

ENHANCED HEALTH (RECORD) INFORMATION MANAGEMENT SYSTEM USING MOBILE APPLICATION DEVELOPMENT FRAMEWORK

B.N. Uchechukwu (1,*)
M.A. Ohinameuwa (1)

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¹ Department of Computer Science, Federal University of Petroleum Resources, Effurun Delta State

* Corresponding Author's Email: Nwozor.blessing@fupre.edu.ng

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

B. N. Uchechukwu
Department of Computer
Science, Federal University of
Petroleum Resources, Effurun
Delta State
Nwozor.blessing@fupre.edu.ng

M. A. Ohinameuwa
Department of Computer
Science, Federal University of
Petroleum Resources, Effurun
Delta State
ataso246@gmail.com

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, unauthorized 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 a mobile application development framework. The system was developed using the Android Studio integrated development environment (IDE) and the Java programming language, with an 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-hours and boosting the morale of both staff and patients.

Keywords— Health Record, Web-Based, Platform, Management, Booking, Appointment, Security, Application, Software.

I. 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 [1]. The World Health Organization (WHO) defines health not just as the absence of disease but as a state of physical, mental, and social well-being

[2]. In all economies, health is a critical element for socioeconomic progress and poverty reduction [3]. 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 [4]. 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 [5]. 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 [6]. 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 [7]. 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.

II. BACKGROUND & LITERATURE REVIEW

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. There are three theoretical contexts in record management, which include functional, professional, and intellectual concepts, respectively [8].

A. 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 [9]. 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 [10]. 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 [11]. 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 [12]. 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.

B. 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 [13]. 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 [14].

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 [15]. The rise of electronic medical records (EMRs) has streamlined records management but faces resistance due to learning curves and legal considerations [16]. 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 [17]. As healthcare evolves, robust health information systems are crucial for managing data effectively and ensuring high-quality care [18].

C. 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 [19]. According to [20], electronic health record (EHR) systems are designed in a way that reduces paper medical records to store data accurately and legibly in a digital format. Digitally, health records reduce the risk of data replication, as files can be shared across the different health care systems and can be modified and updated, which reduces the risk of lost paperwork. EHR programs directly benefit the physicians, patients, and obviously the healthcare systems. Electronic patient information systems, according to [21], 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 [22]. 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 [20].

- 1) *Cost & 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.

- 2) *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.
- 3) *Access & 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.

D. Evolution of Mobile Applications in Health Information Systems

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 [23]. Mobile application development involves creating installable programs that use network connectivity for backend services [24]. 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 [23]. 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 [25]. Initially called "wireless telemedicine" [26], mHealth enhances access, quality, and affordability [27]. Its impact spans chronic disease management, telemedicine, and electronic records. Mobile technologies have disrupted healthcare, improving clinical decision-making and patient outcomes [28]. However, concerns over validation and standardization persist [29]. Faster processors and open-source systems have further accelerated mobile integration into clinical practice [30]. With ongoing innovation, mobile technology continues to redefine healthcare delivery worldwide.

E. 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 [31]. 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 behavior [32]. 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:

- 1) *Professional Healthcare Apps*:
 - a) Medical reference & database apps
 - b) Professional networking apps
 - c) Patient medical health tracking apps
 - d) Doctor appointment & clinical assistance apps
 - e) Telehealth mobile apps (doctor-on-demand apps)
 - f) Mobile Health Apps for Patients
- 2) *Patient Medical Education Apps*:
 - a) Reminder apps -includes medical tracking apps or some health habit
 - b) Patients records and appointment apps
 - c) Diagnosis apps for preventive purposes
 - d) Healthy lifestyle apps
 - e) Monitoring apps for chronic conditions
 - f) Mental health apps
 - g) Dieting apps
 - h) Women's health apps

3) *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 [33], these factors could include:

- a) Proportion of people with a mobile phone in a population in the region
- b) Internet accessibility,
- c) Power supply stability,
- d) Purposes/functionality,
- e) Mobile healthcare application (mhealth apps) authorship and maintenance,
- f) Climatic/environmental conditions,
- g) Data security and,
- h) 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 between healthcare providers and healthcare providers. Because the power source is stable, the gadget's batteries can

be charged on a regular basis to ensure proper functionality. However, when there is an epileptic power supply and the gadget battery runs out, the gadget 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 environmental 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, protects the contents of their devices, and automates user actions is critical.

F. Related Work

Developed a web-based hospital management system using HTML, CSS, and PHP to streamline patient registration, appointments, billing, and medical records [36]. It enhances coordination among hospital staff while ensuring secure remote access to patient data.

Designed an automated patient record system with MySQL, PHP, and JavaScript, improving service efficiency and lowering costs [4]. Highlighted inefficiencies in paper-based records, advocating for an online system to enhance data storage, retrieval, and security [35].

Proposed a smartcard-based electronic health record system at the University of Ilorin, improving accessibility but requiring hospital visits for record retrieval [36]. A PHP-MySQL hospital management system focused on patient and physician data security [37]. Disease prediction and QR code generation using Naïve Bayes and Blowfish algorithms to enhance authentication [40].

Automated search functions for hospital management, optimizing workflow [39]. Replacing paper-based systems for improved data security but noted the lack of pharmacy notifications and asset management [40].

A secure health portal where doctors access reports via OTP authentication [41]. An online healthcare system with appointment scheduling, online payments, and chatbot support [42].

A mobile PHR app to centralize personal health data from smart devices [43]. An RFID-based electronic health record system, improving patient identification [44].

III. 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 [45].

A. Justification of the Adopted Methodology

Rapid application development (RAD) methodology is flexible and adaptable to changes. The following are some of the rationales for the choice of the methodology for the development of a mobile patient's record management system:

- 1) Reduction of the overall project risk,
- 2) It is easier to transfer deliverables as scripts,
- 3) High-level abstractions and intermediate codes are used,
- 4) It enables code generators, code reuse, and reduces manual coding.
- 5) It is prototyping in nature; there is a possibility of a lesser defect,
- 6) Every phrase in the methodology delivers the highest priority functionality to the client with fewer people and increased productivity in a short time.

B. Architecture of the Proposed 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, smartphones, or other handheld devices. The system is secure and personalized for each user, making it more safe and ensuring a 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 one of the functional modules of the system. The proposed system acts as an interface between the patients and the hospital health record management system.

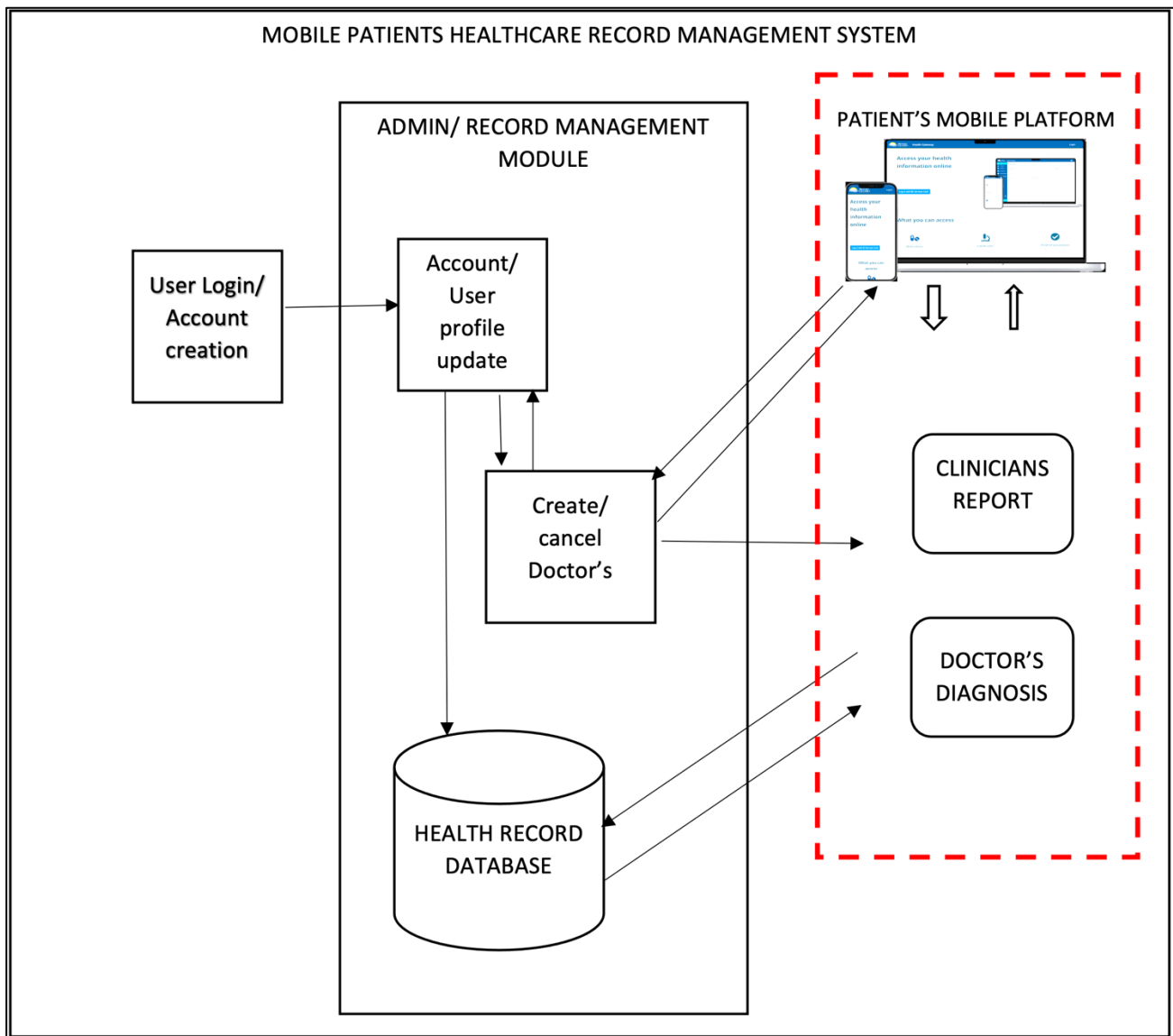


Figure. 1. Architecture of the Proposed Mobile Patient's Record Management System

C. Description of the Proposed Systems Architecture

The proposed system architecture in figure 1 comprises three main modules, which include

- 1) The login/account creation module,
- 2) Patients mobile platform,
- 3) Admin/record management module and
- 4) Physician report modules.

At the login/account creation module, the user/patient, after getting or downloading the mobile patient management application, signs up/creates a user account with a distinct username and password that will allow him to gain access to 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 system's 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 appointments, attend to the patients, and save 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 with a click, and medical attention is given to them.

D. UML Diagram of the Proposed System

Software modeling is an active field of research where the unified modeling language (UML) is considered a standard for software design. UML has played an important role in recent times in eliciting the important understanding of software and its effectiveness [46]. A 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 viewpoint [47]. It is also a good technique for gathering systems requirements from 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 system's activities with regards to what each actor's responsibilities and activities are and how they interact with the system. Figure 2 shows the UML use case diagram for the

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

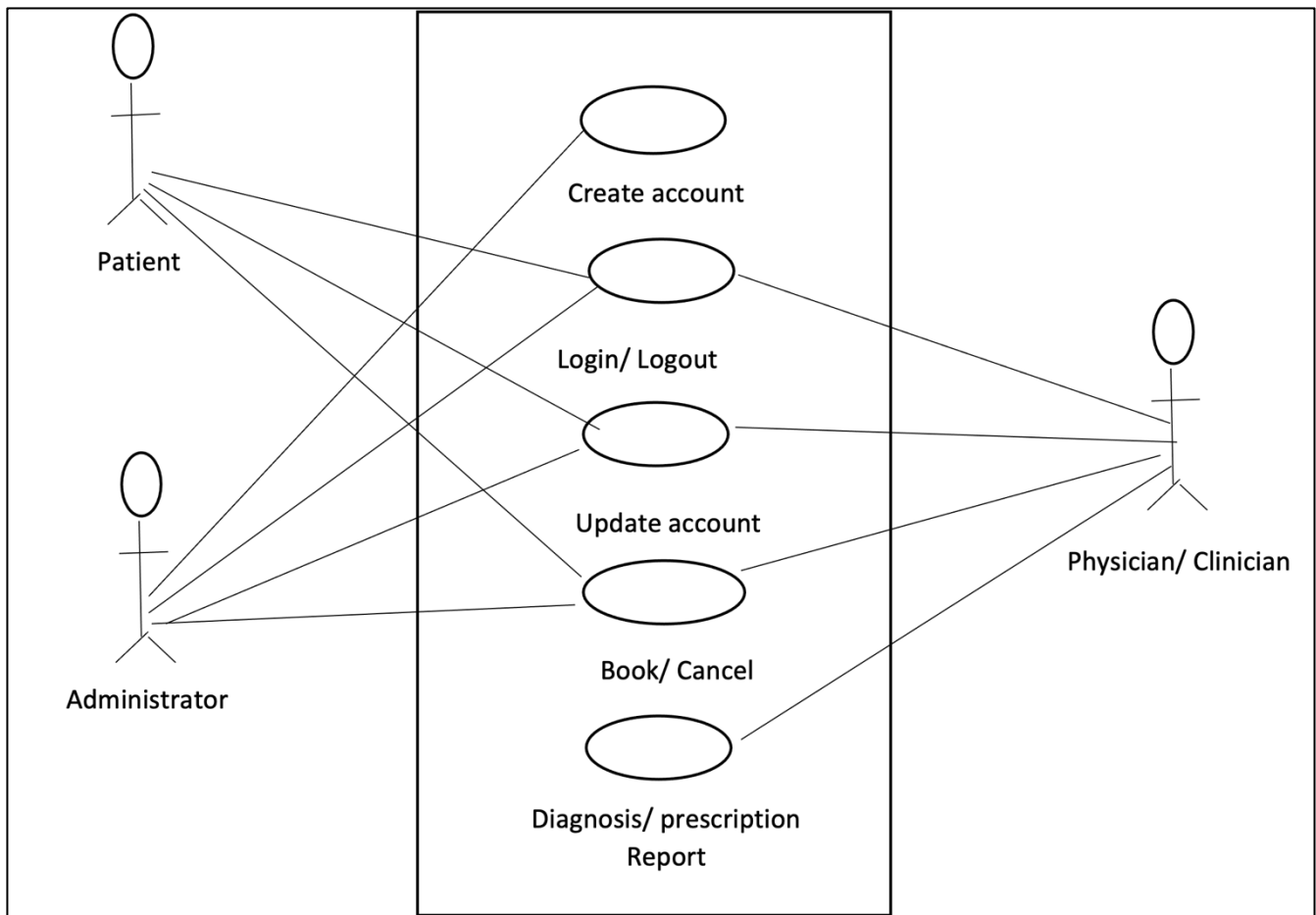


Figure. 2. UML Use case diagram for the proposed patient's record management System
 Flowchart of the proposed System

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 proposed system flowchart in figure 3 shows the flow of operation in the mobile patient record system.

E. 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.

F. 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.

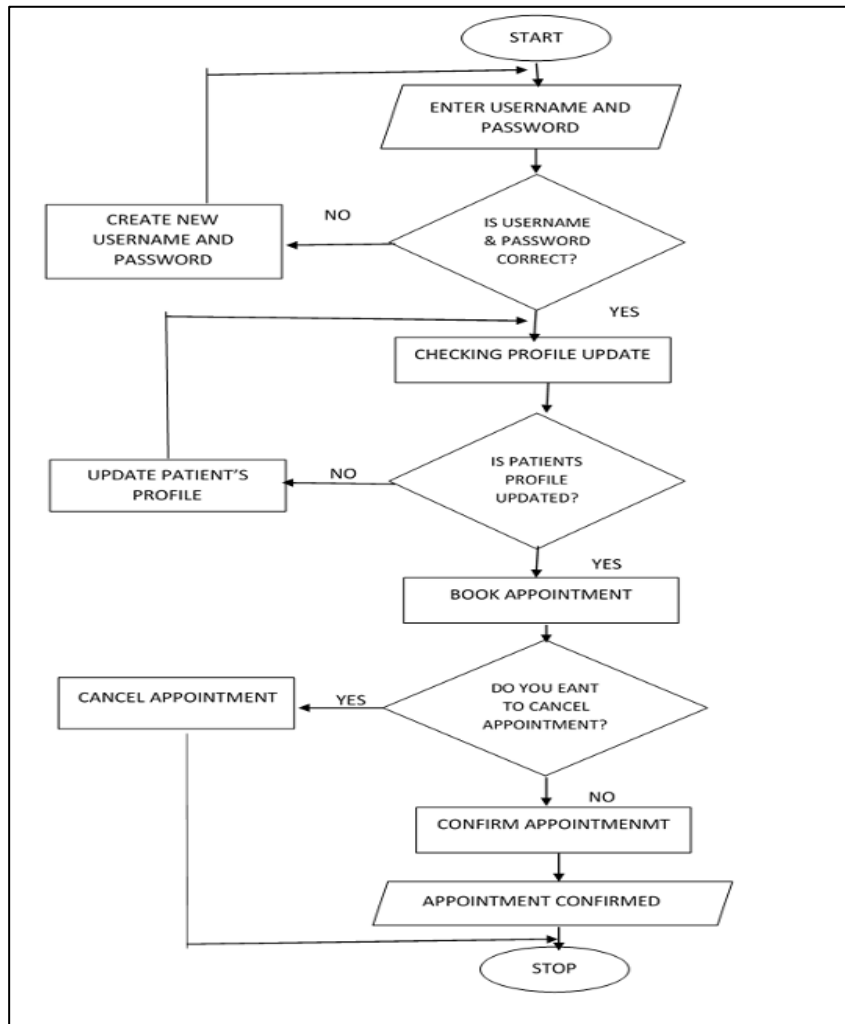


Figure 3. Flowchart of the Proposed Health Record Management System

G. 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. 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:

- 1) Identify weak links and potential bottlenecks in internal activities
- 2) Show where automation might improve a new business procedure

- 3) 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.

H. 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.

Figure 4. Input Design

Figure 5. Output Design

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	

I. Security Design of the Proposed System

The security design of the proposed system includes the data security and privacy concern of the system. This ensures 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.

IV. RESULT ANALYSIS & DISCUSSIONS

This dissertation is implemented using a mobile application development framework with an integrated development environment (IDE) that, as the application is designed to allow the user to perform the basic operation, is mainly an Android-based platform that is designed to support the provision of healthcare delivery services and allow the user to register, book appointments, and check their appointment status at 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-based application, and the implementation programming language is Java programming language on the 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 to download the mobile app, register and create an account, log in, create and update their profile, book an appointment to see a doctor, and 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:

A. 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 the user authentication module of the system. The login form is indicated in Figure 6.

B. 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 hospital's 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 finishes 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 log in and access the various functions of the system.

C. 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.

D. 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 6. Login Form

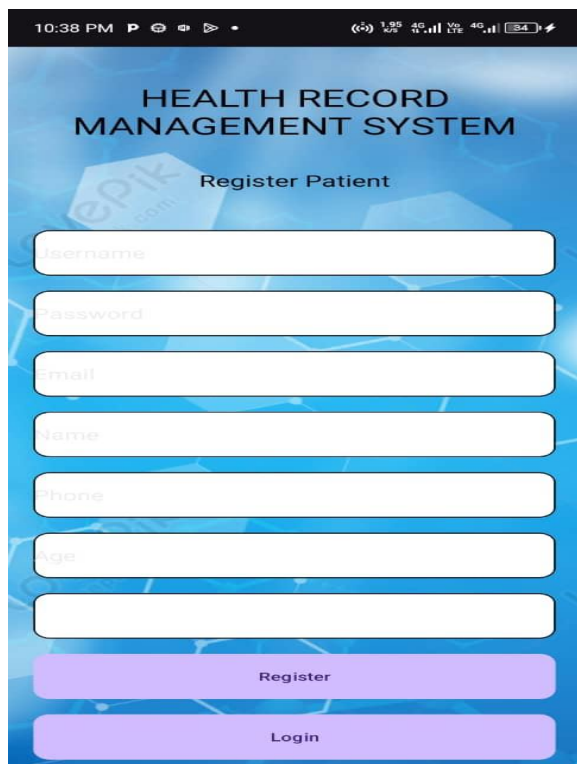


Figure 7. Patient Register

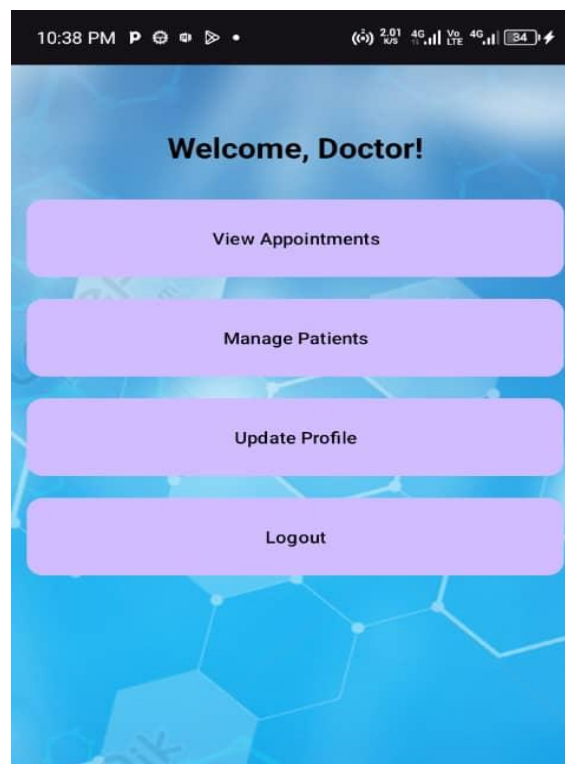


Figure 8. Doctors Module

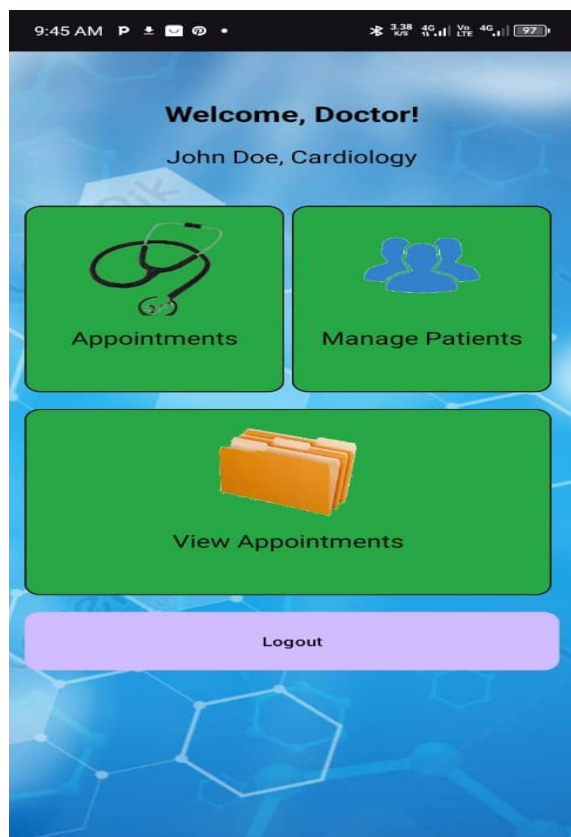


Figure 9. Patients Management Module

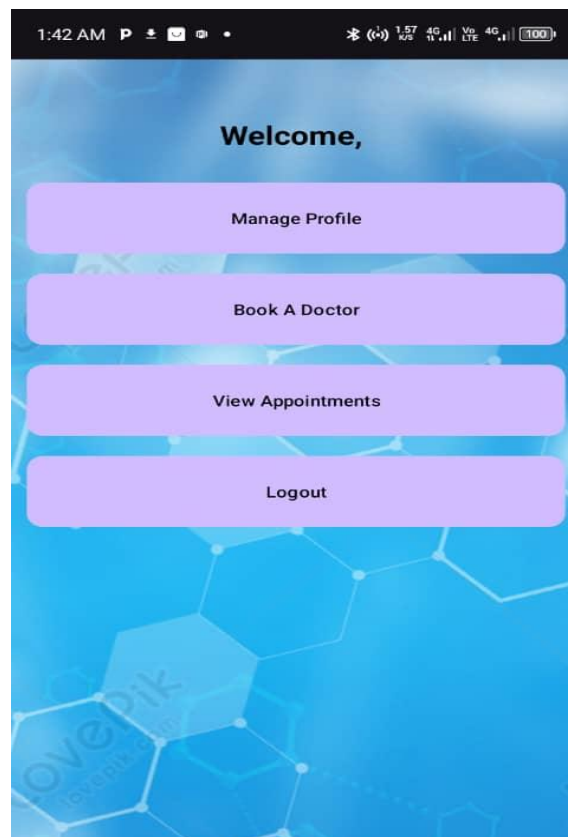


Figure 10. Patients Module



Figure 11. Patients Profile Update

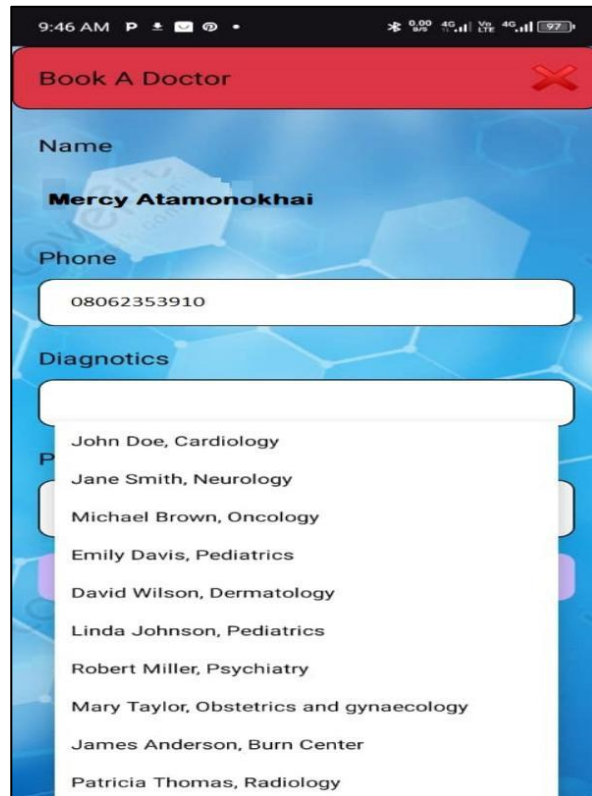


Figure 12. Doctors Appointment Page

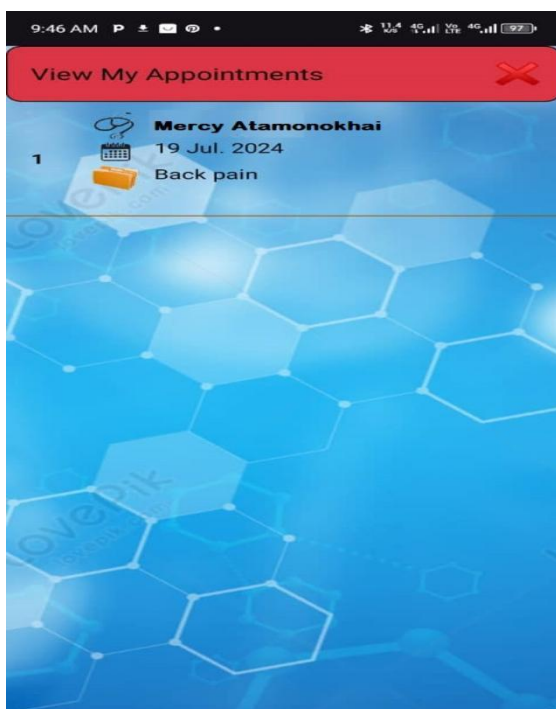


Figure 13. Appointment Viewing Page

E. 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.

F. Comparative Analysis of the Existing and Proposed System

After an exhaustive comparative analysis of the functionality of the existing system by [38] 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. 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.

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

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

G. 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 & 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 & 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.

V. CONCLUSIONS

The importance of an enhanced healthcare record management system cannot be overemphasized in a technologically evolving world like ours, as this changes within split seconds, and human need, as desire for healthcare service delivery increases, so also the need for a proper health record management system. The miniaturization of the electronic health record management information system to

mobile applications has served as a tool for enhancing healthcare delivery, as patients can remotely view their health records and make appointments 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 clientele and boosted the morale of the staff. This has also improved accessibility, reduced booking time, allocated doctors, reduced costs, and enhanced the user experience (UX). The new system developed using JAVA with the Android Studio integrated development environment is easy to use, portable, flexible, robust, accessible, and efficient with a user-friendly interface. With this application, patients can easily assess their portal, view their medical history, 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 a mobile application framework, and the system here developed is meant to simplify the process of health record information management with respect to patients records and care as it provides remote access to patients records and interaction with the hospital record management system. This work therefore could be recommended to the following groups and persons:

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

A. Contribution to Knowledge

The contribution of this work to the body of knowledge is in the area of the development of a mobile application for the enhancement of healthcare information management systems with respect to health record management, giving both the healthcare sector and academia the opportunity for more research and development in health record management to improve service delivery and patient safety, as it is their duty of care to do.

B. Suggestion for Further Studies

This study on the **Enhanced Health Record Information Management System Using Mobile Application Development Framework** has provided valuable insights into utilizing mobile application frameworks for improving health record management, offering a more efficient, portable, and secure solution compared to traditional systems. However, the ongoing development of mobile technologies presents opportunities for further investigation. Below are numbered recommendations for future research and development, aimed at improving the study's findings, enhancing the mobile health record application, and addressing current limitations:

- 1) **Cross-Platform Development:** Future studies could explore the development of a cross-platform mobile application that functions seamlessly across both Android and iOS, ensuring a broader user base and improved accessibility for diverse patients and healthcare providers.
- 2) **Advanced Data Security Measures:** As security remains a top concern in health data management, further research could focus on incorporating advanced encryption protocols, multi-factor authentication, and secure cloud storage solutions to protect patient data and ensure privacy.
- 3) **Integration with Hospital Systems:** Future research can explore the integration of mobile health record systems with existing hospital management systems (HMS), enabling seamless data exchange between various departments, such as patient registration, lab results, and prescriptions, thus improving overall healthcare delivery.
- 4) **Real-Time Data Synchronization:** Investigating how mobile health applications can synchronize patient records in real-time with hospital databases, especially in areas with intermittent internet connectivity, will improve data accuracy and accessibility during patient care.
- 5) **Usability and User Experience (UX):** Further research can assess the user interface and user experience (UX) design to ensure that the mobile health record system is intuitive and easy to use, particularly for patients who may not be familiar with technology or healthcare professionals who require fast access to records.
- 6) **Scalability in Low-Resource Settings:** Future studies could focus on adapting mobile health record systems for low-resource settings, where internet access is limited or unreliable, ensuring that the system can still function efficiently in rural or underserved areas.

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