DEVELOPMENT OF AN AI-POWERED CHATBOT SYSTEM FOR STUDENT SUPPORT AND ADMINISTRATIVE SERVICES IN AFRICAN UNIVERSITIES

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A PROJECT SUBMITTED TO THE DEPARTMENT OF COMPUTER SCIENCE AND MATHEMATICS, FACULTY OF COMPUTING AND INFORMATION TECHNOLOGY, GODFREY OKOYE UNIVERSITY, ENUGU STATE.

IN PARTIAL FULFILLMENT OF THE AWARD OF BACHELOR OF SCIENCE (B.Sc) DEGREE IN COMPUTER SCIENCE.

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JUNE, 2026.

APPROVAL

This research, titled "DEVELOPMENT OF AN AI-POWERED CHATBOT SYSTEM FOR STUDENT SUPPORT AND ADMINISTRATIVE SERVICES IN AFRICAN UNIVERSITIES," has been assessed and approved by the Department of Computer Science and Mathematics Committees in the Faculty of Computing and Information Technology, Godfrey Okoye University, Enugu, Nigeria.

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CERTIFICATION

I certify that I completed the research included herein and that it was primarily based on my own observations and investigation. Consequently, I will fully accept the University's decision if I am found to have engaged in any form of academic dishonesty.

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DEDICATION

This project is dedicated to God Almighty, whose grace and wisdom guided every step of this work, and to my parents, whose unwavering love, sacrifice, and encouragement made this academic journey possible.

ACKNOWLEDGEMENTS

First and foremost, I give thanks to Almighty God for the strength, wisdom and persistence He has blessed me with during the entire academic period.

Secondly, I want to thank Dr. Echezona Stephenson C., my supervisor, for the indispensable advice, constructive criticism and constant support rendered me during the duration of this project.

I want to thank Dr. Frank Okebanama, Head of the Department of Computer Science and Mathematics, and all other lecturers in this department for their teachings, mentorship and valuable contribution to this field of study. I particularly want to thank each lecturer for the part he played in teaching me.

I want to appreciate Prof. Ifeyinwa Ajah, Dean of the Faculty of Computing and Information Technology, for creating the conducive academic atmosphere in the faculty.

My deepest gratitude goes to my parents and families for their constant prayer and financial and moral support rendered me.

Lastly, I want to thank my fellow students and friends for their unswerving support during our academic journey at Godfrey Okoye University.

ABSTRACT

The project is meant to develop an intelligent chatbot which would offer assistance to students of African universities and also provide other administrative services at the institutions in question. This particular research was done in order to create such a chatbot for Godfrey Okoye University situated in the state of Enugu. This study arose from problems that the students of the particular institution had when trying to obtain necessary administrative information through various channels of communication in their institution. A hybrid approach was used, which involved application of Natural Language Processing technology for recognition of user intentions and creation of the knowledge base in the form of rules which was based on information from official documentation of the institution. The software was developed using JavaScript with the help of Next.js framework as well as HTML and CSS for web interface. The knowledge base included data about admissions, course registration, examinations, fees, hostels, results, and policies regarding the students and was organized according to the specified categories and stored in the structured format. The model was installed locally and tested functionally through several input cases, each producing valid outputs. The implemented chatbot system proved the feasibility of the use of a supervised and institutionally controlled AI-based system for the enhancement of accessibility, reliability, and efficiency of administrative services in universities.

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CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

The use of AI in educational systems has been gaining popularity in recent times, especially in helping universities handle administrative activities and serve students efficiently. African universities, specifically, are becoming more and more digitalized in a bid to enhance efficiency and communicate better with the academic community. Still, many universities are faced with difficulties in handling the students' queries concerning academics, registrations, results, accommodation, and administrative activities. In fact, according to Adewale and Garba (2022), the adoption of artificial intelligence in African universities is low due to insufficient digital infrastructure, weak institutional data infrastructure, and the lack of context-driven solutions in spite of the clear capacity of AI to streamline administrative processes and service delivery.

A chatbot is an efficient conversational AI tool that imitates natural human conversation and helps in processing users' requests automatically. The use of NLP and ML algorithms makes the chatbot understand users' queries, respond to them accordingly, and conduct predefined tasks. Chatbots have proved to be very helpful in different sectors, for example; banking, healthcare, e-commerce, and education as virtual assistants.

Considering the African universities scenario, a chatbot application that is enabled by artificial intelligence technology could help fill the communication gap between the students and the administrative departments while improving efficiency. The system acts as a digital assistant that responds to the commonly asked queries and offers personalized advice for the student. This would be beneficial especially in universities with many students but fewer administrative personnel.

1.2 Statement of the Problem

However, even though digital technology is increasingly being used in African universities, students still encounter difficulties when it comes to acquiring information related to academic and administrative activities. The main issues that drive this research are presented below:

1. Inefficiency in Access to Information: Inquiries about course registrations, result checks, allocation of hostels, payment of fees, departmental inquiries, and student services in general take up too much time and cause inefficiency and a breakdown of communication between both students and staff.
2. Lack of Intelligent and Interactive Portal: Most of the existing university portals and websites do not have any intelligent and interactive tools that enable interaction of human and computer in a natural way. Instead, students have to browse through multiple pages or wait for humans to respond to their queries.
3. Increasing Student Population and Limited Administrative Staff: The problem has become worse due to the increase in the student population and limited number of administrative staff members who have to manually handle the inquiries.
4. Lack of Automated Real-Time Chat System: An automated tool does not exist that can enable real-time conversation with the students, listen to their concerns, understand them and reply back accurately. Due to the lack of such tool, an inefficiency in communication has developed between the university and its students. Thus, there is a need to develop an AI-based chat system that can solve these issues.

1.3 Aim and Objectives of the Study

Aim of the Study

The core objective of the study will be to design a chatbot system which is enabled by Artificial Intelligence that can effectively offer student services and administrative services in universities in Africa.

Specific Objectives

The specific objectives of this study are to:

1. Develop and build a chatbot system that can answer the questions raised by students related to both academic and administrative concerns.
2. Implement NLP methods into the system so that the chatbot will be able to interpret the user input.
3. Build an interface that will make it easy for students to communicate with the chatbot using text messaging.
4. Assess the chatbot system based on its accuracy, response time, and level of user satisfaction.
5. Automate service requests of students to lessen the burden of the administrative staff.

1.4 Significance of the Study

This study is significant for several reasons, especially within the context of African universities where digital transformation is still developing.

1. **To Students**

The AI-based chatbot enables students to have immediate and dependable access to information about academic and administrative services. This minimizes unnecessary physical trips to administrative offices and avoids long wait times. Additionally, it ensures that students can get assistance 24/7, even when the university administration is not operational.

2. **To University Administration**

The system makes the job of administrative staff less burdensome by automating repetitive inquiries related to registration processes, tuition fees, results, and other departmental issues. This leaves the staff members to concentrate on complicated issues which cannot be automated.

3. **To the University as an Institution**

Through the adoption of AI solutions, universities improve their digital infrastructure and service delivery. This leads to modernization of the university as an institution and improves its reputation among the smart campus initiative of the world.

4. **Researchers and Developers**

This project will serve as a template and inspiration for other researchers working in the field of artificial intelligence, natural language processing, and educational technology. The project also helps in setting up platforms for further developments in the form of voice-based chatbots, multi-language chatbots, and completely automated student service centres.

5. **African Higher Education Sector**

This research showcases how new technological developments can help solve old problems of African higher education, particularly in terms of communication and service delivery.

1.5 Scope of the Study

This study focuses on the design, development, and evaluation of an AI-powered chatbot system specifically tailored for student support and administrative services in African universities. The scope covers the following areas:

1. Chatbot Functionality: The system offers automated answers to frequently asked questions regarding academics, admissions, enrollment, accommodation issues, fees, exam results, and general administration processes.
2. User Interaction: The chatbot works using the text interface where the students can ask their questions and get instant responses to them.
3. Technology Coverage: The research makes use of artificial intelligence and natural language processing methods so that the chatbot understands the user questions and provides the right answers.
4. System Development: The scope of the system development involves system design, architecture development, database creation, interface development, and chatbot implementation.
5. Evaluation: The chatbot is assessed depending on its performance, response time, user-friendliness, and user satisfaction.
6. Limitations of Technology Coverage: The system does not process any sensitive information such as examination papers, financial operations, or any security issues and does not substitute human administrators.

1.6 Limitation of the Study

Despite the usefulness of the proposed AI-powered chatbot system, the study is constrained by several limitations:

1. Technical Constraints: Performance of the chatbot will depend greatly on the accuracy of the training data and NLP model utilized. It may incorrectly interpret vague questions and reply with insufficient answers if there is no corresponding data in the database.
2. Scope of Replies: This technology is meant to answer standard academic and administrative questions only.
3. Internet Dependency: The chatbot will be able to operate efficiently only if it is connected to the internet.
4. Resource Constraints: Lack of research time, computer resources, and data prevents the chatbot from having more complex functions like voice recognition and multilingual capabilities.
5. User Acceptance: There may be a lack of acceptance among some students and faculty due to low digital skills or desire for personal communication.

1.7 Definition of Terms

1. **Administrative Services:** University-related services such as registration, admissions, course information, fee inquiries, hostel allocation, and general academic procedures.
2. **Artificial Intelligence (AI):** A branch of computer science that focuses on creating systems capable of performing tasks that normally require human intelligence.

3. **Chatbot:** A computer program designed to simulate human conversation by responding to user inputs through text. In this study, it refers to an automated text-based assistant for student and administrative support.
4. **Database:** A structured collection of data that stores information used by the chatbot for generating responses to user queries.
5. **Knowledge Base:** A centralized repository of verified institutional information from which the chatbot retrieves responses.
6. **Machine Learning (ML):** A subset of AI that enables computer systems to learn from data and improve performance without being explicitly programmed.
7. **Natural Language Processing (NLP):** An area of AI that enables machines to understand, interpret, and generate human language.
8. **Student Support System:** A platform or mechanism that provides assistance, guidance, and information to students regarding academic and administrative matters.
9. **User Interface (UI):** The visual and interactive component of a software application that users interact with to input commands or receive information.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, various theoretical approaches, as well as related literature concerning artificial intelligence, chatbot systems, and its applications in higher education will be examined. This review will be presented in such a way that it begins with theoretical approaches and ends with practical applications and functioning of chatbot systems in higher education settings. Special attention will be paid to existing advantages and disadvantages of current systems. In order to establish the need for further research and development of AI-based chatbot system, some gaps in the literature will be outlined.

2.2 Theoretical Framework

2.2.1 Artificial Intelligence Theory

The field of Artificial Intelligence (AI) deals with the creation of systems that can complete tasks that normally need human intelligence, including thinking and making decisions. In this case, the use of AI will be limited to intent recognition where the system will analyze the user's request in order to establish the intention behind the request. After that, the system will retrieve the answers only from the official institutional knowledge repository. As such, AI used in this study acts only as an interpreter and not as a decision-maker.

2.2.2 Natural Language Processing (NLP) Theory

Natural Language Processing (NLP) is an area of Artificial Intelligence through which computers can interpret and analyze human languages. In the current study, NLP is used during the process of query processing to determine the intention of users. Keyword extraction, sentence normalization, and intent classification are some of the techniques used to map the wide range of

user queries into appropriate response types. The incorporation of NLP enhances the flexibility of the system but within controlled response generation.

2.2.3 Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), put forth by Davis (1989), helps understand how users adopt technology as a result of perception of usefulness and ease of use of that technology. For the purpose of this research, TAM was used to design the chatbot in a manner that meets the requirements of users. The chatbot is developed in a way that provides instant answers to make it more useful for users, while the interface is made simple and conversational to ensure ease of use.

2.2.4 Human-Computer Interaction (HCI) Theory

Theory of Human Computer Interaction (HCI) is all about building systems that are efficient, user-friendly, and accessible. In this research, principles of HCI have been applied in the design of the interface of the chatbot system. The chatbot utilizes a simple chat interface which facilitates easy interaction, instant feedback, and fallback messages for any query not understood by the system.

2.2.5 Management Information Systems (MIS) Theory

MIS theory revolves around the manner in which organizations gather, process, store, and disseminate information. As per Laudon and Laudon (2021), an information system is made up of four elements, namely people, processes, data, and technology. In this case, MIS theory provides the theoretical framework behind the development of the knowledge base and administrative module in the chatbot, whose combination constitutes an information subsystem of the university. In other words, institutional data related to admissions, registration, fees, examinations, hostels allocation, and results are systematically arranged for storage and retrieval in a manner similar to that seen in MIS where organizational data are organized in query-able stores. Here, the chatbot becomes an interface layer between the university's information assets and its final user, the

student, who receives information automatically through the bot instead of waiting for administrative personnel to make it available manually. This is in line with the core goal of the MIS that revolves around enhancing the efficiency and effectiveness of information handling within an organization.

2.2.6 Communication Theory

In communication theory, attention is paid to the study of information transmission between a sender and a receiver, as well as to the various aspects that can influence the accuracy of information perception by the recipient. In the Shannon-Weaver model of communication (Shannon, 1948), communication is described as the process of transmitting information from the source through the process of encoding into the channel and then perceiving by the receiver, which may be distorted due to the presence of "noise." Using this theory in this research, the student becomes the source of information, chatbot interface – the communication channel, and the knowledge base is a repository of correctly encoded institutional messages. Natural language queries made by the students are frequently informal, ambiguous, and incomplete; it can be considered "noise" in the channel of communication. The preprocessing pipeline of NLP implemented in this study – tokenization, normalization, removal of stop words, and keyword extraction – acts as the process of noise reduction, which ensures that the chatbot successfully decodes the meaning of the student's message and transmits the correct response.

2.3 Review of Related Literature

Adamopoulou and Moussiades (2020) performed an extensive study of the existing chatbot technologies, classifying them as either rule-based, retrieval-based, or generative. Although their research is a great starting point from a technological perspective, it fails to consider the necessity of deploying chatbots in a controlled manner in sensitive settings like university administration.

This is where this research comes into play as it combines AI-based intention recognition with a tightly controlled knowledge base.

Okonkwo and Ade-Ibijola (2021) researched the application of chatbot systems in higher education and discovered that chatbot systems greatly enhance response speed and consistency. At the same time, there were no intelligent means of dealing with various user inputs. This study further develops it by utilizing NLP-based intention recognition while retaining the structure of responses.

Winkler and Söllner (2018) looked at conversational agents in education and stressed the importance of usability and structured conversation. While their work underscores the significance of design in terms of chatbot performance, it does not deal with the problem of the administration's service provision. This research expands upon their work through application of HCI concepts to administrative chatbot systems.

Labadze et al. (2023) addressed issues related to AI-based chatbots, namely, the problems of misinformation and ethical issues. Nevertheless, their research did not offer a structure for addressing these issues in organizational setting. This research aims to provide solutions to these limitations by limiting response generation to the information verified by the institution while relying on AI solely for queries interpretation.

Følstad and Brandtzaeg (2017) noted trustworthiness, reliability and predictability as important aspects determining users' attitude towards chatbots. This research takes into account structured knowledge validation in order to increase credibility of the system.

Bibauw et al. (2019) addressed the issue of chatbots use in educational environments and proved that conversational systems could be engaging. However, their research was more concerned about

educational environment than administrative issues. This research is concentrated on the administration of universities.

Adewale and Garba (2022) conducted an analysis on the adoption of AI technology in universities across Africa and noted that infrastructural inadequacies, lack of skills, and absence of locally relevant data set posed huge challenges to its adoption. However, the paper failed to come up with a systematic design model for AI adoption in African institutions. This paper seeks to bridge this research gap by coming up with a light weight and locally deployable chatbot design model.

Zhao, Wang, and Sun (2022) conducted an analysis on the use of intelligent conversational systems in universities and came up with findings indicating positive impacts on both students and administrators. The researchers depended on the use of pre-trained language models which require significant computational resources. This paper differs in methodology since it employs a light weight and easy to maintain retrieval architecture.

Xu et al. (2017) have created a chatbot for customer service on social media sites and have proven that automation helps greatly reduce response time to simple customer inquiries. Even though the study is related to the commercial customer service process, the governance aspects which should be taken into account in university administration were not considered. The study applies the main principle of automation and instant response to inquiries in the field of university administration with institutional controls being incorporated in this process.

According to Brandtzaeg and Følstad (2018), efficiency, entertainment and accessibility are key drivers of chatbot use. In this study, the authors apply these findings in the field of university administration where accuracy and institutional control are crucial.

Smutny and Schreiberova (2020) analyzed educational chatbots used on Facebook Messenger and found out that most of the implementations were too narrow-minded and only aimed at delivering educational content with little use of institutional databases. In this study, the authors expand the usage of educational chatbots to provide administrative services based on an institutionally certified knowledge base.

2.4 Summary of Reviewed Literature

Table 2.1: Summary of Reviewed Literature

S/N	Author(s)	Focus Area	Contribution	Limitation
1.	Adamopoulou & Moussiades (2020)	Chatbot architectures	Classification of chatbot types	No governance focus
2.	Okonkwo & Ade-Ibijola (2021)	Higher education chatbots	Improved response efficiency	Limited adaptability
3.	Winkler & Söllner (2018)	UX in chatbots	Emphasized usability	High computational cost
4.	Labadze *et al*. (2023)	AI risks	Highlighted ethical concerns	No mitigation model
5.	Følstad & Brandtzaeg (2017)	User trust	Identified trust factors	No institutional control
6.	Bibauw *et al*. (2019)	Educational chatbots	Improved engagement	Focus on pedagogy
7.	Adewale & Garba (2022)	AI adoption in Africa	Identified adoption constraints	No system design proposed
8.	Zhao et al. (2022)	Conversational systems in HEIs	Improved engagement & efficiency	Not admin-focused
9.	Xu *et al*. (2017)	Customer service chatbots	Reduced response time for routine queries	No institutional governance model
10.	Brandtzaeg & Følstad (2018)	User motivation	Explained chatbot usage drivers	Not institutional
11.	Smutny & Schreiberova (2020)	Educational chatbots on Messenger	Identified common chatbot design patterns	Limited to content delivery, not admin services

2.5 Research Gap

It is clear from the reviewed literature that despite a lot of research done on chatbot technology in various fields, there are some gaps in the use of chatbots in support of administrative services at universities. Previous researches mostly involve rule-based models that are not flexible enough or fully automated AI models that are risky in terms of possible dissemination of false information and lack of institutional control. Moreover, existing models are implemented either within a single department or for teaching purposes only.

Also, there is little attention paid to institutional knowledge preservation, supervised use of AI and implementation of the technology according to the peculiarities of universities in Africa, where the administration is usually disjointed and depends on personal communication between people. Thus, the main gap that should be filled in this research is the development of a structured supervised chatbot model that will combine intelligent interpretation of questions with controlled responses.

CHAPTER THREE

SYSTEM ANALYSIS AND DESIGN

3.0 Introduction

In this chapter, there is the analysis and design of the proposed AI-based chatbot system that will assist in student administration. There is an evaluation of the existing mechanisms that have been used by the students to obtain information about the administrative aspects, with the identification of the shortcomings of these mechanisms. The goals of the proposed system are discussed, together with the system requirements that will be needed to implement the system. There is the discussion of the approach of design of the system, through the discussion of data gathering and system modeling through UML diagrams.

3.1 System Analysis

This chapter discusses the analysis of the present system used to offer support to students and administration within the university. This analysis will be based on how the present system works including the process of seeking information by students. The weaknesses of the present system have been discussed, and there is need to develop a new system.

3.1.1 Analysis of the Existing System

There are certain mechanisms employed to cater to the needs of students and administration of the university such as Godfrey Okoye University in regard to provision of services. These mechanisms comprise formal administrative framework along with informal communication channels. This process is quite manual and non-centralized as well as involves the human factor. The process usually begins from the students' end where the students start asking questions either by visiting the physical offices or student representatives or posting the question on WhatsApp or by searching the university portal.

3.1.2 Limitations of the Existing System

Limitations of the current system include several important aspects. First, there is over-reliance on physical administrative offices that causes long lines and limited availability outside the working hours. Second, there is no single source of information, since the information is distributed via many different mediums and may even contradict one another or become outdated. Third, there are some problems with informal communication channels that cannot be relied on as well as the university portal that is not interactive enough and does not provide any support options. Finally, there are issues related to inefficient use of time and lack of scalability and 24/7 availability of the system.

3.1.3 Objectives of the Proposed System

These limitations can be overcome using the proposed solution that will include:

1. An integrated platform where the students can ask their questions from one location to get correct and consistent information.
2. Timely response to the student's queries without any delay caused due to the manual process.
3. Consistency and accuracy in the provision of information using a structured database.
4. Reduction in the workload of the administration as repetitive questions will be automatically handled.
5. Availability of support services round the clock unlike in the current system.
6. Saving of organizational knowledge in a structured way.
7. A better user experience with an easy-to-use conversational interface.

3.2 System Requirements Specification (SRS)

3.2.1 Functional Requirements

The functional requirements of the proposed AI-driven chatbot solution are as follows:

1. User Query Entry: The system should enable users to enter questions using a text-based input in natural language.
2. Query Processing: The system should process the keywords and patterns used by the users to determine their intent and match queries with appropriate responses.

3. Response Production: The system should produce clear and concise responses relevant to the user's intent.

4. Information Database Maintenance: The system should maintain a structure database that can be updated regularly with information from the university's official sources.

5. Category-based Information Organization: The system should classify the information according to different categories such as Admissions, Registration, Examinations, Fees, Hostel, Students Policies, Course Registration, and Result.

6. Sessions: The system should enable users to continuously interact with the chatbot during sessions.

7. Error Handling and Fallback Response: The system should give a generic response if the system cannot understand the user's question.

8. Access: The system should be available via a web-based platform on both desktop and smartphone 24/7.

9. Update Interface: The system should have an administrative interface for updating knowledge base entries.

3.2.2 Non-Functional Requirements

The non-functional requirements of the suggested system are listed below:

1. Performance: The system must answer the queries of the users within a short period of time using lightweight algorithms for matching keywords and pre-matched answers in the knowledge base.

2. Usability: The system must be user-friendly by means of providing a simple chat interface having only one input text box and a labeled 'Send' button without any previous training.

3. Reliability: The system must generate consistent output based on only one verified knowledge base which is obtained from official university documents.

4. Availability: The system must be available 24/7 using a reliable web server which is not dependent on the working hours of the universities.

5. Scalability: The system must be scalable by making use of a modular three-tier system structure where new data can be inserted without changing anything in the system itself.

6. Maintainability: The system will provide access for authorized individuals to add, modify, or delete knowledge base entries using the administration panel without any changes to the source code.
7. Security: The system will limit the use of the system responses for information searching only; the administration panel will be protected using authentication and validation of all inputs from the server side.
8. Compatibility: The system will be usable on mobile phones and computers using a web browser.

3.3 System Design Methodology

3.3.1 Justification for Methodology

The development of the suggested chatbot follows a mixed approach to design which merges the structured rules based methodology and the simple Natural Language Processing. The choice of this design philosophy was made in order to achieve the balance between the reliability of the system, its simplicity and intelligence. The pure rules based system is easy to develop but is often inflexible. At the same time, the completely autonomous AI systems may bring too much complexity and even risk in the environment where such things are not allowed.

3.4 Method of Data Collection and Data Preprocessing

It is essential to state that the data collection strategy implemented in this research is essentially different from the data collection strategies typical for predictive systems or any other machine learning approaches. The thing is that the majority of predictive systems need a lot of historical data in order to build their models and learn how to generalize new situations. However, this research is not a predictive system since it is an expert system where Artificial Intelligence is applied only on the stage of interpretation of users' queries, whereas the answers themselves are

taken from the fixed verified institutional knowledge base. Therefore, the data collection strategy for this research is a qualitative and documentary one.

The following data collection methods were used:

1. **Analysis of Documents:** A thorough examination of the official university documentation, such as student handbook, academic policies, procedural manuals of administration, and policy documents collected from Godfrey Okoye University.
2. **Informal Structured Interview:** Informal structured interview sessions were held with the administrators of each department and the students to know the most asked questions and the language used by the students to ask questions for designing keywords and intents for knowledge base.
3. **Web Scraping of Official University Websites:** Informational data was extracted from the publicly available information on the official university website.
4. **Extraction of Digital Content:** As some of the sources were available in non-editable form, hence necessary content from such sources was extracted and put into review, cleansing and structuring process suitable for digital storage.
5. **Categorization and Structuring of Data:** The gathered information was grouped under logical categories such as Admissions & Registration, Academic Policies, Examination Policy, Fees and Charges, Hostel & Accommodation, Course Registration, Results, and General Information of Students.
6. **Validation of Information:** The collected information was compared with the sources and only validated information was allowed in the knowledge base to avoid the possibility of misleading students with out-of-date information.

In regards to the volume of the collected data, the resulting knowledge base consisted of about 120 unique question-answer entries classified into eight (8) categories. On average, every such pair had five to eight corresponding keywords or phrase variations. Though this is a small dataset compared to training corpuses typically used for machine-learning purposes, it is a perfect match for the current study since this particular system does not need any pattern recognition algorithms and statistical generalization of data – it uses correct one-to-one mapping between institutional intent and response, which was done manually. A larger system that needs to predict something would need thousands of examples; but here, the requirement is to have an exhaustive and precise knowledge base in regards to the subject matter.

The source of data utilized in this research project was obtained from university-related documentation sources, specifically, the students' guide and administration policy manuals of Godfrey Okoye University. The source data is comprised of structured data relating to procedures, fees, registration, accommodation, and other services offered to the students. In order to process the non-editable source data, there was a need to extract information from the source, clean and organize the text, classify data into administrative areas, and map the data to specific intents for easy retrieval.

A sample of the dataset used in the knowledge base is presented in Table 3.1 below. Each entry contains the category, associated keywords used for intent matching, a representative sample query, and the corresponding response stored in the system.

Table 3.1: Sample of Knowledge Base Dataset

Category	Keywords	Sample Query	Sample Response
Registration	register, courses, course registration, enroll	How do I register my courses?	Log in to the university portal, navigate to Course Registration, select your level and department, choose your courses and click Submit.

Fees	school fees, payment, tuition, pay fees	How do I pay my school fees?	School fees are paid via the university payment portal. Log in, go to Finance, select Fee Payment, and follow the prompts.
Results	results, check results, CGPA, grades	How can I check my results?	Log in to the student portal and navigate to the Results section under Academics. Semester results are uploaded after the examination board meeting.
Hostel	hostel, accommodation, room, bed space	How do I get hostel accommodation?	Hostel allocation is done through the student portal. Go to Hostel Allocation, select your room type, and submit your request.
Admissions	admission, acceptance, admission letter, clearance	How do I complete my admission clearance?	Newly admitted students must report to the Admissions Office with their acceptance letter, WAEC/NECO result, birth certificate, and passport photographs.

The complete dataset consists of entries drawn from the official Godfrey Okoye University student handbook and administrative guidelines, covering all major student support categories.

3.5 System Modeling Using UML

3.5.1 Use Case Diagram

This study presents use case diagrams as an example of how the students and the administration use the AI-based chatbot system to perform various tasks. In this regard, the students can talk to the chatbot through their queries to receive answers and ask further questions. In contrast, the administration has some authorized people who can add information into the database or edit the existing one.

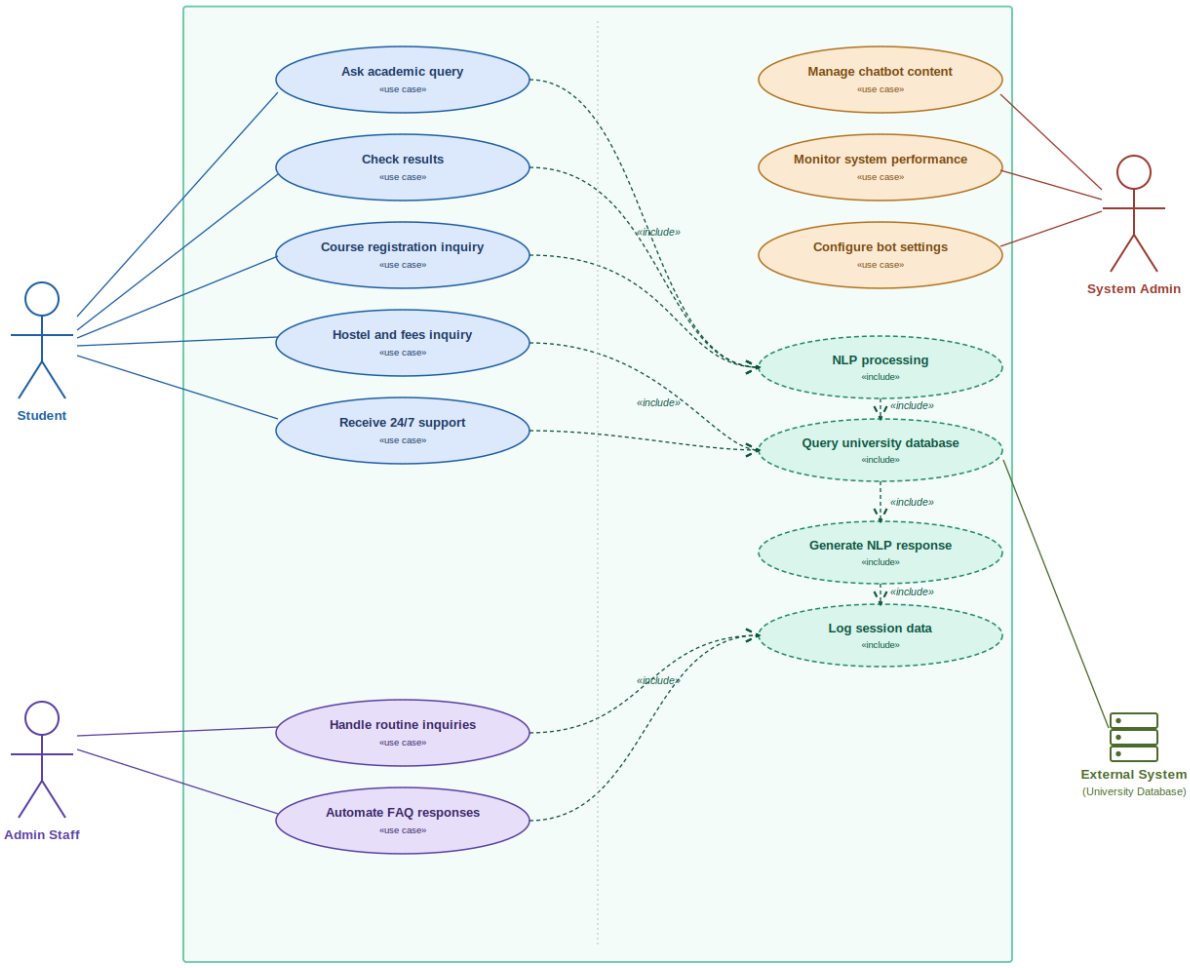

Figure 3.1: Use Case Diagram of the AI-Powered Chatbot System

3.5.2 Activity Diagram

In this study, the activity diagram represents the step-by-step process involved when a student interacts with the AI-powered chatbot system to obtain information. The process continues as long as the user chooses to interact with the system. After receiving a response, the user is presented

with the option to ask another question within the same session. If satisfied, the session ends; if not, the user submits a new query and the process repeats from the processing stage.

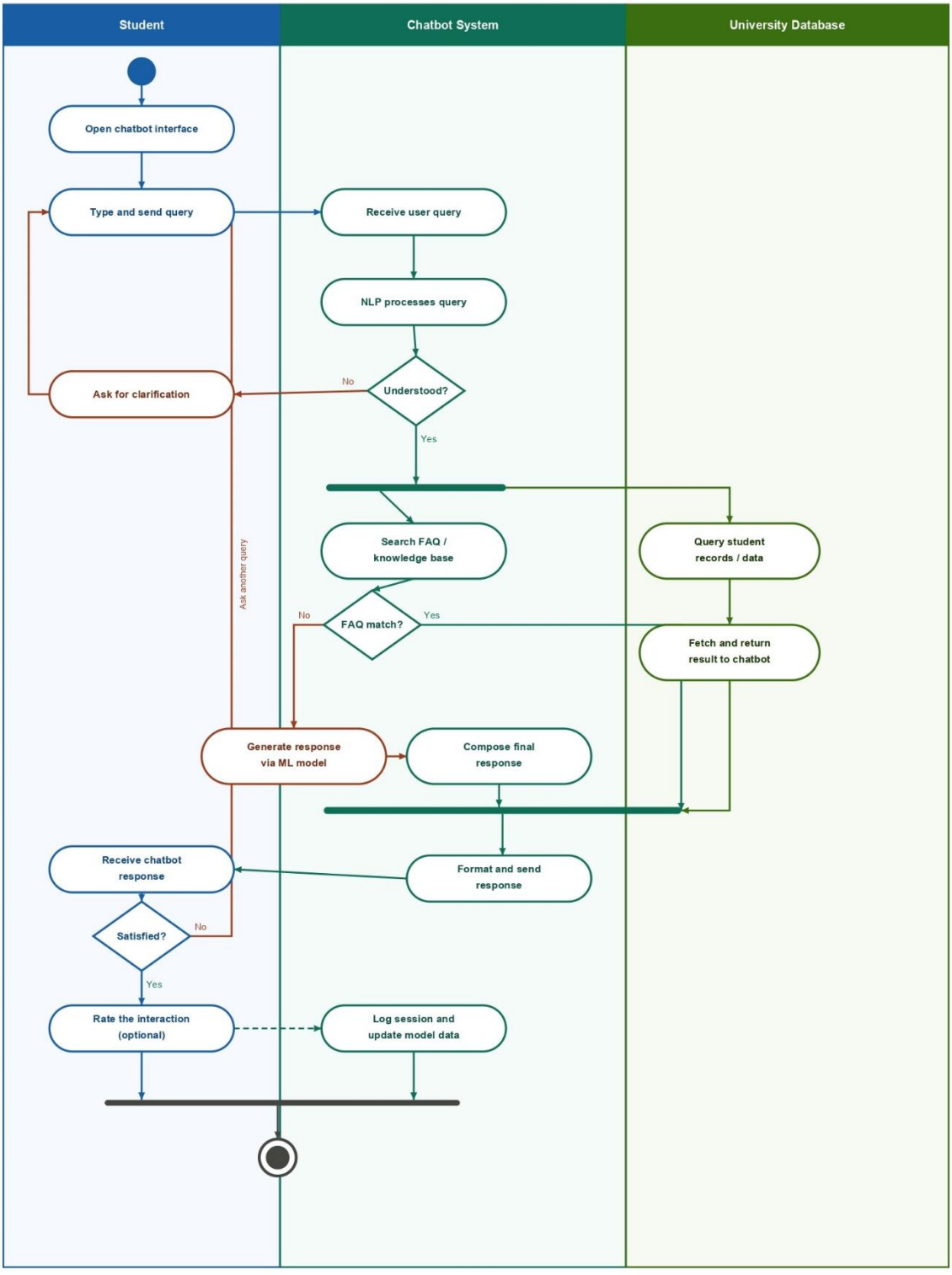

Figure 3.2: Activity Diagram of the AI-Powered Chatbot System

3.5.3 Class Diagram

The class diagram for the intended system depicts all the classes and their interactions. These are the main classes involved: User (has userID, sessionID, and timestamp attributes and startSession and receiveResponse methods); Chatbot (chatbotID, knowledgeBase, responseEngine attributes and processQuery, generateResponse, handleFallback methods); Query (queryID, queryText, timestamp); Response (responseID, responseText, confidenceLevel); KnowledgeBase (dataID, category, content, lastUpdated attributes and fetchResponse, updateData, addData, and deleteData methods); and Admin (adminID, username, password attributes and addKnowledge, updateKnowledge, and deleteKnowledge methods). The user is able to interact with the chatbot; the chatbot uses the queries, accesses knowledge base and produces responses; and the admin manages the knowledge base.

3.6 System Design

3.6.1 Input Design

Input design deals with how the data gets into the system and the design of user interactions in terms of simplicity and ease of use. The input to the system is done via a chat window where the users will be typing their questions regarding educational and administrative issues using natural language. Input design involves a Text Input field where the user inputs his/her question, a Send button where the user sends the query and the Chat Window Interface where both the user's input and system output will be displayed in a conversation style.

3.6.2 Output Design

Output Design deals with the way in which the system shows the information to the users after processing their inputs. The system provides replies via the chat interface through which the input was received. Output elements consist of Chat Response Display (response will be displayed

differently than the user inputs), Text-Based Response (concise answers to the questions asked), Fallback Message Display for unrecognizable inputs, and Sequential Message Flow (maintaining conversation sequence). Output attributes include clarity, relevancy, consistency, and conciseness. Below is the screen design that reflects the expected output interface for a recognizable input and unrecognizable input.

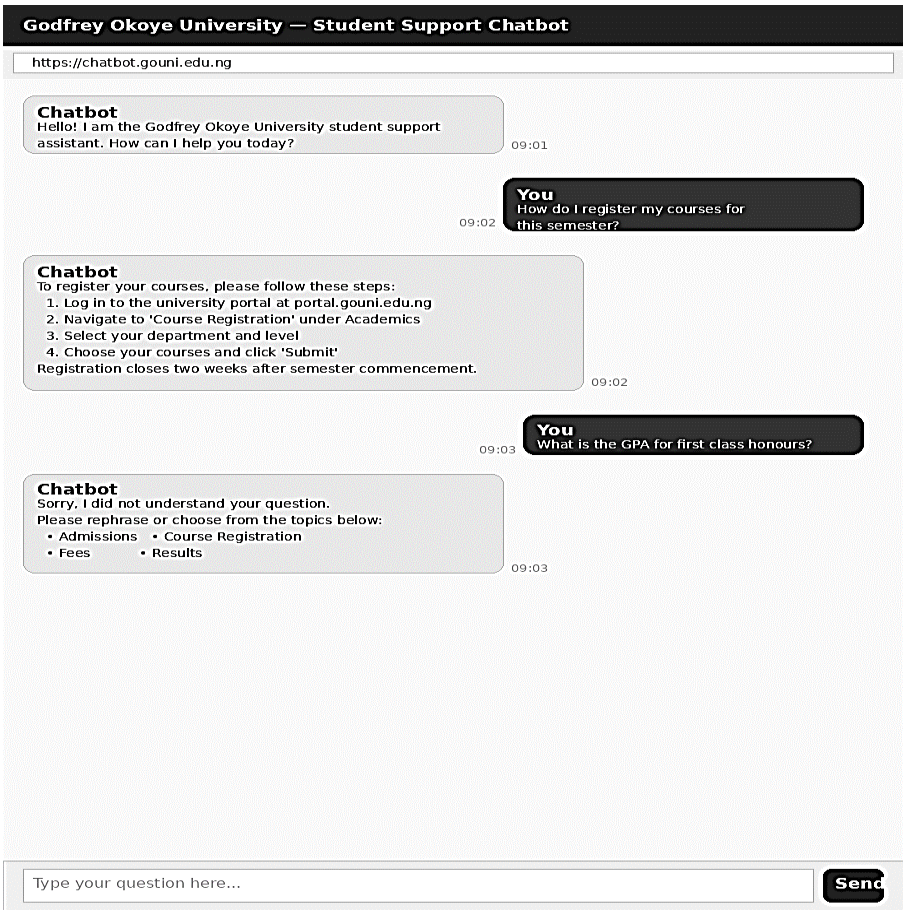

Figure 3.3: Sample Output Screen of the AI-Powered Chatbot System

3.6.3 Database Design

Database design is the way in which data is structured, so that it can be efficiently stored, retrieved, and managed by a computer database. The database is the knowledge base of the chatbot, which includes all institutional information needed to answer the users' questions.

The Database Management System (SQLite): SQLite was chosen as the database management system for this study. SQLite is a very lightweight, serverless relational database engine that stores the entire database on disk in a single file, without needing to run a separate database server process. This was a deliberate choice: a) because the system is designed as an administrative chatbot in a single institution, and not a large-scale enterprise system that is expected to scale horizontally to multiple regions and multiple instances, the concurrency and scalability aspects of heavier database engines (such as PostgreSQL or MySQL) were not a strict

requirement; b) because the knowledge is read only (the system does so much more read/retrieval operations than write/update operations), SQLite's architecture, optimized for fast read access, is appropriate for this use case; and c) the knowledge base, being read-only, was easily backed up, versioned and moved (backwards and forwards) during development and testing without the need for a separate database server installation or configuration in many other cases. The system architecture was, however, built in a modular way, allowing for SQLite to be replaced with a more powerful client-server system like PostgreSQL or MySQL should the institution wish to scale the system up in a production deployment for significantly more concurrent usage, without any changes to the business logic of the system.

The database contains five tables, each of which has a description, a name of the field, field size, field type, description, and key field indication.

Table 3.2: USERS Table

Field Name	Field Size	Field Type	Description	Key Field
user_id	11	INT	Unique identifier for each user session	PK
session_id	50	VARCHAR	Unique session token for the user interaction	
timestamp	20	DATETIME	Date and time the session was created	

Table 3.3: QUERIES Table

Field Name	Field Size	Field Type	Description	Key Field
query_id	11	INT	Unique identifier for each query submitted	PK
user_id	11	INT	References the user who submitted the query	FK
query_text	500	VARCHAR	The full text of the query entered by the user	
timestamp	20	DATETIME	Date and time the query was submitted	

Table 3.4: RESPONSES Table

Field Name	Field Size	Field Type	Description	Key Field
response_id	11	INT	Unique identifier for each response record	PK
response_text	1000	VARCHAR	The text content of the chatbot response	
category	100	VARCHAR	Category the response belongs to (e.g. Fees)	
last_updated	20	DATETIME	Date and time the response was last modified	

Table 3.5: KNOWLEDGE_BASE Table

Field Name	Field Size	Field Type	Description	Key Field
data_id	11	INT	Unique identifier for each knowledge entry	PK
category	100	VARCHAR	Topic category (e.g. Registration, Results)	
keywords	300	VARCHAR	Keywords or phrases used to match user queries	
content	2000	TEXT	The actual response content stored for retrieval	
last_updated	20	DATETIME	Date and time the entry was last updated	

Table 3.6: ADMIN Table

Field Name	Field Size	Field Type	Description	Key Field
admin_id	11	INT	Unique identifier for each administrator account	PK
username	50	VARCHAR	Login username of the administrator	
password	255	VARCHAR	Encrypted password for administrator login	

Design considerations include: data must be well-structured and categorized for efficient retrieval; the database should allow easy updates and scalability as information grows; fast retrieval is essential for supporting real-time responses; and only verified and approved data should be stored in the knowledge base.

3.6.4 System Architecture Design

The design of the system architecture is the structure of the entire system, where there is an interaction between various components for achieving the intended functionality. The suggested architecture of the system is a three-tier architecture, and the tiers include: (1) the Presentation Layer (Frontend), that is, the chat window of the user; (2) the Application Layer (Middle Tier/Processing Layer), including NLP/Intent Recognition module, logic controller, response

engine, and Fallback Handler; and (3) the Data Layer (Database/Knowledge Base), where all the categorized data of institutions are stored.

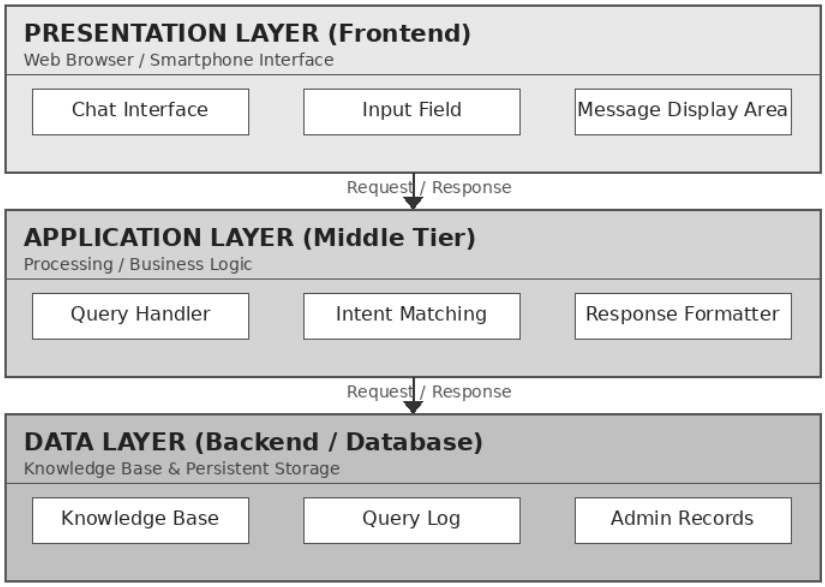

Figure 3.4: Three-Tier System Architecture of the AI-Powered Chatbot

The System Flow follows this procedure: query input through frontend, query processing in application layer, NLP analysis and recognition of intent, searching through the knowledge base, fetching of the response and returning it, then the output is displayed to the user. The architecture design issues considered are as follows: modularity (each layer functions separately), scalability (adding new features becomes easy), reliability (response comes from verified data) and maintainability (admin is able to update the knowledge base without affecting other layers).

CHAPTER FOUR

SYSTEM IMPLEMENTATION

4.0 Introduction

In this chapter, the authors describe the implementation of the proposed AI-assisted chatbot system for student support and administrative services. Describes the development environment, tools and technologies that have been used to develop the system. The chapter also explains the data set used for creation of the knowledge base, system architecture implemented and the different modules developed. Moreover, it introduces the testing procedures that were applied to test the performance of the system and ends with the presentation and discussion of the results.

The system was developed using the latest web technologies which allow fast development, flexibility and scalability.

4.1 Development Environment and Tools

4.1.1 Programming Language and Libraries

The system has been built with the following programming languages and libraries:

1. **JavaScript**: Frontend interactivity and server-side logic using Node.js, through the Next.js framework. JavaScript is a valid server-side language if its execution is done

through the Node.js runtime environment, where routing, API calls and data retrieval are done without the need to use a different backend language.

2. **HTML (HyperText Markup Language):** For structuring the user interface.
3. **CSS (Cascading Style Sheets):** Style and layout design.
4. **Next.js Framework:** Framework used for creating the web-based application with server side support and routing.
5. **SQLite:** The relational database management system used to store and manage information stored in the knowledge base, user sessions, and administrative information. The decision to use SQLite for the database was made due to its lightweight, serverless, and file-based design, making it highly convenient for deployment, especially in a read-intensive query environment that is typical of chatbots.

Furthermore, basic Natural Language Processing techniques were applied with the logic written in JavaScript, for Intent recognition and to handle queries.

4.1.2 Development Platform and Hardware Requirements

The system was made on a standard personal computer having the following specifications:

1. Internet connection: Broadband (128 Mbps or faster is recommended)
2. Processor: Intel Core i3 (development machine specification; web-based and will work with any device capable of at least a dual core processor)
3. RAM: 4GB
4. Use of Visual Studio Code (VS Code) as a development tool.

5. Annual data record: annual data record (used for logging and archiving data; not deployment platform but simple tool to help verify system behavior and user interface rendering during development)

It is Web-based and will run on any device with a modern Web browser and an Internet connection.

4.2 Model Architecture and Training

In the traditional way, the system doesn't have a completely trained machine learning model. Instead, it adopts a combination approach where AI is used for support. The system includes an Intent Recognition Layer where NLP algorithms such as keyword recognition, text normalization, and similarity checking are used to determine the user's intention and a Rule Based Response Layer from which responses are extracted from a pre-existing knowledge base after determining the intention. This method avoids the need for storing very large numbers of training samples, and maintains valuable responses that are controlled, accurate and compliant with the institutional policy.

4.3 System Implementation and Modules

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The system is designed in a modular way for maintainability and scalability. The main modules comprise:

1. **User Interface Module**: Manages the user interaction with the system by using the chat interface, and captures the user's queries, sends the answers to the chatbot and keeps the conversation going.
2. **Query Processing Module:** It is responsible for analyzing user input and determining the intent after text preprocessing, keyword extraction and intent classification.
3. **Response Generation Module**: Provides suitable responses to the intent identified, by accessing information from the knowledge base and formatting the responses to display.
4. **Knowledge Base Module:** A place to store structured information for the institution that allows for rapid retrieval of answers and can be updated by an administrator.
5. **Admin Module:** It enables the authorized users to add new information, update the existing information, and remove old information from the system.

4.4 Testing and Evaluation

Testing was carried out to ensure that the system performs as expected and meets its objectives. The evaluation was conducted in terms of functionality and usability, and response accuracy.

4.4.1 Evaluation Metrics

The following criteria were used for the evaluation of the system:

1. ACCURACY: Appropriateness of answers given.
2. Response Time: Speed of generating responses.
3. Usability: How easy it is to communicate with the system.

4. Reliability – System reliability (consistency of system performance)**.**

4.4.2 System Testing

Functional testing was conducted using various input scenarios to verify system behaviour.

Table 4.1: System Test Cases and Results

Test Case	Input	Expected Output	Actual Output	Status
1	How do I register courses?	Registration steps	Correct response	Pass
2	School fees payment	Payment information	Correct response	Pass
3	Hostel allocation	Hostel info	Correct response	Pass
4	Random / unrecognized input	Fallback message	Correct fallback	Pass

The results indicate that the system functions correctly and responds appropriately to user queries in all tested scenarios.

4.4.3 User Interface Testing and Walkthrough

The user interface was tested to ensure ease of use and clarity. Users were able to enter queries without difficulty, receive responses instantly, and understand system feedback. The conversational interface made interaction intuitive, even for users with minimal technical knowledge.

4.5 Results Presentation and Analysis

4.5.1 Output Samples and Interface Screens

This section presents visual evidence of the system's functionality. The figures below illustrate the key screens and interaction outputs of the developed chatbot system.

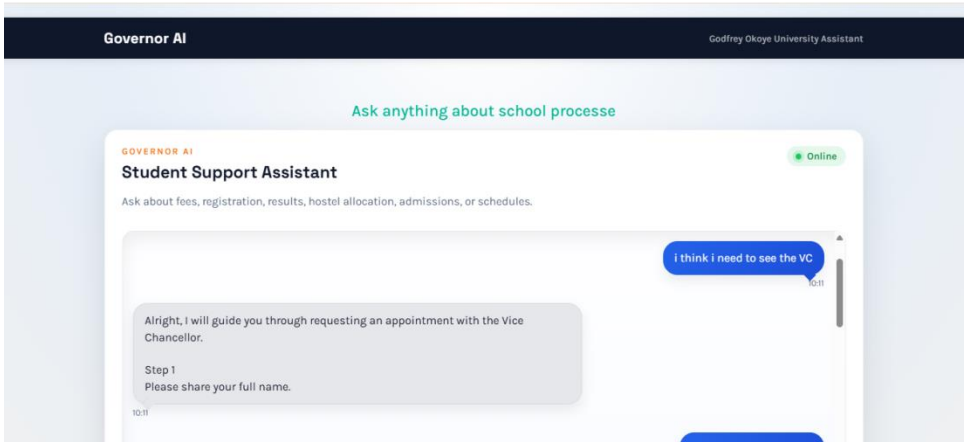

Figure 4.1: Chatbot System Home Screen

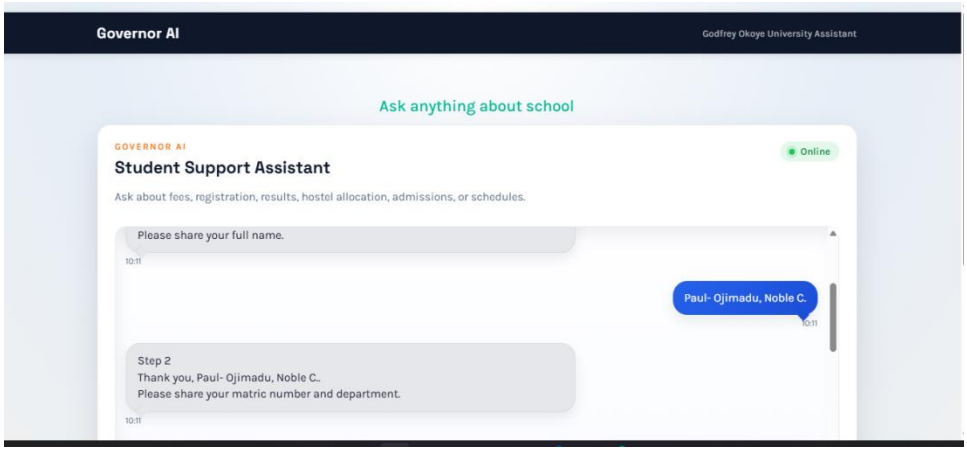

Figure 4.2: Query Input and Response Display

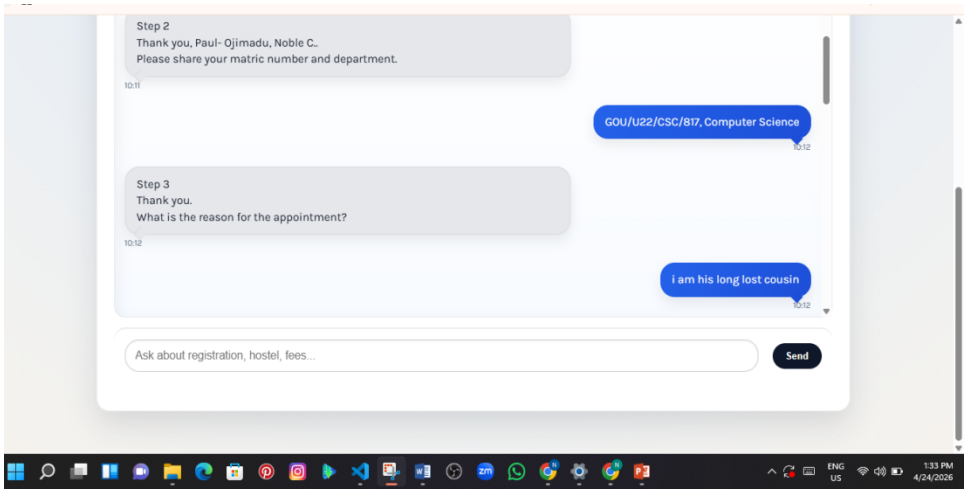

Figure 4.3: Fallback Response Screen

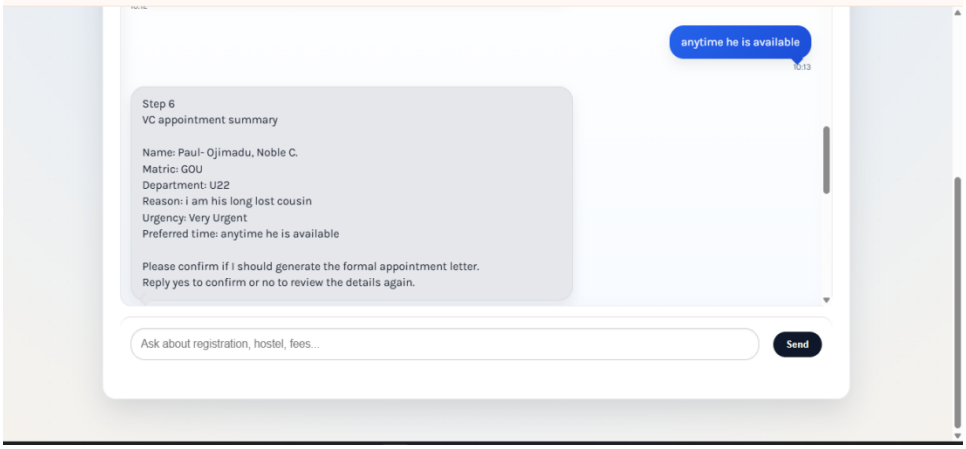

Figure 4.4: Admin Knowledge Base Management Screen

The figure below presents a consolidated form screen through which students can submit a request to see the Vice Chancellor. All required details are captured in a single interface, eliminating the need for multiple separate screens.

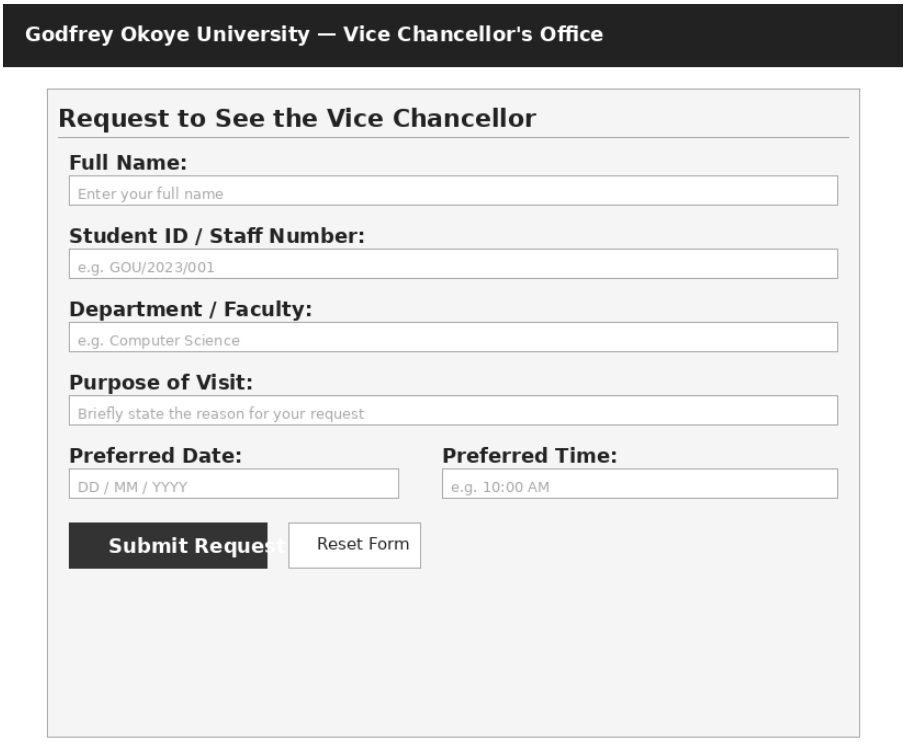

Figure 4.5: VC Appointment Request Form — Consolidated Single-Screen Interface

4.5.2 Discussion of Results and System Performance

The findings clearly indicate that the proposed system has managed to accomplish its objectives of automated administrative assistance. The chatbot is able to understand the questions posed by users through the NLP intent recognition technology and delivers responses obtained from the knowledge base with great efficiency. The system shows good performance when it comes to both time taken to respond and usability. The system also provides reliability through the controlled output delivery process, which eliminates the potential dangers that may arise out of uncontrolled AI outputs.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

The chapter provides a summary of the study, findings and recommendations for the improvement. It emphasizes on the ways the aims of the study are met and introduces the scope of improvement of the system.

5.2 Summary

The design and implementation of an AI-powered chatbot system to support students and administrative tasks in universities was the primary concern of this study. The resulting motivation for the study arose from the students' problems in obtaining information in time and from a reliable source and the inefficiency of manual administration.

The background, problem statement, aim, objectives, significance and scope of the study were given in Chapter One. The relevant literature studied in this chapter, which includes theoretical concepts of Artificial Intelligence, Natural Language Processing, Technology Acceptance Model and Human-Computer Interaction, and empirical studies of chatbot systems, will be reviewed. Existing systems were found to have gaps, such as the absence of supervised and institutionally controlled chatbot solutions.

The system analysis and design of existing and proposed system were described in chapter three. It also described the system requirement, modeling using UML diagram and the system design.

The system implementation was discussed in Chapter Four, where the tools used, the system modules, the preparation of the datasets, and the testing procedures were discussed. The

outcomes demonstrated that the system could correctly understand users' queries and return relevant answers relying on a structured knowledge base.

In general, it was well established that the use of a Chatbot system in supporting administrative services in the University Environment is feasible.

5.3 Conclusion

It can be concluded that an AI-driven chatbot system can be a great solution to make administrative information more available and communicate with the university management, after analyzing the results of this study.

The system designed in this research is indeed an appropriate solution to such issues as delay in response, inconsistency of information, dependence on physical administrative procedure. Indeed, the use of NLP in intent detection and the knowledge base which is organized and verified ensures that the communication process is flexible and responses provided are precise. It is crucial that the system is not meant to replace humans working in administration, but acts as a tool to perform administrative procedures associated with query completion.
Thus, the system appears to be useful and appropriate in institutional context.
In conclusion, this research confirms the application of rule-based, supervised chatbot system as a feasible approach to improving administrative services in universities.

5.4 Recommendations

Following the findings of this study the following recommendations are made:

1. Integration into Existing University Portal: The future implementation will require integrating the chatbot with existing universities' portals to ensure access to personalized information about students, including results and enrollment.
2. Expansion of Knowledge Base: Future developments will see an expansion of the knowledge base by updating the information.

3. Use of Advanced NLP Technology: Advanced natural language processing techniques can be used to improve query interpretation in the case of ambiguous questions.

4. Multilingual Functionality: The system can be modified to provide multilingual support in order to reach more users.

5. Voice Input Feature: Future improvement option for ease of access and convenience of use.

6. Implementation at Institutional Level: Universities are recommended to consider using such technologies in order to carry out digital transformation of their service delivery.

5.5 Suggestions for further studies are provided.

Here are some areas where further research and development are advised:

1. Development of voice-operated versions of chatbot systems for learners with typing difficulties.

2. Utilization of multilingual capabilities to accommodate various learners in African universities.

3. Improvement in chatbot capabilities of handling complex inquiries through advanced NLP models like deep learning transformers.

4. Deployment and evaluation of the system within an institution to determine its long-term impact on student satisfaction and administrative efficiency.

5. Extending the system to other African universities for testing its viability in other institutional environments.

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