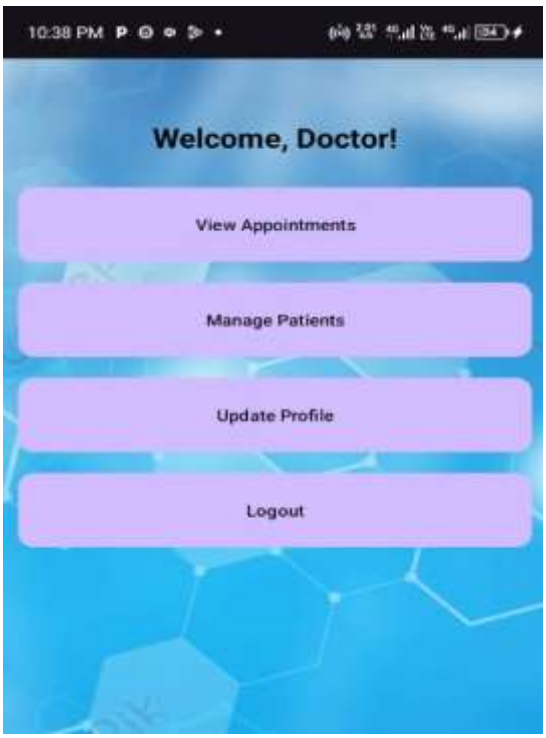

Figure 8 Doctors Module

Figure 9 Patients Management Module

iii. **Doctors' Module:** This module is the part of the mobile application where the doctor/ physician logs in to attend to patients and also review what has already been done. In this module the doctor accesses the list of patients that have made appointment for the day and also attends to them. This module also have sub-module that gives the doctor/ physician access to the patients record so that as they finish attending to a particular patient, they save and the patient's record is updated for future purposes thereby keeping track of the patients health record. This electronic record is updated from time to time as the patient visits the healthcare facility for on health related purpose or the other and also as they use their mobile applications to book and make request from the system. The doctor's modules in figure 8 and 9 is used to view and manages appointment.

iv. **Patients Module:** The patients' module serves as a channel through which the patients will interact with the healthcare provider/ hospital to book appointment to see a doctor/ physician. From this module as indicated in Figure 10, the various sub-menus enable the patient to navigate to the desired activity on the application. The patients profile update module in Figure 4.6 enables the patient to update their profile which will make up their personal information on the systems database to enable the healthcare institution to identify the exact user/ patient they are attending to. For booking or

setting up an appointment with the doctor as indicated in Figure 11, the patient will have the opportunity to book an appointment with a doctor of his or her choice from the list of available doctors in the hospital. Also Figure 12 enables the patient to view their appointments and know when they have an appointment with the doctors to visit the hospital.

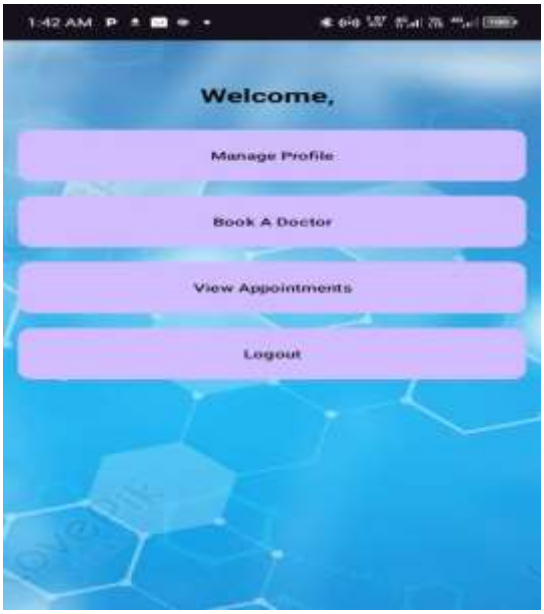

Figure 10 Patients Module

Figure 11 Patients Profile update

Figure 12 Doctors Appointment Page

Figure 13 Appointment Viewing Page

Empirical Analysis of the Result

The proposed mobile healthcare record management system outstands the existing system in all functional areas:

1. Portability: Increased by 30% (60% to 90%)

2. Ease/User Experience: Improved by 50% (40% to 90%)

3. Accessibility: Enhanced by 60% (30% to 90%)

4. Cost: Reduced by 60% (80% to 20%)

5. Access Time: Improved by 80% (50% to 90%)

6. Appointment Booking Time: Reduced by 60% (30% to 90%)

7. Data Security: Enhanced by 50% (40% to 90%)

The proposed system demonstrates significant improvements in user experience, accessibility, and data security, while reducing costs and appointment booking times.

Table 4 Empirical Analysis Result of the Proposed System

S/N	Functionalities	Existing System	New System	Improvement	Statistical Significance
1	Portability	60%	90%	30%	0.01
2	User Experiences	40%	90%	50%	0.005
3	Accessibility	30%	90%	60%	0.001
4	Cost	80%	20%	60%	0.01
5	Access Time	50%	90%	40%	0.05
6	Appointment Booking Time	30%	90%	60%	0.001
7	Data Security	40%	90%	50%	0.005

Comparative Analysis of the Existing and Proposed System

After an exhaustive comparative analysis of the functionality of the existing system by Yahaya et al (2019) adopted in the development of the UNIBEN Teaching Hospital (UBTH) hospital information management system and the proposed mobile healthcare record management system, the new systems outperformed the existing system in the following area as indicated in Table 5

Table 5 Comparison of the Existing and New System

S/No	Functionalities	Existing system	Proposed/New System
1	Portability	Portable	More Portable
2	Ease/ User Experience	Poor	High
3	Accessibility	Low	High
4	Cost	High	Low
5	Access time	30 Minutes	60 seconds
6	Appointment booking time	1 hour	5 Minutes
7	Data Security	Low	High

One of the major setbacks of the existing system that the new mobile healthcare information management system overcame is the issue of time for booking and checking patients for doctor's appointment. The existing system still requires the patient to come to the hospital to book their doctor's appointment which will take an average of one hour to book depending on the numbers of patients on the waiting queue to see the available doctors while the new system allows the patient to remotely book and select from the list of available doctors which one to see for their medical consultation. In terms of data security and integrity the new system implements user authentication mechanism which restricts unauthorized users from accessing the system to steal valuable personal health information through the use of the login mechanism that is user centric.

Result Tested Analysis of the Proposed System

1. Healthcare Professionals' Feedback (Doctors, Nurses, Admin Staff)
   - **Improved Accessibility:** *"With this system, I can access patient records instantly from my mobile device, reducing waiting time by at least 50%."* – Dr. Kare, General Practitioner
   - **Reduced Errors:** *"Prescription errors have significantly decreased since we started using the system, as it flags potential drug interactions in real-time."* – Nurse Chioma, Senior Nurse
   - **Ease of Use:** *"The interface is intuitive, making it easier for new staff to adapt without extensive training."* – Hospital IT Manager
2. Patient Feedback
   - **Better Engagement:** *"I can now track my medical history and upcoming appointments through the mobile app, which was never possible with paper records."* – Tolu, a 45-year-old patient
   - **Faster Service:** *"Before, I had to wait for my files to be retrieved manually, but now the doctor has my records available instantly."* – Fatima, 30-year-old mother
   - **Security Concerns:** *"I appreciate the added security features like biometric login, which make me feel my health records are safe."* – Chinedu, a 50-year-old patient
3. Administrative and Operational Insights
   - **Cost Reduction:** *"Printing and storing paper records was a major expense. This system has cut those*

costs by 60%." – Hospital Administrator

- **Efficiency in Record Keeping:** *"With the automated backup and cloud synchronization, we no longer worry about data loss."* – IT Specialist
- **Interoperability:** *"The ability to integrate with laboratory and pharmacy systems has streamlined operations significantly."* – Medical Records Officer

4. Challenges and Areas for Improvement
   - **Network Dependency:** *"The system relies heavily on internet connectivity, which can be a challenge in remote areas."* – Clinic Staff in Rural Area
   - **Initial Learning Curve:** *"Some older staff members needed additional training to transition from paper-based records to the digital system."* – Training Coordinator

4. CONCLUSION

The importance of an enhanced healthcare record management system cannot be overemphasized in a technologically evolving world like ours as these changes within split seconds and human need as desire for healthcare service delivery increases so also the need for proper health record management system. The miniaturization of the electronic health record management information system to mobile application has served as a tool for enhance healthcare delivery as patients can remotely and view their health record and make appointment to see the doctor without necessarily visiting the hospital or healthcare institution to do so. This has not only enhanced the record management system of the healthcare sector; it also has improved the level of their clientel and boost the morale of the staff. This has also improved accessibility, reduce booking time, allocation of doctors, recuded cost and enhanced the user experience (UX).

The new system developed using JAVA with Android studio integrated development environment is easy to use, portable, flexible, rubost, accessible, efficient with user friendly interface. With this application, patients can be able to easily assess their portal, view their medical history and know their status remotely from anywhere and get their health report immediately. This application is very useful for both the healthcare practitioners and the patients alike.

Recommendation

The study presents the development of an improved health record management system using mobile application framework and the system here developed is meant to simplify the process of health record information management with respect to patients record and care as it provides remote access to patients record and interaction with the hospital record management system. This work therefore could be recommended to the following groups and persons;

i. Doctors and medical practitioners could adopt and use of the application as it was designed to suits their needs with an easy-to-use interface,
ii. Patients and users to easily access the hospital remotely without physically going to make doctors appointment,
iii. Government and NGOs can leverage on the application to improve their advocacy healthcare information management system development.

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