Development of a Web based Health Application for Improved Healthcare Delivery Services in Nigeria

O.A. Daramola, O.A. Madamidola, H.T. Odewale
Department of Information Technology, School of Computing,
The Federal University of Technology, Akure, Ondo State Nigeria
Corresponding Author: Madamidola Olugbenga Ayomide

ABSTRACT
The healthcare sector in Nigeria is facing several challenges such as inadequate healthcare facilities, shortage of skilled healthcare professionals, and lack of adequate infrastructure. As a result, patients are forced to travel long distances to receive medical attention, which often results in increased healthcare costs and sometimes decreased quality of care. This work involves the development of a web-based health application that connects patients with healthcare providers in a timely and efficient manner. The application provided patients with access to a range of healthcare services such as booking appointments, viewing medical records, and communicating with healthcare providers. Additionally, the application allowed healthcare providers to manage their patient's medical records, schedule appointments, and provide remote consultations. The implementation of the web-based health application involved the use of modern web technologies such as JavaScript, PHP, and Laravel. The application was also designed with security and privacy in mind, as patient data was highly sensitive and must be protected always. The effectiveness of the application was evaluated through user acceptance testing, which involved gathering feedback from patients and healthcare providers. The project focuses on improving the efficiency and effectiveness of healthcare delivery services in Nigeria, which could lead to improved health outcomes for the population.

Keywords
Health Application, Improved Healthcare, Web Technologies, Healthcare Providers, Patient

1. INTRODUCTION
The healthcare sector plays a vital role in the well-being of a nation's citizens. With the increasing population and rapid urbanization, there is a rising demand for quality healthcare services. The healthcare system in Nigeria is plagued by a few challenges such as inadequate funding, inadequate number of healthcare facilities and personnel, and poor access to healthcare for rural and low-income populations. In recent years, the use of technology has been identified as a potential solution to these challenges (Madamidola et al, 2017). In particular, the use of web-based healthcare applications has the potential to improve communication and information-sharing among patients, doctors, and other stakeholders, and to make healthcare services more accessible and cost-effective.

The healthcare industry has been undergoing significant advancements in computing technology to electronically manage and disseminate patient information, enhancing the quality of care. Mobile e-health utilizes a range of information and telecommunication technologies to offer healthcare services to distant patients and support mobile healthcare professionals. These applications bring numerous benefits, primarily improving access to medical resources and care. In recent times, the healthcare and related fields have embraced mobile technology through the adoption of e-healthcare applications. While some smaller medical units have implemented mobile workstations for easier access to specialist advice, most of these applications are geared towards supporting patients in their homes (Avancha, Baxi and Kotz, 2012). Mobile e-health solutions can take two forms: one that places the patient or caregiver in control, providing direct access to a mobile phone to communicate with healthcare professionals such as doctors, nurses, or counselors. The other form places the nurse in charge, giving those who care for patients at home direct access to mobile applications for communication with other medical staff. Mobile healthcare has immense potential to enhance efficiency, enhance the quality of care, enable doctors to monitor patients' health, provide patients with more convenient healthcare outside the hospital, improve the quality of home care for seniors, and reduce the cost of care by reducing the need for visits to the doctor (Wenquan and Kim, 2018). A recent study suggests that patients who review their e-health records are more likely to comprehend their medical conditions better and to adhere to their prescribed medications (Shoewu et al, 2021). E-health applications are believed to empower patients, reducing confusion, enhancing medication adherence (Shoewu et al., 2021), fostering stronger doctor-patient relationships, facilitating informed questions, and alleviating anxiety and confusion without adding workload for healthcare providers (Jonathan, 2012). According to Dr. Jonathan Pell, an assistant professor at the University of Colorado in Denver, quoted by the World Health Organization (WHO, 1993), increased transparency through sharing electronic medical records with patients during hospitalization is expected to increase patient engagement, satisfaction, and lead to the detection of errors through informed questions (Madamidola et al, 2024).. However, some experts believe that an excess of information may cause patients to panic, and that less-educated patients may require additional support to understand their health records (WHO, 1993).

2. RELATED WORK
In the healthcare system, different applications have been designed and implemented from a plethora of scholarly works. Extant literature has proven the resourcefulness of these initiatives across different countries whether developed or developing. The models used in developing these applications and their specific functionalities differ in accordance with their needs.

Grant et al., (2006) presented a study on a diabetes patient web-portal aimed at addressing the challenges faced in providing effective diabetes care. The web-portal was designed with a conceptual framework and linked directly to the electronic

health record (EHR) of a large academic medical center through secure internet access. The study also described the implementation and analysis plan for the web-portal.

Lekan and Oloruntoba (2017) designed a web-based appointment and scheduling system with the aim of improving efficiency and reducing waiting time in healthcare facilities. The system was developed using AngularJS for the front-end, an Ajax framework for handling client-server requests, and Sqlite3 and MYSQL for the back-end. The system was created to ensure efficient use of resources and improve the overall experience for patients by reducing the amount of time they must wait for appointments.

Gárate et al., (2018) presents the development of a mHealth system that utilizes WebRTC technology to enable videoconferencing and messaging between patients and their healthcare providers. The aim of this system was to decrease in-person visits, reduce the burden on healthcare systems, and enhance the quality of care provided. However, the team faced difficulties in integrating the OpenVidu architecture into the system. Additionally, the system faced resistance from both patients and healthcare providers, with some concerns over the security of information shared online and the potential for doctors to be overwhelmed by an excessive number of patient requests.

Mahapatra et al. (2020) presented a cloud-based dermatology information system model for healthcare. The system is designed to serve skin disease patients who may have difficulties with mobility. The cloud-based model is cost-effective, as users only pay for what they use. It offers remote access to the patient data via the internet, making it accessible from any location. Authorized units can share patient data, and the medical history is updated in real-time, providing valuable information for future treatment. This system enables a more efficient and streamlined approach to healthcare for skin disease patients.

Gomes, (2020) created a web-based application utilizing a lightweight software that can be accessed through a web browser and can be used on various hardware, including mobile devices such as tablets and smartphones. During initial user testing, the digital approach was deemed more appropriate than traditional pen and paper methods which require manual digitization of follow-up content. The aim of the application is to simplify data collection during doctor-patient interactions by enabling the recording of data through both handwritten and spoken notes, which are automatically converted to text format through handwriting and speech recognition.

Alazzam et al., (2021) presented a study on the development of a web application for patient-doctor-specialist interaction in rural areas of Iraq. The authors described the design and evolution process of the software development, and the application was built using the Design Linking process and Running Lean process to obtain the minimum viable product and iterate to reach a valuable application. The evolutionary development model and agile scrum framework were applied for the software development. The goal of the application was to provide prompt medical guidance to patients in rural areas without the need for unnecessary transfers, allowing for doctor-patient-specialist interaction through the application.

Al Khatib, (2022) presents a new approach to online medical care by using a Voice over IP (VoIP) protocol called the Medical Real-Time Protocol (MRTP). The MRTP protocol is designed to carry both real-time voice and medical data in a single stream while maintaining good quality of service (QoS). The application is created to enable patient-doctor online consultations and monitoring, and the MRTP protocol is designed to be compatible with the existing Real Time Protocol (RTP) while incorporating advanced features for medical data transmission. The MRTP protocol aims to deliver real-time performance with less delay and overhead, as some medical data being transmitted may be life-critical and losses could potentially cause harm.

3. METHODOLOGY

The methodology chosen for this project is the Waterfall model. The Waterfall model is a sequential software development process, where progress flows in only one direction (like a waterfall) through the phases of requirements gathering and analysis, design, implementation, testing (validation), and maintenance. Each phase must be completed before the next phase can begin and there is no overlapping in the phases. The Waterfall model is well suited for projects where the requirements are well-understood and unlikely to change, and the solutions are clear and straightforward.

3.1 System Architecture

The architecture illustrates the design and interaction between the components of this software system. Generally, shown below, the web-based healthcare system can be divided into front-end and back end components. The proposed system comprises of the following major components, as outlined below:

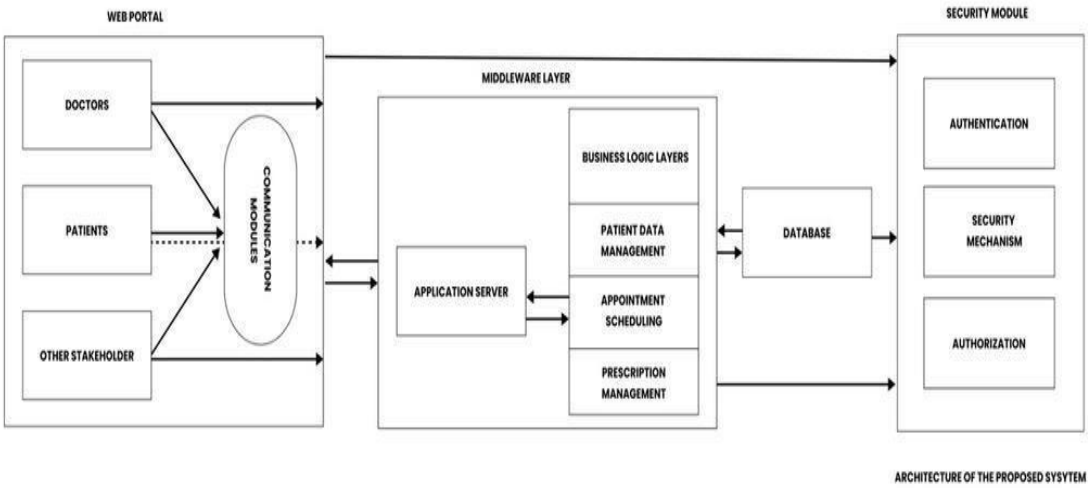


Figure 1 System Architecture of the web based health application

a. Web Portal: The Web portal component of the proposed system would provide a visual interface for users to interact with the various features and functions of the system. This would include patients, doctors, and other healthcare stakeholders, who would use the Web portal to access and manage information, communicate with each other, and perform various other tasks related to the healthcare delivery process in Nigeria.

b. Communication Module: The communication module is a key component of the proposed system architecture for healthcare delivery in Nigeria. The primary role of the communication module is to facilitate communication and information sharing between different stakeholders, such as patients, healthcare providers, and hospital administrators.

c. Application Server: The application server is another critical component of the proposed system architecture. The application server acts as a bridge between the business logic component and the web portal (UI), providing the necessary infrastructure to handle the communication and data transfer between these two parts of the system.

d. Business Logic: This component serves as the core engine that powers the system, providing the underlying algorithms and processes necessary to perform the tasks required by the system. This component is responsible for ensuring that all data is processed correctly, and that the system operates in a manner that is consistent with the defined business requirements.

e. Database: The database component of the proposed system is responsible for storing and organizing the vast amounts of information that would be generated and used by the various stakeholders in the healthcare delivery process in Nigeria. This information would include patient data, appointment schedules, prescription records, and much more.

f. Security Module: The security module is a critical component of the proposed web-based healthcare application, responsible for protecting the privacy and confidentiality of patient data, as well as ensuring the authenticity and integrity of the information stored in the system.

3.2 System Modeling (UML)

3.2.1 Use Case (Activities of the patient)

Patients must provide a valid username and password in order to log into the system. If the credentials match, they will be successfully logged in and able to access their personal information, medical records, and the doctor's notes. Patients can also reset their password from within the system. They have the ability to communicate with their doctor through messaging in case of any issues or concerns with their treatment. Additionally, patients can read and comment on any blogs posted by the doctor. If the login or password is incorrect, a red notification will be displayed to inform the patient.

Figure 2 Use Case diagram

3.2.2 System Flow chart

The administrator's role in the system is outlined in the System flow chart. Upon logging in, the administrator has two options available to them. They can create doctor or specialist accounts. To add a doctor account, the administrator must complete all the necessary fields such as name, surname, username, password, birthday, specialization, email, and phone number. If the form is filled out correctly, the administrator can edit, modify, or delete it in the future. The process is the same when adding a specialist account.

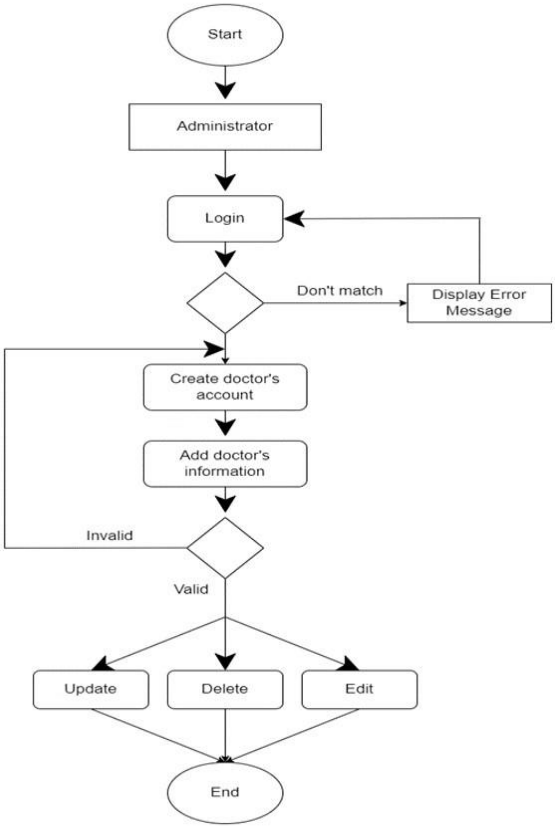


Figure 3 Administrator Activity Flowchart

3.2.3 Sequence Diagram

This flowchart shows the steps involved in the process of how the patient and the doctor interact with the system and its components. The doctor creates an account for the patient and awaits approval from the system. In case of a failed authentication, the patient is required to enter their username and password again. Upon successful login, the patient can read the specialist's blogs, review their medical prescriptions and notes, access their therapy, and communicate with the doctor by sending and waiting for a response.

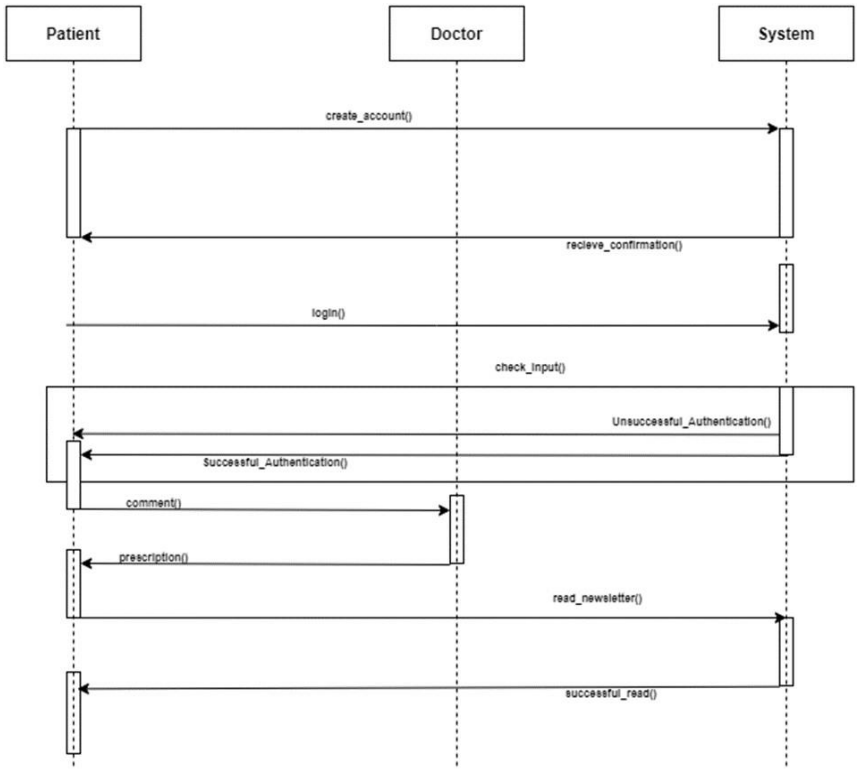


Figure 4 Patient Sequence Workflow

3.2.4 Collaboration Diagram

The collaboration diagram demonstrates the interaction between the various users and objects within the system, including the Admin, Specialist, Doctor, Patient, Blog, Notes, Treatment, and Message. The functions depicted in this diagram include submit_register_form(), send_for_confirmation(), new_register_request(), success(), create_treatment(), send_msg(), read_blog(), read_notes(), read_treatment(), leave_comment(), and create_blog(). These functions highlight the actions and communication between the objects as they work together to achieve the desired outcomes in the system.

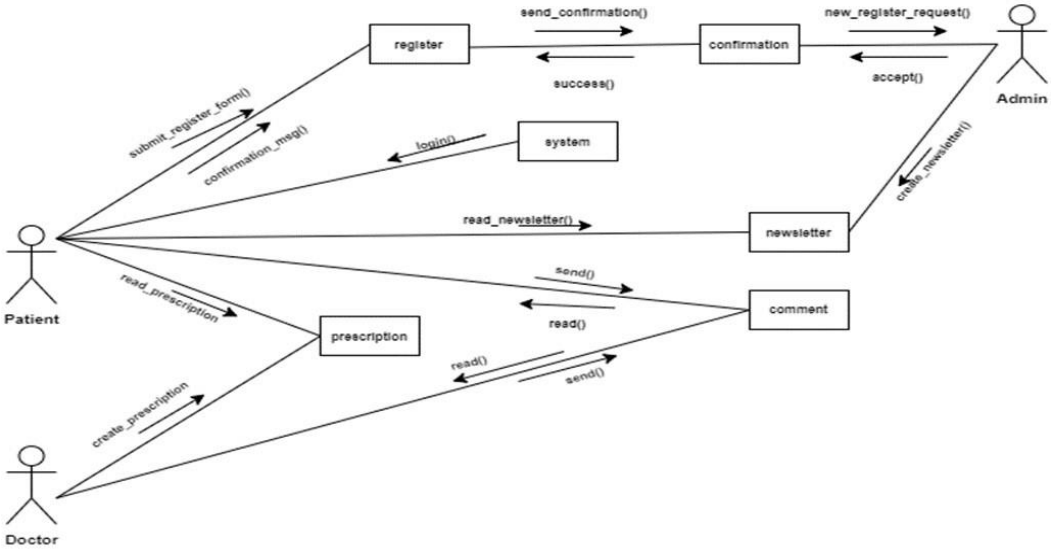


Figure 5 Collaboration workflow

3.2.5 Class Diagram

The class diagram represents the entities in the system, including the tables in the database, and their relationships with each other. The entities depicted in the diagram include Specialist, Patient, Administrator, BlogPost, Doctor, and Treatment Note. Each entity has unique attributes and methods that cater to their specific purposes.

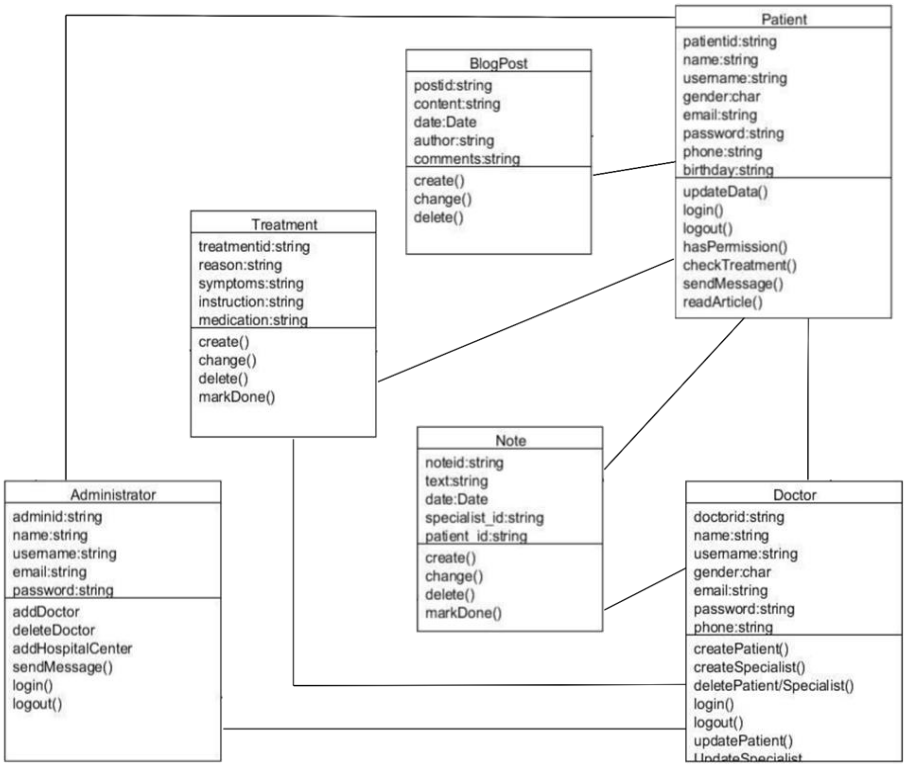


Figure 6 Class Diagram

4. RESULTS AND DISCUSSION

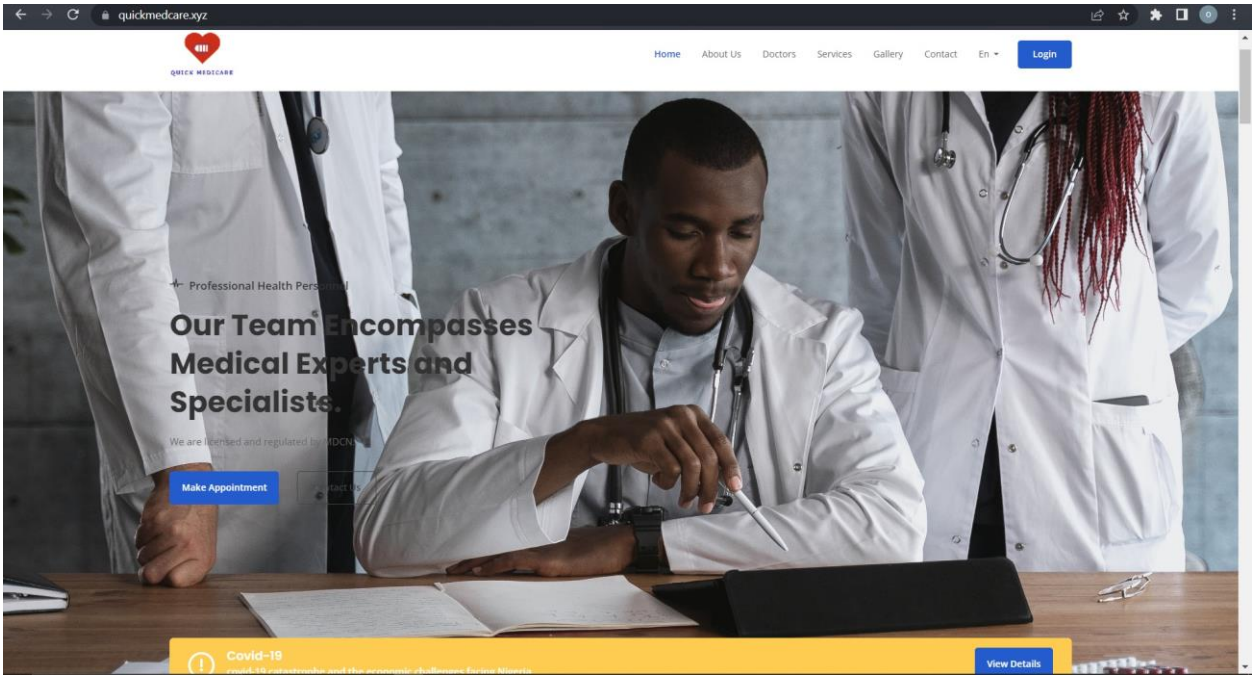


Figure 7 Homepage

The homepage serves as the entry point of the web application and plays a crucial role in creating a first impression on users. The design of the homepage is user-friendly and provide clear navigation options to guide users to other sections of the application.

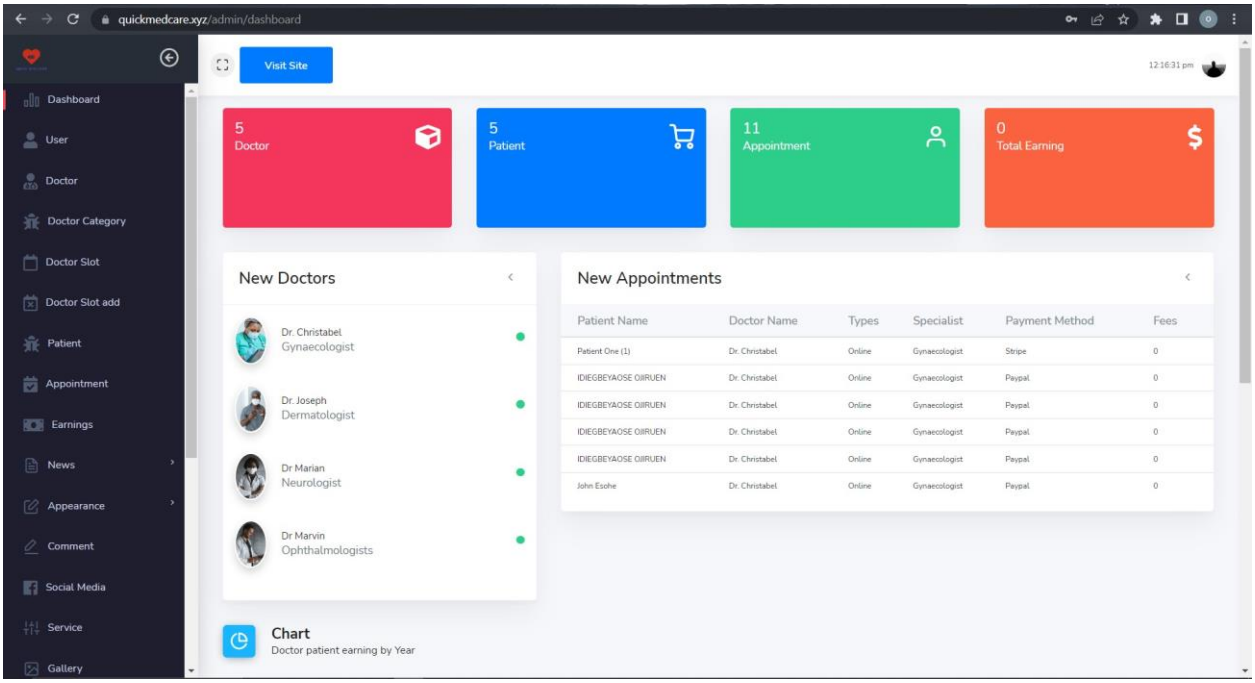


Figure 8 Administrator Panel

The administrator has full control over the user management in the system through the admin panel. They can add new users, including doctors and specialists, and also have the ability to add new services and their associated costs. The administrator has the capability to update the services and pricing available in the system, which can be utilized by the doctor when adding a treatment for the patient. The system administrator is responsible for the overall operation and maintenance of the web-based healthcare application. The system administrator's role includes tasks such as installing, configuring, and updating the software, managing user accounts and permissions, monitoring system performance and security, and ensuring that the system is in compliance with relevant regulations and standards.

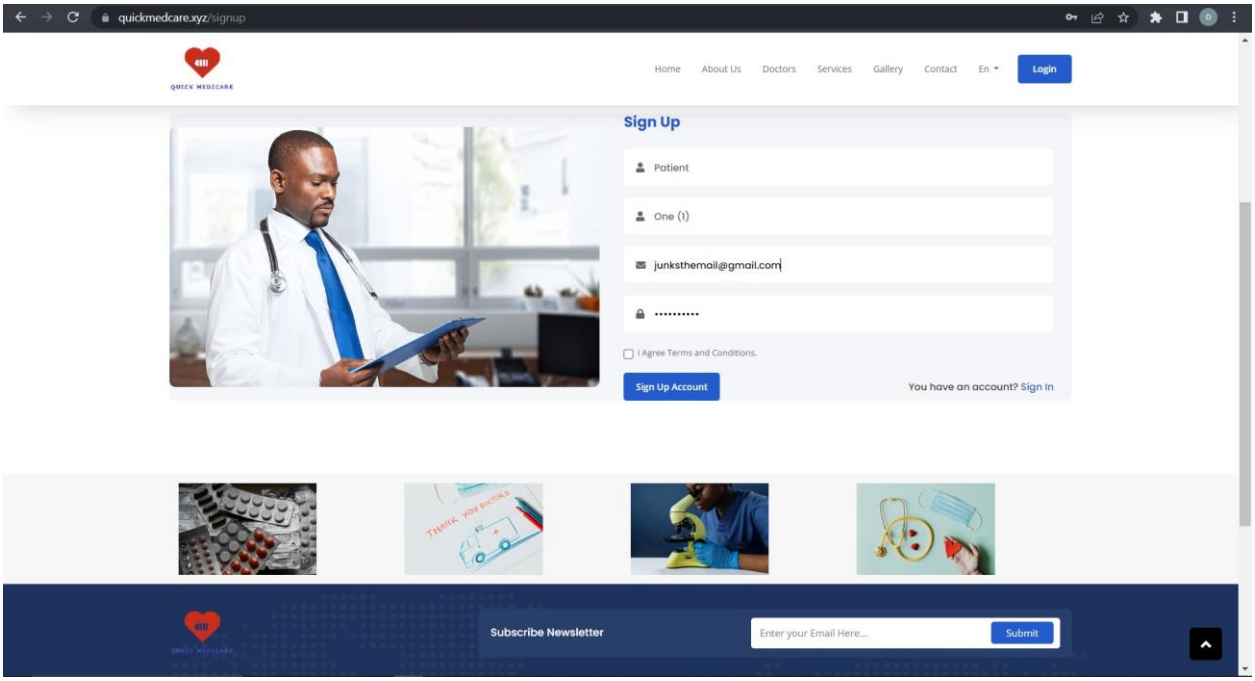


Figure 9 Registration Page

The registration page is the first step for a patient to become a user of the web-based healthcare application. On this page, the patient will be required to provide some basic information such as their full name, date of birth, contact information, and a unique username and password. This information will be used to create a user account for the patient and provide them with access to the system.

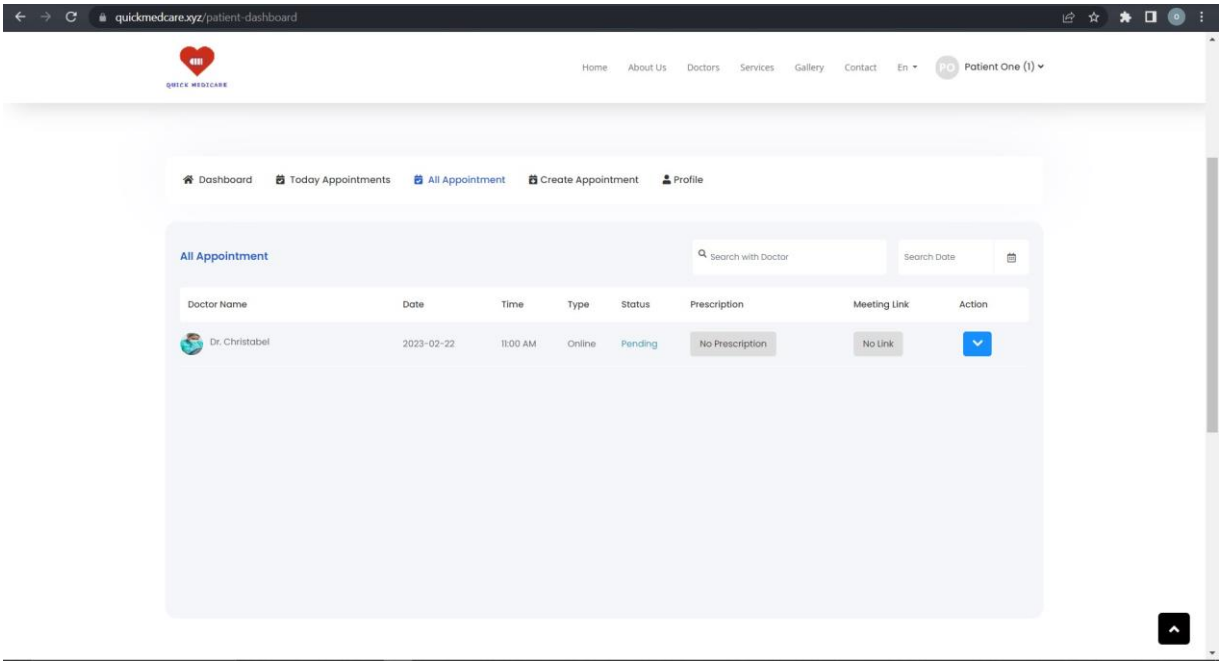


Figure 10 The Patient Dashboard

The patient dashboard is a central location within the healthcare application that allows patients to access and manage their personal health information, including details about their medical history, current conditions, medications, and upcoming appointments. The dashboard is designed to be user-friendly and intuitive, so that patients can easily view and update their information, as well as communicate with their healthcare provider.

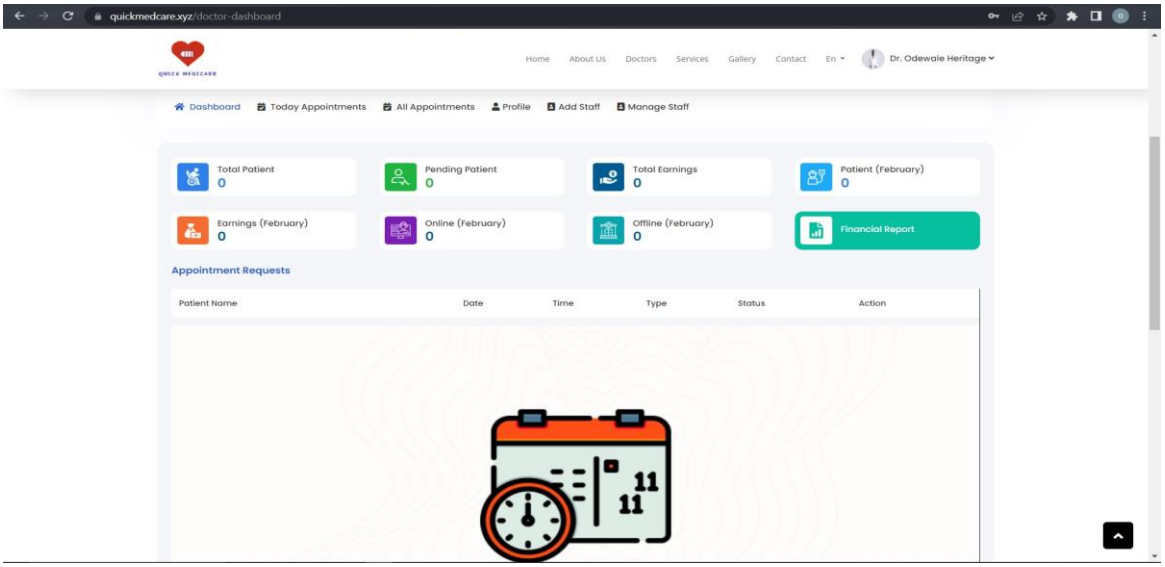


Figure 11 The Doctor Dashboard

The doctor dashboard is a feature of the web-based healthcare application that provides a centralized platform for doctors to manage their patients, appointments, and medical records. The doctor dashboard typically has a user-friendly interface that allows the doctor to quickly and easily view and update patient information, view appointment schedules, and communicate with patients. In addition, the doctor dashboard also has tools for tracking patient progress, ordering tests and treatments, and creating and updating medical records.

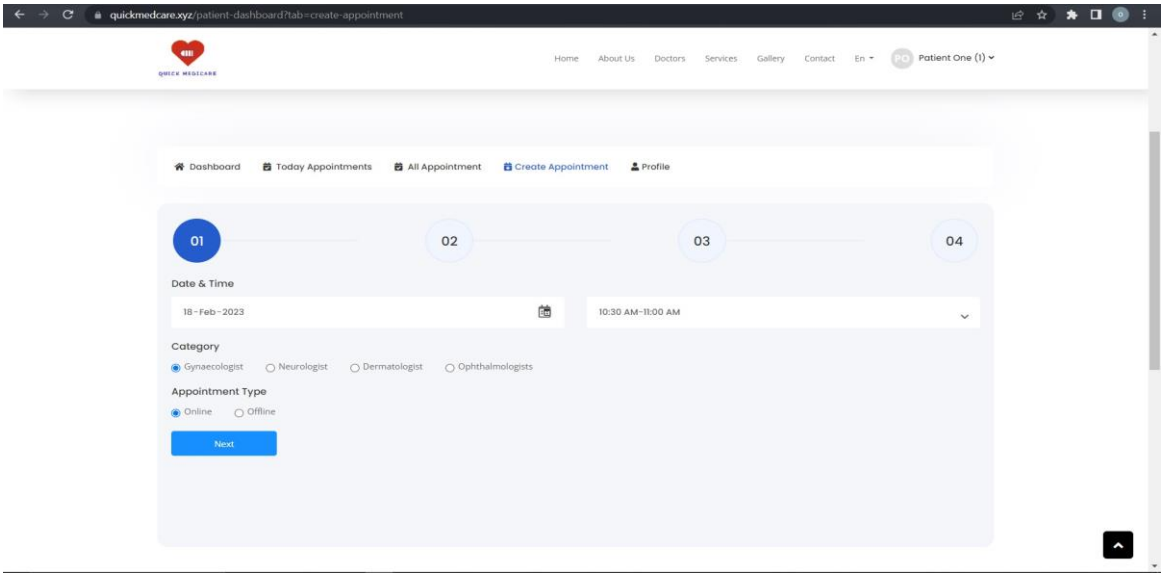
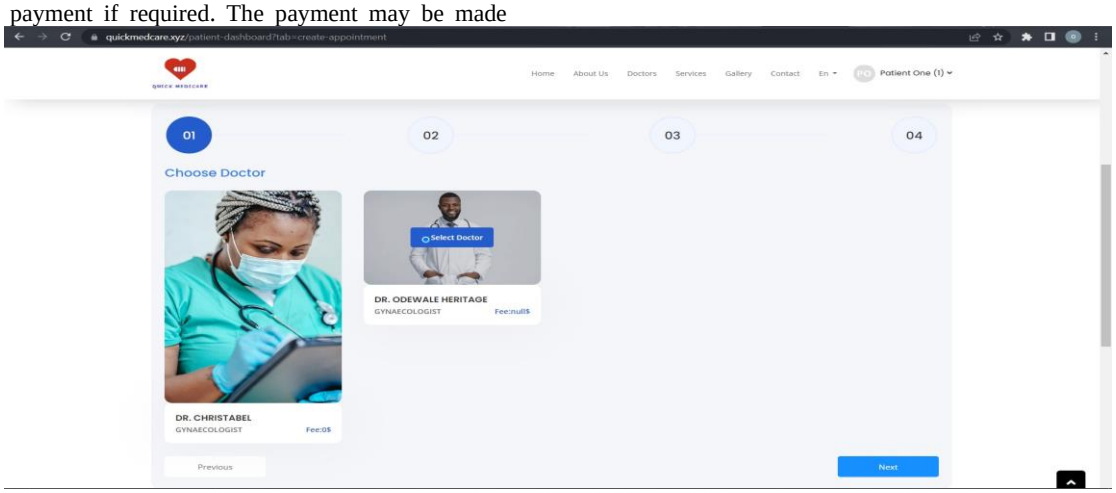


Figure 12 Appointment Scheduling and Online Consultation

The appointment scheduling process typically involves browsing through a list of available healthcare providers, selecting a suitable date and time slot for their appointment, and making a payment if required. The payment may be made through the application's secure payment system or through other available options such as bank transfers or mobile payments.



5. CONCLUSION

This work presents the key objectives, findings, and outcomes of the web-based healthcare application designed to improve the healthcare delivery service in Nigerian hospitals. This system has the potential to greatly improve the quality and efficiency of healthcare delivery in Nigeria by providing patients with a convenient and accessible platform to access medical services and health information.

The system includes various features such as patient registration, appointment scheduling, medical records management, and doctor-patient communication, among others. The system is user-friendly, secure, and operates in a way that streamlines the traditional healthcare delivery process. The implementation of this system involves the use of various technologies and software development methodologies.

In conclusion, this project has the potential to revolutionize the healthcare delivery system in Nigeria and improve the quality of life for its citizens. The deployment of this system would require the commitment and cooperation of various stakeholders, including the government, healthcare providers, and patients.

6. REFERENCES

[1] Adewole, O. A., & Adekeye, P. (2019). The use of information and communication technology in healthcare delivery in Nigeria: A review. Journal of medical systems, 43(11), 208.

[2] Akinode, John, L. and Oloruntoba, S. (2017). Design and Implementation of a Patient Appointment and Scheduling System. International Advanced Research Journal in Science, Engineering and Technology, Volume 4 (12).

[3] Alazzawi, A., Hassan, R., & Mohammed, A. (2021). Development of a web application for patient-doctor-specialist interaction in rural areas of Iraq. International Advanced Research Journal in Science, Engineering and Technology, 5(2), 67-89.

[4] Al Khatib, S. (2022). A new approach to online medical care: The Medical Real-Time Protocol (MRTP).

International Journal of Medical Technology, 10(3), 123-135.

[5] Ali, A., & Feng, C. (2022). Appointment Scheduling Problem in Complexity Systems of the Healthcare Services: A Comprehensive Review, Journal of Healthcare Engineering. Retrieved from: https://doi.org/10.1155/2022/5819813.

[6] Avancha, S., Baxi, A. and Kotz, D. (2021). Privacy in Mobile Technology for Personal Healthcare. ACM Computing Surveys, 45, Article No. 3.

[7] Demirel, D. (2017). Effectiveness of Health Information System Applications: Clinical Information and Diagnosis Treatment Systems in Turkey. European Journal of Multidisciplinary Studies, Volume 2, No 5.

[8] Ernest, O., & Tivani, P. (2021). Mobile health applications for disease screening and treatment support in low-and middle-income countries: A narrative review, Medical journal. National Library of Medicine, Volume 7(3).

[9] Ganapathy, K. (2019). E-Medicine: transforming healthcare with information and communication technology. Medical journal, Armed Forces India, 67(2), 106–107.

[10] Gárate, S. (2018). A Development of a mHealth system utilizing WebRTC for videoconferencing and messaging between patients and healthcare providers. International Journal of Telemedicine and Applications, 10(3), 67-89.

[11] Grant, T., Anderson, H., & Parker, K. (2006). Diabetes patient web-portal: Addressing challenges in effective care. Journal of Healthcare Information Management, 24(3), 45-62.

[12] Gupta, D., & Denton, B. (2008). Appointment scheduling in health care: Challenges and opportunities. IIE Transactions, 40, 800-819.

[13] Jonathan, W. (2012). Doctor-patient communication in the e-health era. Israel Journal of Health Policy Research, 1, Article 33.

[14] John, W. H., & Phillip, P. (2009). The national healthcare crisis: Is ehealth a key solution Business Horizons, 52(3):265–27.

[15] Madamidola, O. A., Daramola, O. A., Akintola, K. G., Akinwonmi, A.E., & Adeboje, O. T. (2024). A Framework for an IoT-enabled Intelligent Inventory Management System. International Journal of Advances in Engineering and Management (IJAEM) Volume 2, Issue 1, pp: 01-05

[16] Madamidola, O. A., Oladoja, I. P., Falola, P. B., & Omojola, M. W. (2024). Development of a phishing website detection model using classification algorithm. International Journal of Wireless and Microwave Technologies (IJWMT), 14(5), 31-43. https://doi.org/10.5815/ijwmt.2024.05.03

[17] Madamidola, O. A., Daramola, O. A., Akintola, K. G., & Adeboje, O. T. (2024). A review of existing inventory management systems. International Journal of Research in Engineering and Science (IJRES), 12(9), 40-50.

[18] Madamidola O.A., Daramola O.A and Akintola K.G. (2017) "Web – Based Intelligent Inventory Management System". International Journal of Trend in Scientific Research and Development, Volume 1 (4), ISSN: 2456-6470. Pp. 164 – 173.

[19] Mahapatra, S., Johnson, A., Smith, J., Brown, L., Garcia, M., & Patel, R. (2020). Cloud-based dermatology information system model for healthcare. Journal of Medical Informatics, 10(2), 45-62.

[20] Nazia, S. and Sarda, E. (2014) Online Appointment Scheduling System for Hospitals—An Analytical Study. International Journal of Innovations in Engineering & Technology, 4, 21-27.

[21] Omole, G. (2015). Health Management Information System for Decision-Making in Nigeria:

[22] Challenges and Resolutions. International Journal of Science and Research, Volume 4, No 5.

[23] Sarah, D., Tessa, c., Niels, P., Susan, M., Sabine, N. V., David, C.W., and Benjamin, C. B. (2022). Understanding How the Design and Implementation of Online Consultations Affect Primary Care Quality: Systematic Review of Evidence With Recommendations for Designers, Providers, and Researchers. Journal of Medical International Research. Volume 24(10).

[24] Shoewu, O.O., Ayangbekun, O.J., Lamina, I.S. (2021). Design and Implementation of Health-based Emergency Reporting Mobile Application. Engineering & Technology Research Journal Volume 6(1) pp. 9-21.

[25] Wenquan, J., & Do Hyeun Kim. (2018). Design and Implementation of e-Health System Based on Semantic Sensor Network Using IETF YANG, Volume 18, No 2.

[26] Zhan, X., & Liu, X. (2013). Design and Implementation of Clinic Appointment Registration System. International Journal of Innovations in Engineering and Technology, 5, 527-529.