LARGE LANGUAGE MODEL ENABLED MULTILINGUAL CHATBOT FOR INCLUSIVE BANKING AND FINANCIAL ACCESSIBILITY

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ABSTRACT: *In the world today, the financial inclusion drive is on the rise, and Nigeria is making efforts to achieve it. However, having over 500 indigenous languages, linguistic diversity remains a critical problem, among other factors, in achieving financial inclusion. Digital platforms, especially artificial intelligence-enabled chatbots, are gaining traction as avenues for inclusion, but the English-centric characteristics observable in them are limiting financial inclusion, thereby excluding millions of citizens who need financial services. Hence, there is a need for the design and implementation of a multilingual chatbot that includes capability for interaction in four of the major Nigerian languages (Hausa, Igbo, Yoruba and Pidgin) using the Gemini Large Language Model (LLM) as the driver of the needed natural and context-aware conversations across these languages. The system's architectural components are client, middleware, Artificial Intelligence and data layers, which interacting together enables scalable support for banking services that could be common or core. The results of the evaluation show that the system improves accessibility and user satisfaction among the linguistically diverse users. Therefore, this study contributed to enhancing the strategy of Nigeria's National Financial Inclusion while incentivizing the necessity of adopting localized AI solutions as instruments of bridging socio-economic divides.*

KEYWORDS: Artificial Intelligence, Chatbot, Financial Inclusion, Large Language Models, Multilingual.

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INTRODUCTION

The financial industry in Nigeria has come a long way with interest directed at the improvement of the economy, which in turn affects the well-being of the citizenry. This pursuit has defined the country's local and its international stance (Adrian 2015; Nkechika n.d.; Ogie and Adekunle n.d.). This journey, from the nascent days till date, has metamorphosed into the building of a robust and stable financial sector that is making a huge impact on the economy. However, there have been several obstacles in Nigeria's quest for financial inclusivity. One such lingering setback is deeply rooted in the existence of a language barrier. Hence, financial inclusion remains a pressing challenge in Nigeria, where many of Africa's largest Black populations are excluded from formal banking services due to linguistic barriers, with resultant socio-economic burdens (Nkechika n.d.). Also, despite the fact that significant progress has been made in this sector driven by financial technology (FinTech) innovations such as mobile banking and point-of-sale terminals, exclusion rates remain high among rural populations and those who are non-English speakers. Hence, since Nigeria has over 500 indigenous languages, this diversity of languages further complicates access to financial inclusion as a result of most digital banking platforms and customer service channels operating exclusively in English (Udoh and Emmanuel n.d.).

The emergence of artificial intelligence (machines that act or think with some attributes of intelligence typically associated with humans) and the rise of conversational agents, also an emerging aspect of AI, are enabling global production of transformative tools useful in various industries, especially financial industries, for customer engagement in banking. Recently, the use of chatbots (Kumar Sharma and Joshi n.d.; Muhammad et al. 2020; Nwosu and Nwachukwu 2018; Singh et al. 2025) that derives capacity from the Natural Language Processing (NLP) techniques that enable what is called natural language understanding and generation is increasing the pace with which scalable and cost-effective solutions or products and processes are being churned out for routine banking inquiries and transactions. However, existing chatbots (Ajani et al. n.d.; Hammed et al. n.d.; Okeke 2025; Team et al. 2023), such as ZiVA, Tamara, and Leo, which are some of the thriving chatbots in use in some Nigerian banks, remain limited to English, thereby leaving a substantial gap in inclusivity for those who speak indigenous languages only. The researcher's motivation for this study is to address this gap with the development of a chatbot that caters to multilingual languages. This chatbot will support Hausa, Igbo, Yoruba, and Pidgin while using LLM for communication and context-aware conversations needed for the multiple languages and the integration of multilingual service capabilities in the chatbot. This work, therefore, contributes to the National Financial Inclusion Strategy of Nigeria, especially in regard to the drive for inclusive banking and promotes a demonstration of the potential of localized AI solutions in bridging communication divides, enhancing trust, and expanding access to financial services.

LITERATURE REVIEW

The banking industry in Nigeria, like many other banking industries across the world and Africa, has evolved significantly from colonial foundations to this digitally driven era. Institutions such as the African Banking Corporation (1892) and the Bank of British West Africa (1894) primarily were saddled with the responsibilities of serving colonial trade and limited services to Nigerians. Later on, with post-independence reforms, which included indigenization decrees of the 1970s, services were expanded, which resulted in local ownership, while the Structural Adjustment Programme of the 1980s was introduced to liberalize the banking sector. Also, In 2004-2005 a landmark consolidation of banks was undertaken to achieve strengthened capitalization and resilience and thus paved the way for modern banking. Despite these reforms, financial exclusion remains high, with over one-third of adults excluded as of 2020, particularly in rural and linguistically diverse communities (Nwosu and Nwachukwu 2018; Wezel and Ree 2023).

Across the world, artificial intelligence is transforming banking experiences (Madiha et al. 2025; Okeke 2025; Thippeswami H and Sathisha n.d.) with positive impacts in fraud detection and prevention, customer credit scoring and customer service automation. In the same vein, chatbots utilize AI. Chatbots are also built upon Natural Language Processing (NLP) techniques and are central to customer engagement as a platform that allows customers to interact with organizational services. Bank of America's "Erica" (Smarter Banking: The Role of Artificial Intelligence in Redefining Finance n.d.) and HSBC's "Amy" are some chatbots that handle millions of interactions (Lau 2025). A multilingual chatbot such as India's "SIA" is a practical demonstration of the possibility of using conversational AI to address the barrier of linguistic diversity (Singh et al. 2025; Thippeswami and Sathisha n.d.). On the other hand, banks such as Access Bank, Zenith Bank (Hammed et al. n.d.; Okeke 2025) and United Bank for Africa [12] have deployed chatbots (Tamara, ZiVA, and Leo) in their operations to foster improvement in accessibility and customer experience. However, their systems' shortcoming excludes myriads of Nigerians from several works of life because they operate exclusively in English. Therefore, given Nigeria's linguistic diversity of more than 500 languages, this excessively undermines national financial inclusion goals.

Review of Existing Systems

This section discusses a few of the current chatbots that are in use in Nigeria with the view of establishing the gap that this work seeks to resolve.

LEO

The United Bank for Africa is a Nigerian bank with a presence both locally and internationally. Its chatbot named LEO [38] is AI-powered and has been a significant step in AI adoption in the region. The chatbot stands as one of the most prominent intelligent banking assistants in Nigeria as an enhancer of customer engagement. It also allowed users to perform banking activities that are not limited to checking account balances, transferring funds, paying bills and accessing transaction histories. Its presence is also available across multiple platforms-- Facebook Messenger, WhatsApp, and the banks' mobile app. Designed to provide a seamless and responsive customer experience, Leo led to the reduction in the need for in-person banking and the long wait times at branches. Furthermore, its conversational interface and ability to handle routine queries have significantly improved service efficiency for the bank's customers

across the country and beyond. However, despite its success, Leo is primarily built to provide service in English, which limits its accessibility and usefulness to non-English-speaking customers. Consequently, there remains a gap in reaching linguistically diverse populations, particularly those who live in rural areas. Figure 1 showcases the interface of Leo, which confirms that it is essentially monolingual in its presentation.

Figure 1: Leo interface.

ZIVA (Zenith Intelligent Virtual Assistant)

Zenith Bank's intelligent virtual assistant, ZIVA [18], was launched to operate on platforms such as WhatsApp and the bank's mobile app to enable users to perform banking tasks and provide 24/7 support for fund transfers, bill payments, account inquiries, card management and more. This. Also, it has positively impacted the reduced dependency on branch visits and the need to engage several call centers/agents since customers can access essential banking services anytime through the chat's interface. This conversational interface allowed interactive and responsive engagements with improvement in user convenience and customer satisfaction. However, like LEO, despite its technological capabilities, ZIVA also functions in English as depicted in figure 2, thus limiting its reach among Nigeria's linguistically diverse population. Hence, while it simplifies digital banking for English-speaking users, customers who prefer or can speak other local languages such as Yoruba, Hausa, Igbo and Pidgin may face difficulties in accessing banking services with such tools.

Figure 2: ZIVA Interface.

Comparative Analysis of Chatbot Frameworks

This section attempts a comparative analysis of three popular chatbot frameworks to reveal their strengths and weaknesses and justify the choice of Gemini as the large language model that was adopted for this study since the choice of development framework is crucial for the success of a conversational AI project.

Dialogflow

Google developed Dialogflow (Nwosu and Nwachukwu 2018), a cloud-based platform for the use of developers to create conversational interfaces based on using predefined intents and entities. The intents and entities are simply a pair of prompts and possible responses. Dialogflow is suited for situations where quick deployment of chatbots is needed and it supports integration with popular messaging platforms such as WhatsApp, Telegram, and Facebook Messenger. Also, one of its strengths lies in its multilingual support with pretrained models for several global languages. However, its flexibility is also limited to the platform's configuration options. There is less control for the developer to think outside the box as may be needed over the underlying natural language processing pipeline, thus making it less adaptable for complex or highly customized use cases.

Rasa

In terms of control for developers, Rasa (Kumar Sharma and Joshi n.d.), an open-source conversational AI framework, provides developers with full control over the NLP pipeline, the intent recognition, and the dialogue management as in its design, the building of context-aware, enterprise-grade chatbots that can operate either on-premise or in the cloud is flexible. Unlike Dialogflow, Rasa allows extensive customization, and the data privacy enhancements it provides make it ideal for developers that require more control over their AI models. However, the framework demands significant technical expertise and large volumes of training data.

Gemini

Large language models are credited with the ability to generate natural languages using large corpora of data. Several organizations are currently driving the progress in this area of AI. Google's Gemini (Team et al. 2023) is one of the latest families of LLMs that has multilingual, multimodal and reasoning capabilities and understands and generates human-like dialogues under many linguistic and contextual domains. Also, unlike rule-based or intent-based frameworks, Gemini uses contextual understanding and prompt engineering for more natural, intelligent and highly adaptive interactions.

Table 1: Comparative Analysis of Chatbot Frameworks

Feature	Dialogflow	Rasa	Gemini API
Type	Cloud-based SaaS	Open-source, on-premise/cloud	API-based, LLM-centric
Multilingual Support	Strong, pre-trained models for many languages	Requires custom training data for each language	Excellent, inherent in the LLM's training
Complexity	Low-to-medium, suitable for simple intents	Requires significant NLP-related expertise	Requires sound API integration skills
Control/Customization	Limited to platform features	High, full control over NLP pipeline	High, via prompt engineering and function calling
Scalability	High, managed by Google Cloud	High, self-managed infrastructure	Highly scalable and is managed by Google Cloud
Best Use Case	Simple FAQ bots, quick deployment	Complex, stateful, enterprise-grade bots	Advanced, multilingual, natural conversation

Having compared these frameworks, Google Gemini is adopted for this study as a result of its capacity for multilingual, enhanced natural language understanding and its ability to generate or handle complex conversational flows. Although Rasa has extensive customization and control, its data-intensive requirements for training models, especially in low-resource languages, make it less practical for this study. In the same vein, Dialogflow provides multilingual support and rapid deployment, but it lacks the flexible context understanding.

METHODOLOGY

In order to achieve the objectives of this study, a modular architecture was adopted to ensure scalability and adaptability to additional languages in the future. This work focused on a multilingual chatbot with capacity for interactions in English, Hausa, Igbo, Yoruba, and Pidgin

System Architecture

The system architecture involved the layers discussed forthwith and depicted in figure 3:

Front-End

The interface through which users interact with the chatbot is the client layer built using HTML, TypeScript and cascading style sheets to handle message display, voice input and text-to-speech output using the browser. The Speech-to-Text (STT) Module uses the Web Speech API for real-time conversion of user voice input into text, while the Text-to-Speech (TTS) Module then converts chatbot responses into speech using the Gemini TTS model. The Language Control Interface enables the users to switch between English, Yoruba, Hausa and Pidgin either manually or using voice commands. Also, Error Overlay Handler (EOH) detects missing or invalid Gemini API keys stored in ".env.local" and is able to display configuration errors clearly to the developer.

Middleware

The middleware coordinates communication needs between the user's interface and the Gemini API. The implementation utilized TypeScript with asynchronous API calls while ensuring real-time responsiveness. Other components in this layer included Session Manager (SM) for tracking the active language, interaction mode (voice or text), and the conversation history within the browser's memory. Also, the Language Controller (LC) routes text input to the correct processing pipeline based on the user's preferences or spoken commands. The API Manager, however, handles secure calls to the Gemini endpoints using a defined API key. The Audio Handler (AH) also synchronizes playback of text-to-speech responses and manages microphone input. Furthermore, the Error-Handling Engine (E-H-E) captures network/runtime errors and returns descriptive feedback of the error to the user.

Backend Services

The integration of the AI component (Google Gemini) is in this layer and performs language understanding, response generation, and speech synthesis with its communication with Hypertext Transfer Protocol (HTTP) requests that are made using the front-end. Also, the Gemini Model handles natural language understanding in this case for English, Yoruba, Hausa, and Pidgin while its TTS service converts the generated text responses into relevant audio output. The API Gateway is also there to manage all request authentication and data transfer between the chatbot and Gemini.

Data and Configuration Layer

There is a lightweight storage mechanism for essential data to cater to user preferences like selected language and voice options, conversation logs for testing or analytics, and API configuration details. Also, this storage can be handled locally using browser cache or remotely on a lightweight database if persistent data tracking is required.

Figure 3: System Architecture.
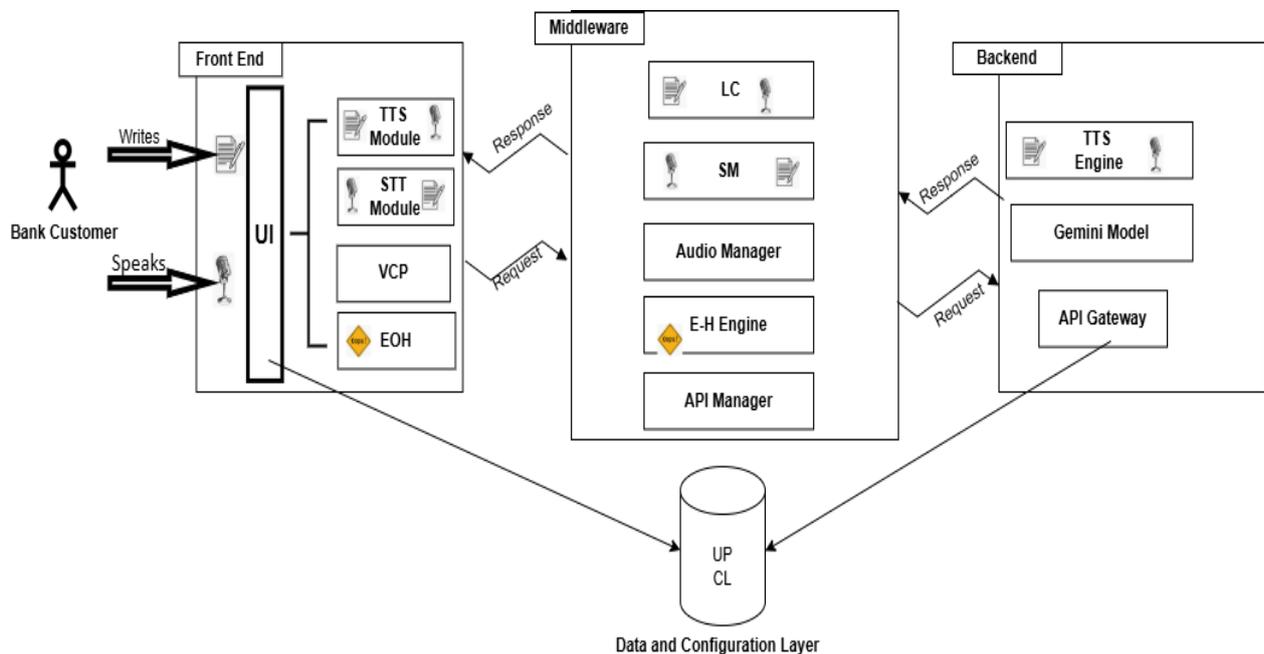
The languages currently supported are Hausa, Igbo, Yoruba, and Pidgin English. The language detection and routing ensure that user queries are processed in the appropriate language, while code-switching was considered to give the prevalence of mixed-language communication. Some of the development tools used are HTML, CSS, and JavaScript for the front-end; Node.js for managing requests and API calls in the middleware; and Gemini API for multilingual NLP and conversation management.

System Flow and Use Cases

Figure 4 depicts the system flow, and Figure 5 shows the use cases. The multilingual banking chatbot system is designed to promote financial inclusion in Nigeria by allowing customers to access banking services in their preferred local languages. Customers can use the chatbot to make inquiries, request support, learn about financial services, and provide feedback, while the AI language model interprets queries and the banking system delivers real-time information. Administrators maintain language support, update the knowledge base, monitor performance, and ensure secure data handling, with customer support agents stepping in when complex issues arise.

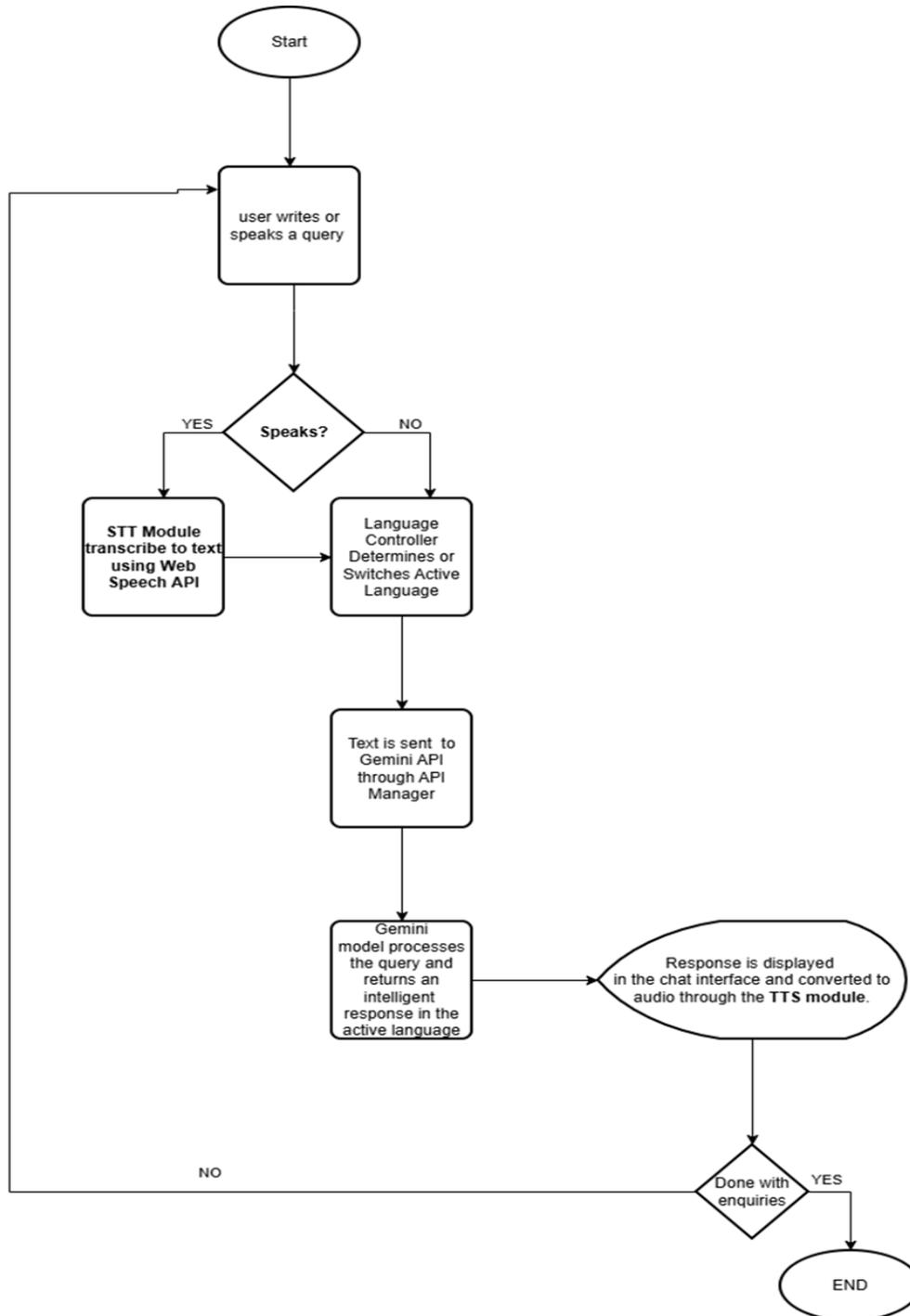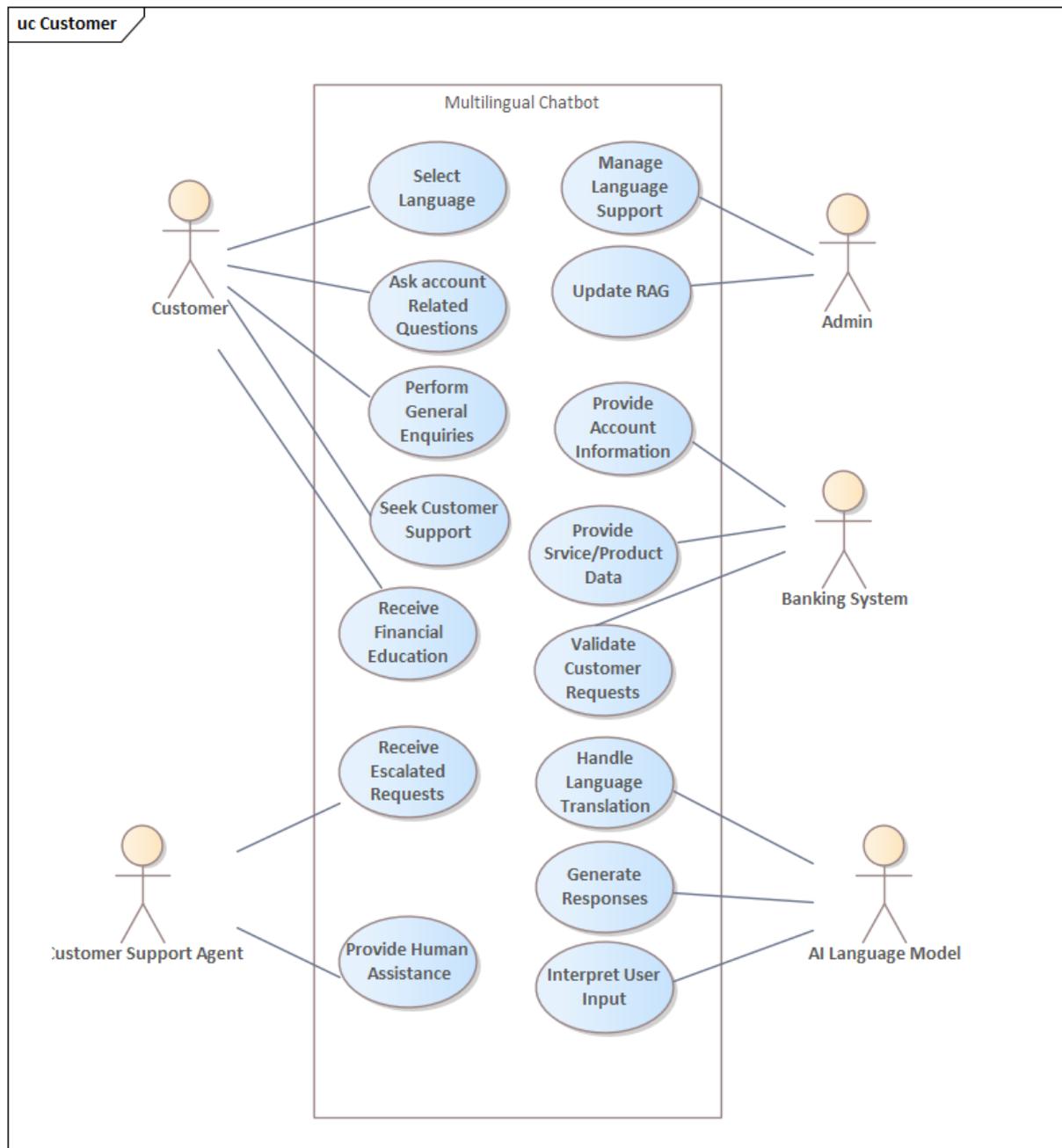**Figure 4: Flowchart of the proposed system.**

Figure 5: Use Cases of the proposed System

Evaluation

The system was evaluated through beta testing with native speakers of the supported languages, and user satisfaction was measured through a survey based on the Technology Acceptance Model framework.

RESULTS AND FINDINGS

The inclusive banking chatbot was successfully implemented, as shown in figures 6 and 7 to support English, Hausa, Igbo, Yoruba, and Nigerian Pidgin. The interface allows users to select their preferred language and interact through text or voice input.

Figure 6: Default page of the inclusive multilingual chatbot
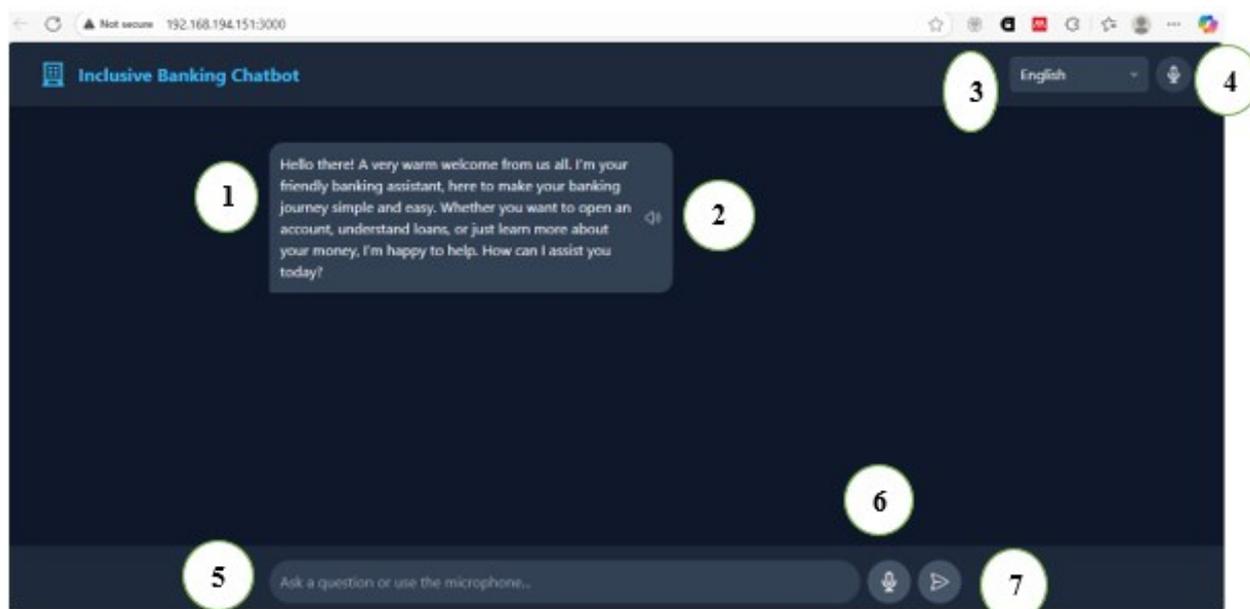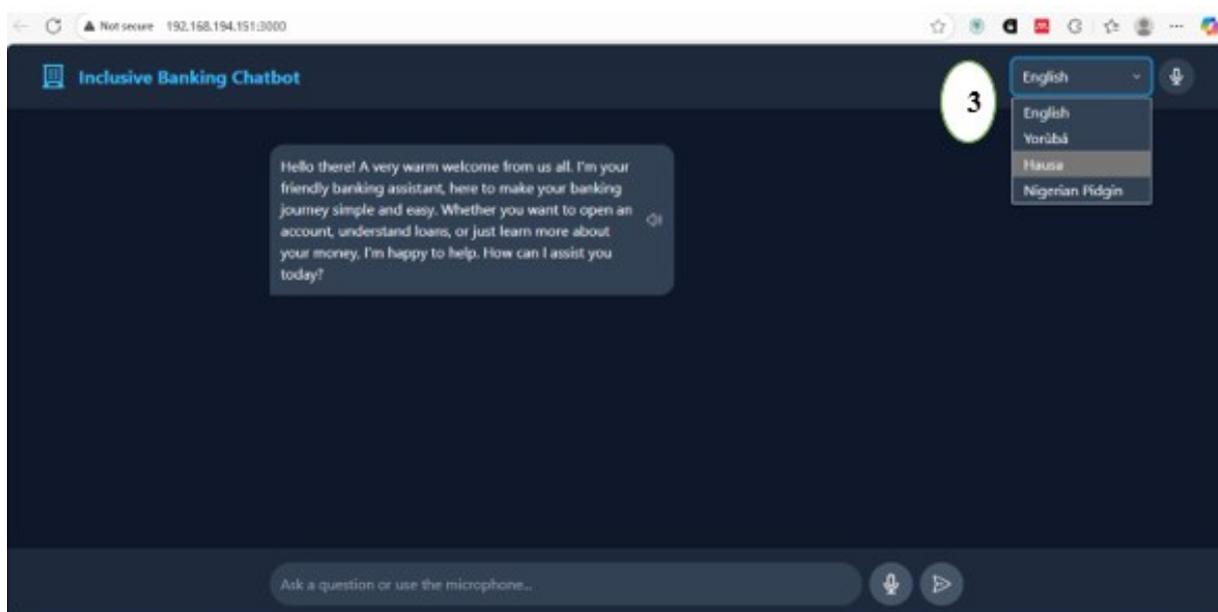

Figure 7: Multilingual options on the inclusive banking chatbot.

Experimentations with the other language options as shown in figures 8 and 9 confirmed that the chatbot could process queries and provide responses in each supported language and that the Gemini LLM is functioning as expected.
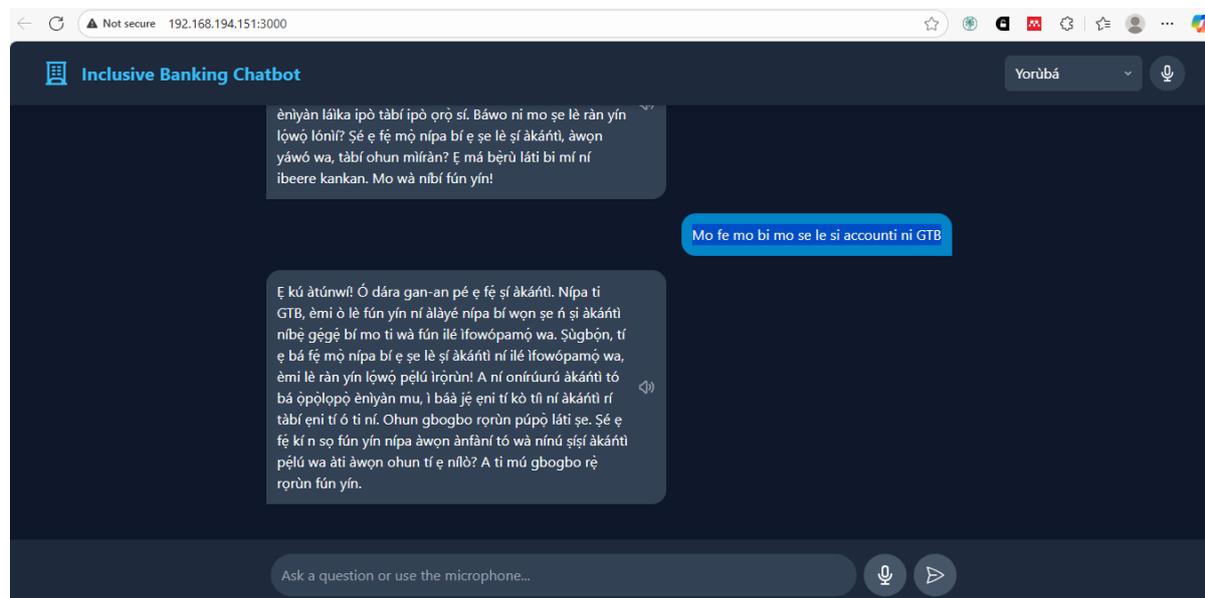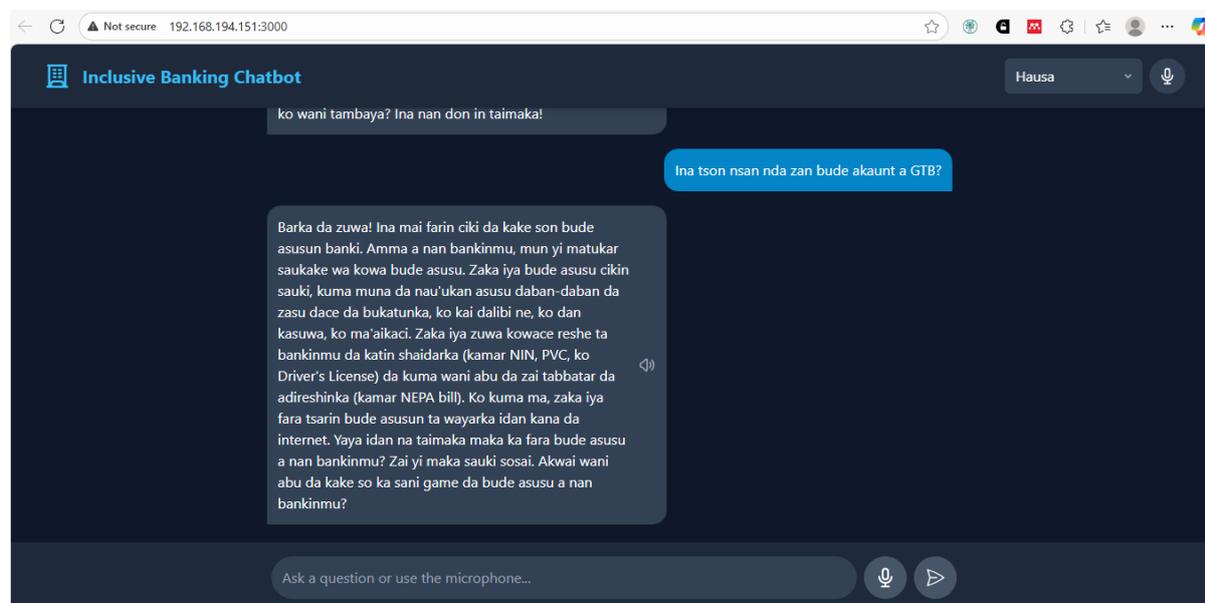
Figure 8: Prompt and response in Yoruba.

Figure 9: Prompt and response in Hausa.

EVALUATION

The evaluation began with the comparison of the responses from similar prompts in the various languages by three people who are versed in the languages featured. The participants were restricted to determine whether the responses of the chatbot were intelligent and relevant to the prompts. Finally, a beta test was conducted to evaluate the usability and user acceptance of the multilingual banking chatbot developed in order to assess how real users interact with the system and to gather feedback that would guide the system improvements. Also, a selected group of participants representing different user categories including students, workers, nonreaders and elderly users. Each participant interacted with the chatbot in at least one preferred language. Data was collected using interview-based Technology Acceptance Model questions focusing on perceived usefulness, perceived ease of use, user satisfaction, and behavioral intention to use. Through the evaluation by the participants, it was discovered that the chatbot is not only useful but also easy to use and supportive of inclusive banking.

DISCUSSION

Improved accessibility, as provided in this work, is a valuable pointer to the usefulness of a multilingual chatbot for banking services, especially as regards Nigeria, with the communication barriers that have historically bedeviled the inclusion drive of the banking industry and led to the exclusion of millions of people who need to use digital financial platforms. Furthermore, the beta testing that was carried out showed that users were comfortable and confident in engaging with the chatbot using their chosen preferred language(s). Also, comparing this work to the ZiVA, Tamara, and Leo chatbots, which operate exclusively in English, the developed system is a step forward in the achievement of inclusivity.

The developed system also uses Gemini LLM and currently supports only four languages but is extendable. However, there still exist challenges to its deployability, as it depends on internet connectivity, power and API services whose level of availability may hamper the use of the system in rural areas. Despite these limitations, this work is foundational support for future work in multilingual chatbots, which can lead to increased language coverage in banking applications.

CONCLUSION AND RECOMMENDATIONS

This study developed and evaluated a multilingual chatbot for inclusive banking in Nigeria, supporting Hausa, Igbo, Yoruba, and Nigerian Pidgin leveraging the Gemini Large Language Model. The chatbot provided context-aware, natural interactions across multiple languages, thereby addressing one of the most persistent barriers to financial inclusion: linguistic diversity. Evaluation results demonstrated high accuracy and user satisfaction, thereby confirming the feasibility of localized AI solutions in advancing Nigeria's National Financial Inclusion Strategy. And, compared to existing English-only chatbots in Nigerian banks, this system represents a significant step toward equitable access to financial services.

Future attempts at multilingual chatbot development should consider expanding the scope of the language coverage in order to inch in on inclusivity and ensure that more communities are brought into the digital banking services in their preferred tongue. Consideration for the integration of multilingual capabilities should be extended to other banking applications especially mobile and web, as these are widely used platforms, and doing so would lead to enhanced accessibility. Notably, also, to further promote inclusion, voice-based interaction should be incorporated to cater for users with limited literacy. Developing lightweight versions of the multilingual chatbot to operate with minimal internet connectivity is a step in the right direction to ensure improved usability in less developed regions where infrastructure remains a challenge. Furthermore, continuous evaluation through user testing and feedback will remain a critical need to guide the needed improvements and ensure that the system remains culturally, linguistically and practically relevant while adapting to evolving user needs. Finally, further studies could explore the integration of multimodal capabilities, such as visual aids for financial literacy, and investigate the socio-economic impact of multilingual chatbots on financial inclusion metrics in Nigeria and other linguistically diverse developing economies.

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