LEVERAGING AI CHAT BOTS AND MESSAGING PLATFORMS FOR REMOTE HEALTHCARE DELIVERY IN NIGERIA.

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ABSTRACT
This project illustrates the design and development of AI Chatbot and in-app patient hospital messaging platform as well as their integration into an electronic hospital management system for smart, safe, and reliable remote health care services in Nigeria, with the FUTO Medical Centre serving as a case study. The development tools utilized were Microsoft Azure AI Services, PHP, MySQL, and other web development technologies, as well as the Object-Oriented Analysis and Design Methodology (OOADM) and Unified Modelling Language (UML), and the Object Oriented SDLC. The incorporation of an in-app patient-hospital messaging platform and a smart AI agent that learns from these conversations has proved to reduce the risk of receiving misinformation from the internet as well as providing safe and reliable remote health care delivery in Nigeria. The reporting of emergency situations and the making of complaints through the messaging platform also contribute to the improvement of healthcare delivery.

Keywords: Chatbot in health, Remote Medical Service, Hospital Management Systems, FUTO Medical Centre, Smart Health.

1.0 INTRODUCTION

1.1 Background to the Study

Technology is contributing more and more in the transformation of the healthcare delivery system on the world stage. As technology advances, especially in the health sector, the AI-driven chatbots and messaging systems are becoming increasingly popular. As has been described by Rezaei et al. (2023), AI has revolutionized telemedicine by increasing the diagnostic accuracy, speeding up the workflow, and improving the treatment outcomes. AI virtual assistants and chatbots are getting more and more capable of replacing human beings in doing routine jobs, while the healthcare support staffs are moving towards providing personalised care (Chow & Xu, 2021). These technologies are also useful tools for communication, process automation and patients' engagement.

Many hospitals in Nigeria have recently employed electronic native desktop applications as hospital management systems to address or reduce the issues related to paper-based hospital administration. As per Vijaysarveswari et al. (2021), major functions of a typical hospital management system are the patient registration, appointment scheduling, and patient admission. However, in the light of the challenges of healthcare in Nigeria, which are the lack of services access, inability to pay bills, and need for effective doctor-patient communication, the innovative solutions are becoming more and more in demand (Oduenyi, 2023).

Concerning the developments of information and communication technology, website intelligence can be defined as the intelligent and efficient utilization of the World Wide Web as a phenomenon for retrieving information from data storage. Website intelligence is a well-known research area that integrates AI, databases, web science, semantic web, and information retrieval (Yao et al., 2004). In accordance with its knowledge base and level of intelligence, the intelligent website application can learn from its experience and act on user input.

The incorporation of Iintelligent chat agents and messaging platforms into Hospital Management Systems (HMS) provides a chance to address these issues in an effective manner. Through the use of smart agents and a patient-hospital messaging platform, HMS can improve patient care, streamline workflows, and enable the smooth communication between healthcare providers and patients, thus, leading to better outcomes in healthcare delivery.

1.2 Healthcare in Nigeria

The Nigerian health sector faces problems of inadequate infrastructure, insufficient medical personnel, limited access to health facilities in the rural areas and inequalities in the quality of healthcare. As reported by the World Health Organization (WHO), there are 4 doctors per 10000 people in Nigeria (Kareem, 2021). Such barriers ultimately result in a delayed diagnosis, poor treatment adherence and escalated healthcare expenditures.

(Oduenyi, 2023) points out that many Nigerians do not go to the hospitals due to the fact that they are faced with factors such as a long time of waiting for medical attention, inadequate healthcare, poverty, cultural practices, poor access to healthcare, and lack of knowledge. Oduenyi (2023) proposed that investing in health care technology with other comprehensive strategies, might be one of the solutions to the health care system's existing challenges.

For many countries, Information and Communications Technology has become a blessing as a development tool. The use of ICT in Nigeria spans a wide range of applications, but even with a physician-population ratio of about 1:83, as the Nigerian Medical Association reported, figures indicate that this technology did not have a significant effect on the health sector (Abolade & Durosimi, 2019).

A study by Adamu & Oche (2013) in a Tertiary Health Institution in North Western Nigeria found that 61% of patients in the general outpatient department (GOPD) waited 90-180 minutes, with 36.1% spending less than 5 minutes. The main reason was the large number of patients with few healthcare workers, highlighting the need for increased staff. But according to the research by Sancheti & Upare (2020), there are 60% doctor visits for simple small-scale diseases, 80% of which can be treated at home if the patient has the necessary information. Such sicknesses mostly associated with the common cold and cough, as well as the headaches and abdominal pains can result from be the weather, nutrition, lack of sleep, and others, and they can be managed without a doctor (Sancheti & Upare, 2020). This could imply that some patients need not visit the hospital if they can get necessary advice from their doctors, giving the doctors enough time to attend to patients with severe illnesses.

1.3 AI chat bot and patient-doctor messaging platform

More than 70% of people turn to the internet as their first source of health information (Finney Rutten et al., 2019), and lots of persons spend time on various websites and search engines when they feel some disturbing symptoms in their body. A study by Harvard Medical School (Miller, 2015) has found that millions of people spend their time on symptom checkers, online software used to self-diagnose symptoms and to get advice on whether they should seek further medical care or just rest at home until they feel better. The study found that 23 symptom checkers provided correct triage advice in 58% of cases, with the checkers performing better in more critical cases, recommending emergency care in 80% of urgent cases.

The study of Kurniawan et al. (2024) provided valuable insights into the effectiveness and user-friendliness of AI-powered chatbots in handling various chronic conditions. Generally, the patients embraced the use of chatbots as tools for the self-managing of chronic illness condition. The reviewed studies suggest promising acceptance of AI-powered chatbots for self-managing chronic conditions.

While the information provided by these tools is useful, users should be cautious and not take the information they receive

as gospel. As described by Sorich et al. (2024), these AI tools are accompanied by several risks like the compilation bugs, health misinformation, conflict of interest, and the privacy and bias issues.

Given one of the greatest problems of the internet is people are able to develop misleading and unsafe health resources on the web, as well as the security issues surrounding the use of patient health information, the internet is riddled with health misinformation. A hospital management system with a doctor-to-patient messaging service that feeds a knowledge base to make room for an intelligent chatbot will make such a big difference. One of the features of this particular system is that the patient can ask questions and get them answered by certified experts of their local hospital, which is a more reliable source. This tool, moreover, enhances communication between doctors and patients (Passaic, 2021). And while the doctors are offline, the chatbot should be able to provide credible data, because it has learned from the real-time conversations between true known expert doctors and patients..

2.0 RELATED WORKS

2.1 Conceptual Framework

Hospital Management Systems

Toussaint (2015) points out that no matter how good the healthcare systems are, the hospitals cannot improve without better management systems, as the management issues is among the main factors of today's healthcare cost and quality crisis. The computerized hospital management system is a system that aids in managing healthcare information, and effectively completing healthcare providers' jobs. (Sanjana, 2020) The hospital managements system links all the hospital's data and procedures on one platform for patient management, physician management, inventory management, appointment management, billing information, and money, and many more.

Mobile technology has literally put healthcare management in the hands of patients and patients are using their mobile devices to seek information and get their needs met. HMS was brought on to handle the complexities of the paperwork which required a lot of data entry while also maintaining confidentiality. HMS facilitates the whole team at the hospital to keep all their paperwork in one place, and there will be less time to organize and analyze patient documents. HMS can do several things like keeping the patient's medical history, keep the patient's contact information and so on (Sanjana, 2020).

Intelligent Systems

Intelligent systems are the enhancement of systems using Artificial Intelligence technologies that can continuously deliver valuable information services to all users, even disadvantaged individuals, to increase results such as their contentment, reuse, trust in them, and profits obtained after using their information (Yao, Zhong, Liu, & Ohsuga, 2004).

Following the emergence of websites and mobile apps, virtual chatbot applications are the most recent digital design innovations. These applications are well known for their automatic conversational agents that operate on computer programming or a type of artificial intelligence (AI) interaction between users and machines using natural language processing (NLP) (Jadhav et al., 2020).

According to Ariyasipak & Harnpornchai (2016), intelligent websites are created as forms of websites based on tacit knowledge through the use of knowledge representation. An intelligent website comprises rules, facts, and an inference engine. This component is a feature of Knowledge-Based Systems (KBSs), and all intelligent websites must incorporate KBSs to infer tacit knowledge utilizing reasoning processes.

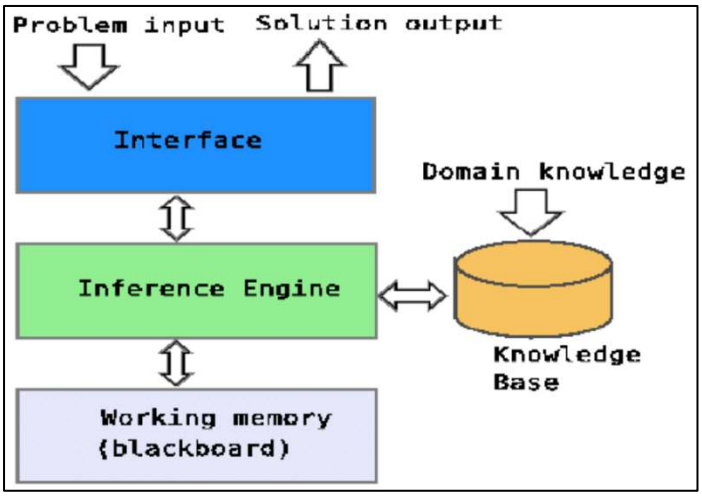

Figure 1: Knowledge based expert systems architecture (Abu-Naser, 2016)

Knowledge from experts acts as the knowledge base, questions are asked via the interface, the system makes inference and gets the solution from the knowledge base and give out the solution through the interface. These can also be called expert systems.

2.2 Literature Review

Shukla et al. (2020) developed a chatbot for healthcare that employed AI techniques to recognize symptoms and provide basic medical information. The chatbot employs n-gram, TFIDF and cosine similarity for the purpose of sentence ranking and calculation, while the third-party expert program is in charge of any unanswered questions.

Bibault et. al. (2019) in their study implied that chatbots can be used by breast cancer patients to get advice for minor health concerns, to decrease the number of hospital visits. As a result, the physicians will do more consultation to those who are seriously ill.

In the study by Elochukwu et al. (2024), they developed a Progressive Web Application for Seamless Primary Healthcare Delivery in Nigeria and they also proposed the implementation of AI that will deliver safe health advice automatically and medical treatment digitally by telemedicine and in-app messaging platform for emergency response or receiving medical advice without visiting the hospital.

This project is set to develop an Intelligent Chatbot Agent and an in-app patient-hospital messaging platform for remote medical care, so that healthcare becomes more accessible, affordable and health AI agents more reliable.

3.0 METHODOLOGY

This study builds upon the project conducted by Elochukwu et al. (2024). Elochukwu et al. developed a Progressive Web Application (PWA) aimed at enhancing access to primary healthcare in Nigeria, using the FUTO Medical Centre as a case study. The project was built on actor-network and socio-technical theories, as well as Object-Oriented Analysis and Design Methodology (OOADM) and Unified Modeling Language (UML), and Object Oriented SDLC. In their recommendations for future work, Elochukwu et al. suggested the Implementation of AI that will deliver safe health advice automatically, and integration of Digital medical treatment via telemedicine and in-app messaging platform for emergency response or receiving medical advice without visiting the hospital.

Building upon these recommendations, this study delves into the development of in-app patient-hospital messaging platform, development of a knowledge-based AI Chatbot, and their integration into the hospital management system for safe and reliable remote medical care, employing similar frameworks, methodology and software development lifecycle.

3.1 Analysis of the proposed system

An Intelligent Chatbot and in-app messaging platform to be integrated to the existing computerized hospital management system is proposed for this study. Patients are able to ask doctors questions relating to their health via the HMS and also make enquires regarding the hospital from the admin/receptionist, the doctors or the receptionists give response to the users' questions once they see the questions on their dashboard. Asides asking questions, there is a report platform for the patient to make reports of emergency situations so that the hospital can dispatch ambulances to attend to them, or reports about grievances with bridges in code of conduct, and dissatisfaction or satisfaction about services received, so that their complaints can be addressed and compliments noted and improved on for better healthcare provision at the healthcare center.

Questions asked by patients and replies given by doctors or receptionists can be reviewed by the admin and may be edited to remove sensitive information that may be personal to the patient before that are added to the frequently asked questions page which in turn serves as the knowledge base for the Intelligent chatbot.

The system saves the IDs of the patient that asked the questions or made the reports, the staff that answered the questions or responded to the remarks, and when edited, the admin that made the edit.

The intelligent chatbot provides a 24/7 service answering questions based on his knowledge base, and can make inference and understands various structures of how a question can be asked through natural language processing (NLP). When asked a question it has not been trained to answer, it saves the question which will be answered by the administrator later on and added to the knowledge base, it also gives a default advice of coming to the hospital for more professional advice and doctors' attention.

3.2 Activity diagram of the new system

Below is the new hospital management system's remote services activity diagram, showing the various actors, the workflow of stepwise activities and actions, and the control flow to complete a remote service using the new application.

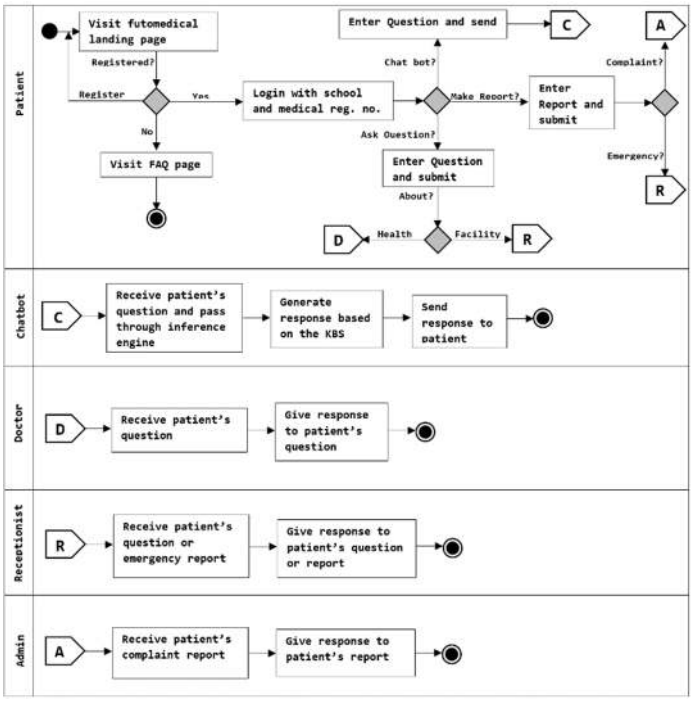

Figure 2: HMS remote services activity diagram for the proposed system.

3.3 Use case diagram of the new system

The use case diagram below demonstrates the key actors and their use case actions in the new system, especially the in the use of the messaging platform for communication and the chatbot integration.

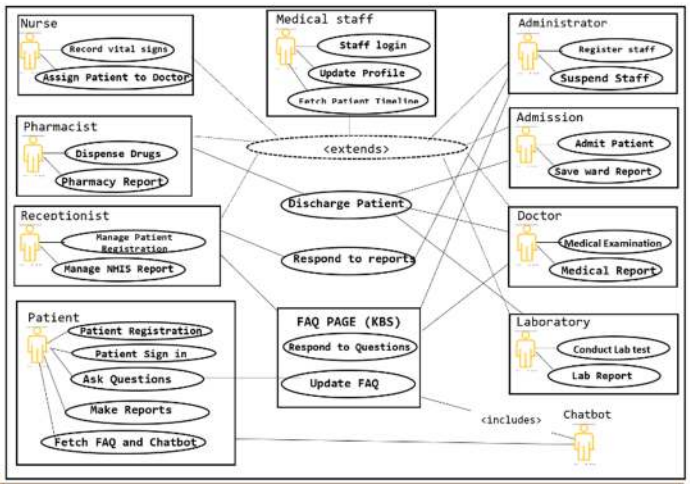

Figure 3: High level use case diagram for the new intelligent system.

3.4 Sequence diagram of the new system

The sequence diagram below shows the structure of interaction by time sequence of the actors in the system. It illustrates how the objects interact with each other in remote medical service scenario using the new system.

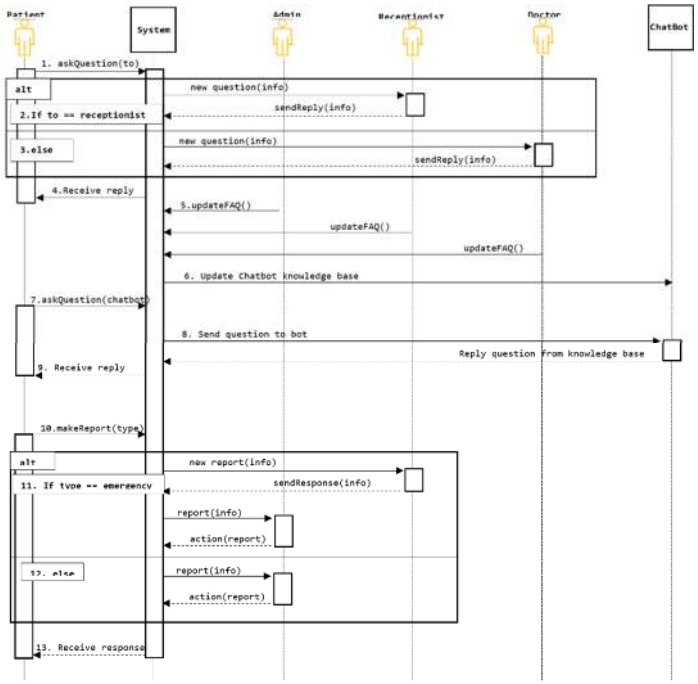

Figure 4: HMS remote services sequence diagram for the proposed system.

3.5 Component diagram of the new system

The component diagram below comprises four main components: web server, application server, database server, and the AI chatbot server.

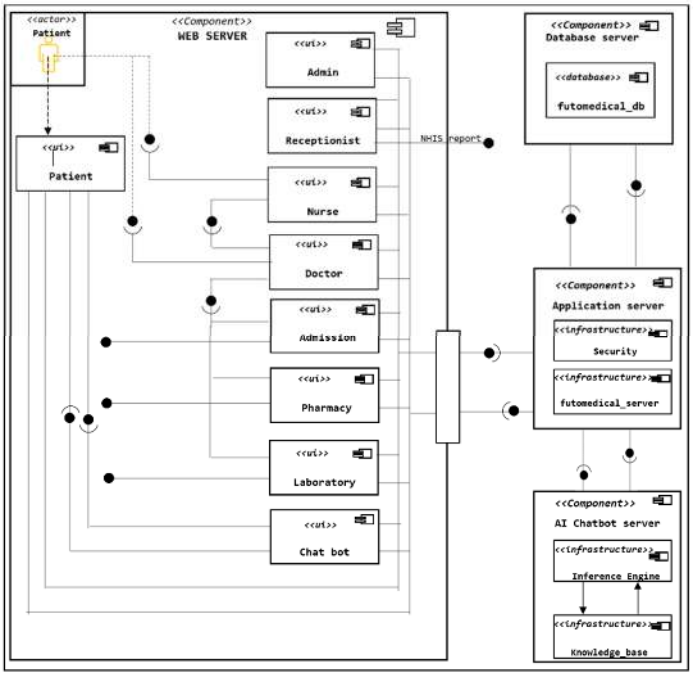

Figure 5: Component diagram of the proposed system.

The web server serves static content and acts as a reverse proxy for application server, the application server processes requests and accesses database, the Database server manages database, data storage, retrieval, and secure connection, while the AI Chatbot Server manages the Chatbot service, making inferences based on knowledge base.

3.6 Site map of the new intelligent system

The top-down site map of the new intelligent HMS is shown below shows the high-level socio-technical model, also showing how the authorized users can access the in-app messaging platform, and the chatbot from their dashboards.

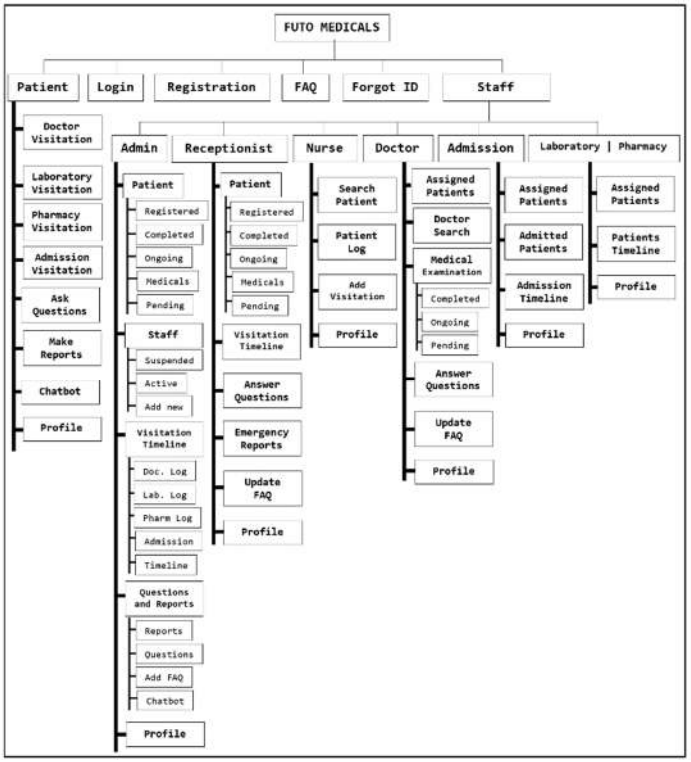

Figure 6: Site map for the new intelligent HMS

4.0 SYSTEM IMPLEMENTATION

4.1 Choice of Development Tools

Front-end technologies: HTML and CSS, Back-end tools: PHP for dynamic websites, JavaScript used for interactive user experiences, MySQL for storing and retrieving data for various applications, and Microsoft Azure AI service for intelligent chatbot implementation and integration to the hospital management system.

4.2 Software Requirements

Operating system (Windows, iOS, or Android) for devices and Linux on server, Apache web server for hosting the application, Web browsers, MySQL database management system for data storage and management.

4.3 Hardware Requirements

A server or cloud-based hosting platform, Accessible computers or devices, Network infrastructure for connecting server and devices, and Peripheral devices as needed.

1. Start
2. Remove the faqdata.json file if it exists:
   2.1. Check if the faqdata.json file exists
   2.2. If it exists, delete the file using the unlink() function
3. Include the configuration file
4. Execute an SQL query to select questions and answers:
   4.1. Connect to the database using mysqli_connect() function
   4.2. Execute the SQL query "SELECT question, answer FROM questions WHERE status != 'pending' ORDER BY id" using mysqli_query() function
5. Create an empty PHP array to store data:
   5.1. Initialize an empty PHP array named php_array
6. Iterate over the query result and populate the PHP array:
   6.1. Use a loop to fetch each row from the query result
   6.2. Append each row to the php_array using the array_push() function
7. Encode the PHP array to JSON format
8. Write the JSON data to the faqdata.json file
9. faqdata.json is used to populate the faq page which serves as knowledge base.
10. End

Algorithm 1: FAQ Knowledge base creation algorithm.

1. Start
2. Include the configuration file
3. Define a function named updateKBS():
   3.1. Connect to the database
   3.2. Execute an SQL query to select non-pending questions and answers not already in the database.
   3.3. Create an empty PHP array to store the retrieved data
   3.4. Iterate over the query result and populate the PHP array with question-answer pairs
   3.5. Open the faqdata.json file in append mode
   3.6. Encode the PHP array into JSON format
   3.7. Write the JSON-encoded array to the faqdata.json file
   3.8. Close the faqdata.json file
4. Call the updateKBS() function
5. End

Algorithm 2: Knowledge base updates algorithm.

4.4 Knowledge base creation and update algorithms

4.5 System security

To ensure system security, SSL certificates are added to the server for secure HTTPS connection, user authentication, input validation, access control, data encryption, and a PHP Firewall library to block malicious IP addresses or networks. These measures protect the patient management system from common threats and ensure its safe and secure use by authorized users. Azure AI also has it security layer to unauthorized access to the chatbot services.

4.6 System Testing

System testing for the new intelligent system involved unit tests, integration tests, and system tests. These tests validated the functionality and performance of the chat bot and messaging platform and their integration to the hospital management system.

Below are sample webpages taken from the various system testing stages.

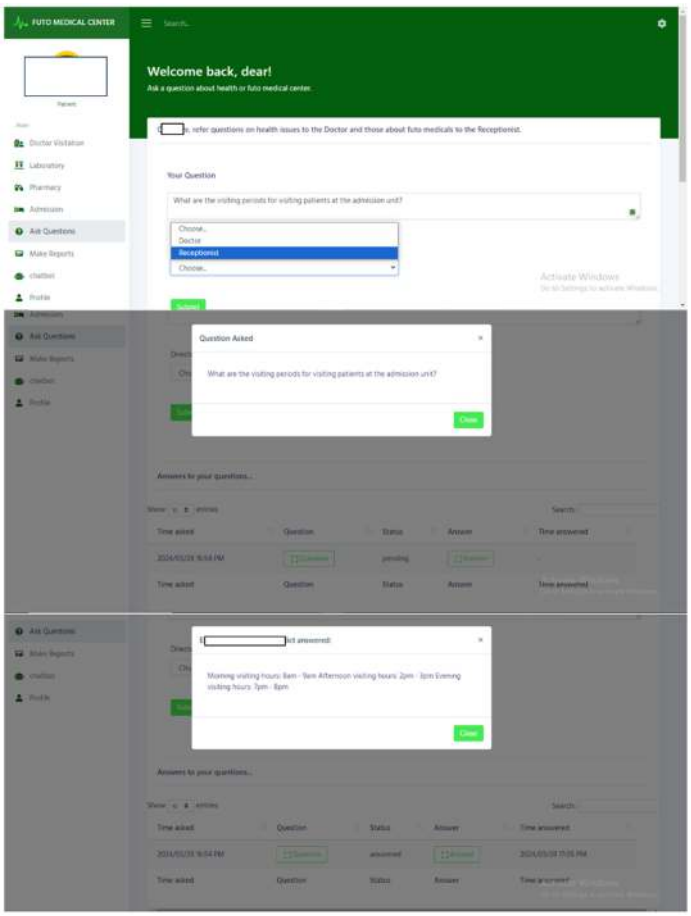

Figure 7: System testing: Patient was able to ask a question directed to the receptionist and received an answer, showing timestamps and who answered the question.

Figure 8: Visitors are able to access the FAQ page from the landing page but cannot use other features, encouraging them to register with their healthcare centers.

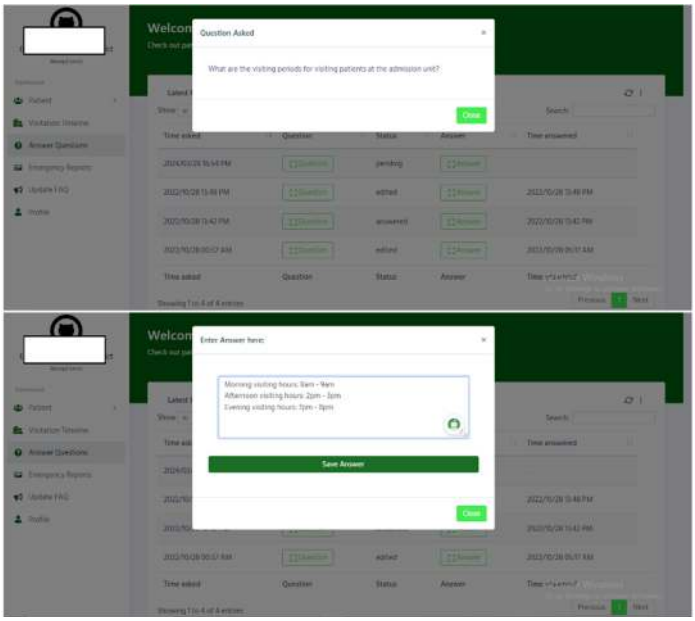

Figure 9: Receptionists, from their dashboards were able to receive patients' questions directed to receptionists, and provide answers to pending entries.

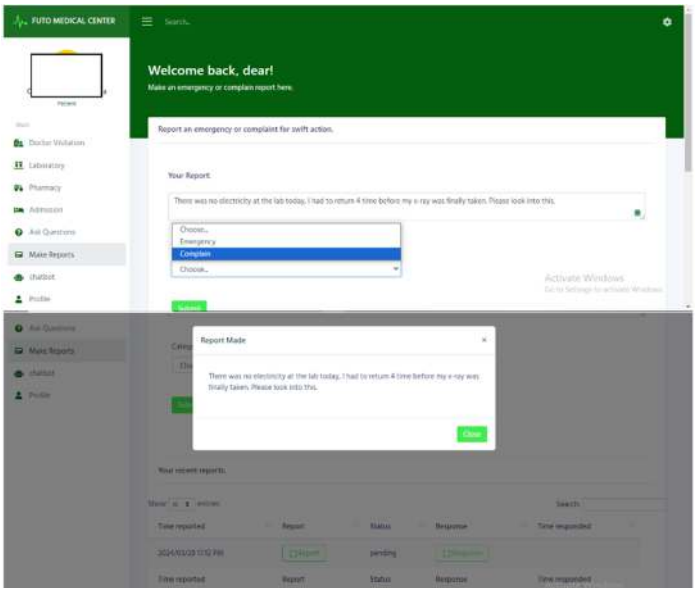

Figure 10: Patients were able to make emergency or complaint reports and receive a response.

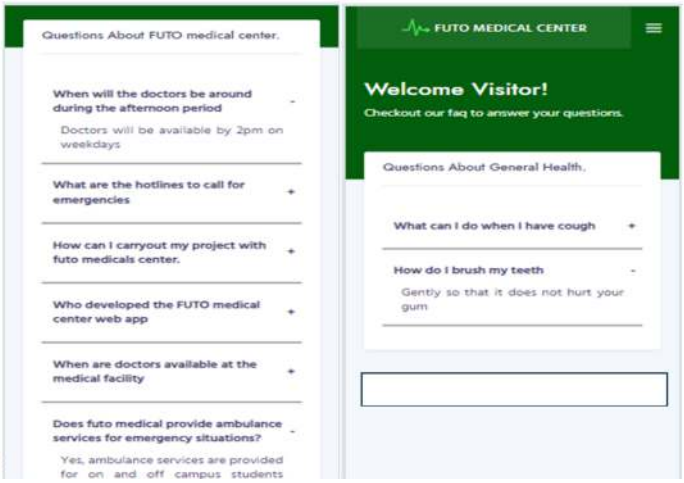

Figure 11: Platform testing – FAQ page mobile view

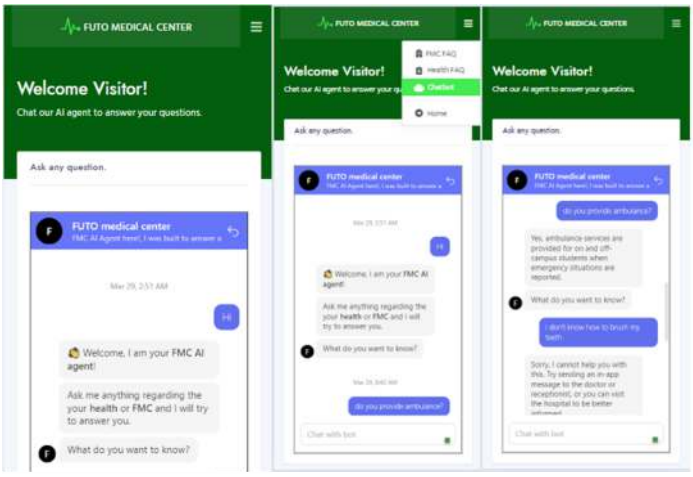

Figure 12: HMS integrated intelligent chatbot, answering user's questions -

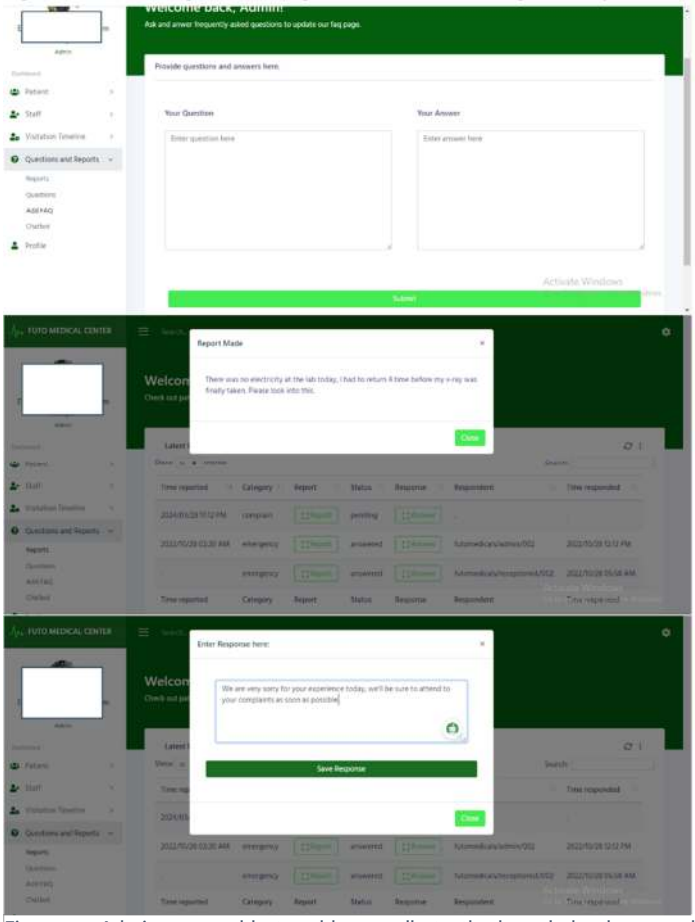

Figure 13: Admins were able to add manually to the knowledge base, and also respond to reports from their dashboards.

5.0 CONCLUSION

5.1 Summary

This project saw the development of an in-app messaging platform for patient to hospital communication, and an intelligent chatbot which utilized knowledge base from conversations with expert doctors and medical staff, and their integration into a hospital management system to provide reliable and safe remote medical care, thereby

improving healthcare provision in Nigeria. The architecture was based on actor-network and socio-technical theories, OOADM, and UML, and the development process involved rigorous testing and debugging.

5.2 Recommendation for future work

Based on this work, the following recommendations are made for further research and development on the use of AI gents for smart and remote healthcare delivery in Nigeria:

1. Improvement of bots and messaging platform to support multimedia communication for remote healthcare.
2. Integrating IoT devices is a means to achieving personalized healthcare delivery.

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