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Implementing an AI Agent Chatbot to Improve Service Effectiveness in Mobile Phone Spare Parts and Service Stores

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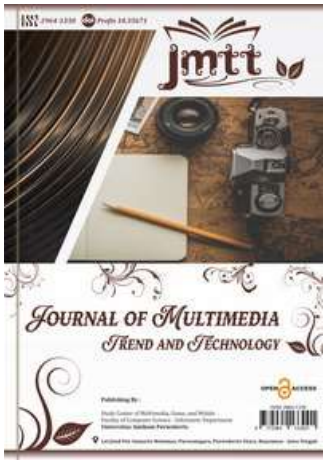

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ABSTRACT

The development of digital technology encourages MSMEs to shift to automated service systems to increase efficiency. This study aims to develop a WhatsApp-based AI Agent Chatbot to improve the effectiveness of customer service at the Citra Karya Gemilang Store, especially in handling spare part stock information and cellphone service consultations. This study uses the Software Development Life Cycle (SDLC) Waterfall model with the stages of requirements analysis, system design, implementation, testing, and maintenance. The system was developed by integrating the WAHA API Gateway as a WhatsApp connector, n8n Workflow Automation as a conversation flow manager, Gemini AI as an artificial intelligence engine that understands message context, and Google Sheets as a dynamic database that stores product and service information in real-time. The implementation results show that the chatbot is able to provide a fast response 24 hours. Based on User Acceptance Testing (UAT) of 20 respondents, the system obtained a satisfaction level of 92% (Very Satisfied).

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INTRODUCTION

The development of digital technology in recent years has driven significant changes in the communication and marketing patterns of micro, small, and medium enterprises (MSMEs). MSMEs are shifting from conventional systems to digital media because they are considered more efficient, able to reach a wider customer base, and enable faster and more sustainable interactions [1]. One of the digital platforms most widely utilized by MSMEs in Indonesia is WhatsApp Business. According to a report by We Are Social & Meltwater (2024), more than 91.2% of internet users in Indonesia use WhatsApp as their primary communication application [2]. Furthermore, data from the Ministry of Cooperatives and SMEs of the Republic of Indonesia, cited by the Ministry of Communication and Digitalization, shows that more than 3.79 million MSMEs have utilized digital platforms, and the majority use WhatsApp Business as a means of communication and promotion due to its ease of use and broad customer reach [3][4].

Several studies have shown that using WhatsApp Business can increase customer interaction and loyalty through features like product catalogs and automated messaging. However, the automation features available on WhatsApp Business are still limited, such as template-based quick replies, so they cannot provide a personalized and responsive communication experience to a variety of customer inquiries [5][7]. One technology that is increasingly being adopted by MSMEs is Artificial Intelligence (AI). The use of AI in digital marketing has been proven to improve operational efficiency, accelerate service responses, and provide a more interactive and personalized customer experience [6][8][9].

A widely used AI implementation in business communications is chatbots, AI-based systems capable of conducting automated conversations with users using a Natural Language Processing (NLP) approach [10][11]. Several examples of NLP use in academia have been conducted, demonstrating that chatbots can assist in communication and service delivery using platforms like Dialogflow. Previous research has shown that AI-based chatbots on the WhatsApp platform can increase customer satisfaction and engagement because they can respond to messages quickly and accurately and operate 24/7.

Observations show that in-store service responses are relatively fast, while WhatsApp responses are often delayed, particularly during peak hours and outside of business hours. This situation results in customers having to wait long periods for information, with some messages not even being answered the same day [12][13]. Customers expect fast, 24/7 service. If left unchecked, this situation could potentially decrease customer satisfaction, reduce sales opportunities, and weaken long-term customer loyalty. Similar issues were also found in a similar study at Toko Micro Batam, where manual communication limited technical consultation services and delayed customer responses [14]. This study implemented a WhatsApp-based AI chatbot, but still focused on simple product Q&A functionality [15].

Furthermore, implementing chatbots in MSMEs is considered effective for businesses with high levels of customer interaction and limited human resources. Chatbot technology is very relevant for businesses that sell technical products, such as spare parts and cellphone repair services, because customers generally need detailed information before making a purchase or service. In contrast to those studies, this study develops an AI Agent Chatbot integrated with WAHA (WhatsApp API Gateway), n8n's automated workflow, and the Gemini AI model to support more complex services [16][17]. The developed system not only answers customer questions but is also capable of checking spare part stock in real-time, providing pricing information, and providing initial consultations for mobile phone damage automatically via WhatsApp [18]. The novelty of this research lies in the integration of the AI Agent Chatbot with n8n's automated workflow and a real-time database specifically designed for the operational needs of MSMEs in the e-commerce and services sector. This approach has not been widely applied to MSMEs, especially in non-urban areas such as Banyumas Regency. Therefore, this research has high urgency both practically and theoretically.

Utilizing digital media for MSMEs is considered more efficient in reaching customers. WhatsApp Business is the primary platform with a usage rate reaching 91.2% in Indonesia. However, its built-in automation features are still limited to static message templates. Citra Karya Gemilang Store faces manual communication challenges that cause response delays during peak hours or outside operating

hours. This has the potential to reduce customer loyalty. This research offers a novelty through the integration of an AI Agent Chatbot with n8n workflows and real-time databases to provide automated cellphone damage consultations, a practice not yet widely implemented among MSMEs in non-urban areas.

METHOD

Data analysis is a systematic process of grouping, interpreting, and deriving meaning from collected data to provide a deeper understanding of the phenomenon being studied. Data analysis encompasses processing procedures, interpretation of results, and support for the data collection process to ensure the accuracy and relevance of the findings [19][20].

This study employed a qualitative descriptive analysis method because the data collected consisted of observations, interviews, and literature reviews. This approach aims to gain a deeper understanding of customer communication patterns, system requirements, and the effectiveness of the AI Agent Chatbot implementation on WhatsApp at the Citra Karya Gemilang Store. This study adopted the analysis model conducted using Miles & Huberman (1994) [19], which includes four main stages to ensure a systematic and valid analysis process.

1. Data was collected through direct observation of customer communication activities, semi-structured interviews with store owners and service technicians, and a literature review of AI chatbot development. Primary data describes actual conditions in the field, while secondary data supports the theoretical and technical analysis of the system.
2. The collected data was selected and simplified to highlight key information relevant to the research objectives. The reduction focused on key themes such as manual communication barriers, the need for automated features, and the potential for increased efficiency through chatbots.
3. The reduced data was then organized into narrative descriptions, tables, and simple graphs to clarify the relationships between findings. The data presentation aimed to provide a visual depiction of changes in communication patterns and increased service effectiveness following the chatbot implementation.
4. Conclusions are drawn based on an analysis of patterns and themes that emerged during the research process. These conclusions are verified against the initial data through a triangulation process to ensure the validity and consistency of the findings, allowing the analysis to serve as a basis for system design and evaluation.

The concept and framework for completing this is divided into several stages as shown in Figure 1 below:

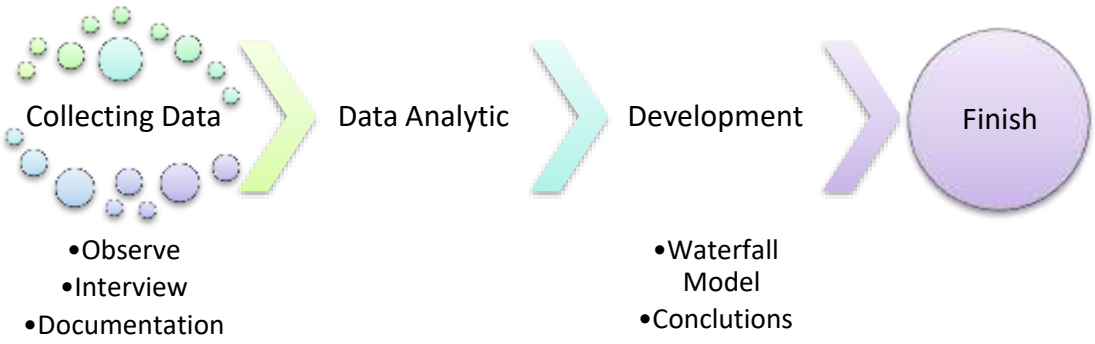

Figure 1. Completion Stages

In this research, system design encompasses three main parts: system model design, system architecture design, and database design. These three parts are interrelated and serve as the foundation for the implementation phase in the following chapter.

The first stage is system modeling, which illustrates the interaction process flow between the user, the chatbot, and the backend system. Modeling is performed using flowcharts and use case diagrams. Flowcharts are used to show the logical sequence and workflow of the chatbot, from when a customer sends a message via WhatsApp to when the chatbot provides an automated response. Meanwhile, use case diagrams illustrate the relationships between the main actors—the developer, the customer (user), and the AI chatbot agent—in carrying out system functions. The developer plays a role in system configuration and maintenance, the customer acts as the user interacting via WhatsApp, and the AI chatbot agent acts as an intelligent interface that processes each message using Gemini AI and retrieves data from Google Sheets to provide appropriate responses.

The second stage is system architecture design, which describes the component structure and integration between the platforms used. The system architecture is designed so that all components work in a coordinated manner through the n8n Workflow Automation platform, which acts as the primary workflow manager. WAHA (WhatsApp API Gateway) serves as a communication bridge between customers and the system, automatically receiving and sending messages. Received messages are processed by the Gemini AI Model through n8n to understand the context of the conversation, while supporting data such as spare parts lists, prices, stock, and service options are retrieved from Google Sheets in real time. This architecture ensures that every customer message is processed quickly, accurately, and relevantly according to context.

The third stage is database design, where the system uses Google Sheets to store dynamic data. This database consists of two worksheets: "Products, Spare Parts" and "Service." Using Google Sheets allows store admins to update data directly without requiring access to complex backend systems. This way, the chatbot always reads the latest data when customers inquire about prices, stock, or service options, ensuring accurate and up-to-date information.

RESULT

The system design stage is the process of creating a model that describes the workflow, system structure, and relationships between the main components involved in developing an AI Agent Chatbot on WhatsApp. This stage involves a series of modeling activities, including system modeling, architectural design, and database design used to support chatbot operations. System modeling serves to simplify complex elements to make them easier to understand and develop. In this research, the system modeling is presented in the form of a flowchart and use case diagram.

1. System Flowchart Design

A flowchart is used to illustrate the logical flow and interaction process between the user and the chatbot system. This diagram explains how customer messages are processed by the system to produce an appropriate response. The flow begins when a customer sends a message to the store's WhatsApp number. The message is first received by WAHA (WhatsApp API Gateway), which serves as a communication bridge between the chatbot system and the WhatsApp platform. WAHA then forwards the message to n8n Workflow Automation, which acts as a process manager and conversation logic controller. Within n8n, customer messages are analyzed to determine the context and purpose of the conversation. If the message is a general question or greeting, the system will invoke the Gemini AI module to generate a context-appropriate response. If the message contains a request regarding stock or spare part pricing, n8n will access data from Google Sheets and display the results in real time to the customer. Meanwhile, if a customer reports a phone malfunction, the system

will provide an initial response based on common damage categories and suggest bringing the device to a store for further inspection.

The end result of this process is an automated reply sent via WAHA back to the customer on WhatsApp. The design of this process flow is illustrated in the System Flowchart shown in Figure 2.

Figure 2. Flowchart model.

2. Creating a Use Case Diagram

A Use Case Diagram is used to illustrate the interactions between actors and the system in carrying out the main functions available to users. In this study, the actors involved in the Use Case Diagram are the Customer (User) as the primary external actor who interacts directly with the system, and the AI Agent Chatbot as the system that provides automated services via the WhatsApp platform. The Customer (User) is the party who uses the chatbot system to obtain information and services from the Citra Karya Gemilang Store. Customers can interact with the system by checking spare part stock and prices, consulting about initial phone damage, requesting service, and ordering products via WhatsApp. All of these interactions are conducted directly without involving the store administrator, allowing customers to obtain information quickly and efficiently. The AI Agent Chatbot acts as the system that processes every incoming message from customers. The chatbot utilizes Gemini AI technology to understand natural language and the context of user inquiries, then accesses data from Google Sheets as a product and service database. The chatbot then provides automated, contextual, and real-time responses to customers via WhatsApp. With these two main actors, the AI Agent Chatbot system can operate in an integrated manner, with the customer acting as the service user, and the chatbot acting as an intelligent intermediary, bridging communication between the two. Figure 3 shows the use case diagram for this study.

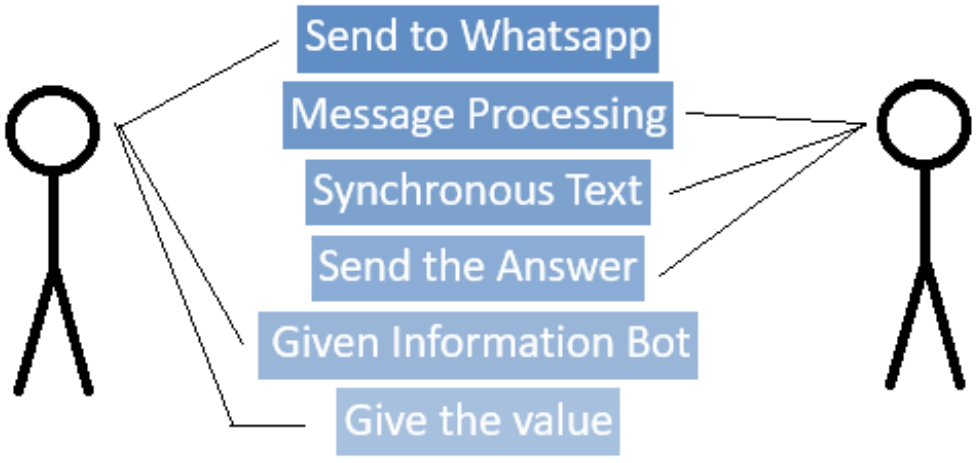

Figure 3. Usecase Model.

3. Architectural Design

Architectural design aims to describe the structure and relationships between the main components that make up the chatbot system. This system architecture explains how each component, from the user, server, to the artificial intelligence module, interacts with each other to form a complete automated service system. Figure 4 shows the chatbot architecture used in this study.

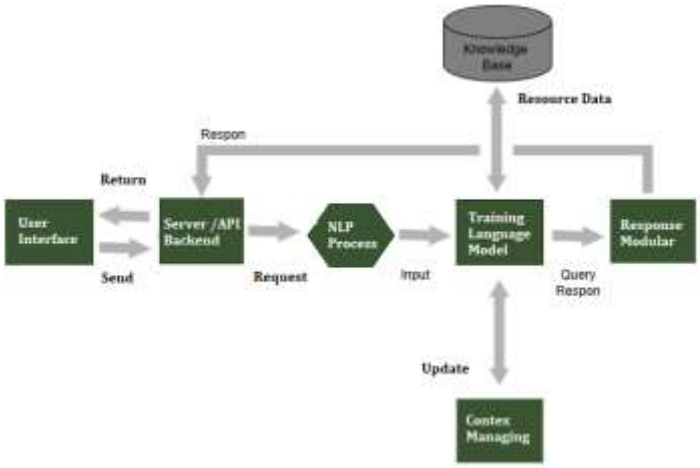

Figure 4. Bot Architecture

4. Implementation.

The implementation process begins with the installation and configuration of WAHA (WhatsApp API Gateway) on a cloud server. WAHA acts as the primary bridge between the chatbot system and the WhatsApp Business platform. Configuration is accomplished by linking the store's WhatsApp business number, creating a webhook endpoint to receive and send automated messages, and connecting it to the workflow in n8n. With WAHA, the chatbot can communicate directly with customers through the store's official number in real time without requiring human admin involvement. Figure 5 shows the WAHA dashboard.

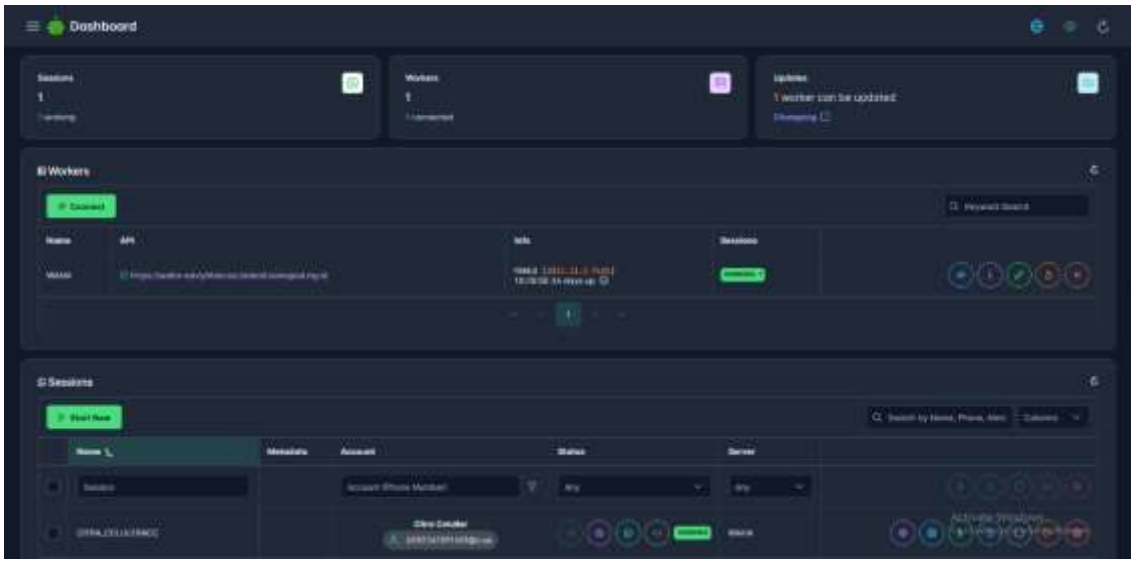

Figure 5. WAHA Dashboard.

The next step is to create the main workflow in n8n, which serves as the core of the chatbot's conversational logic. This workflow is built modularly using integrated nodes that handle each stage of communication. Implementation begins with the creation of the "WAHA Trigger" node, which receives incoming messages from WhatsApp customers. This node activates every time a new message is received by the system, and the conversation data is automatically sent to the "Edit Fields" node to extract important information such as message content, sender ID, and communication session status. Figure 6 illustrates the n8n automation workflow.

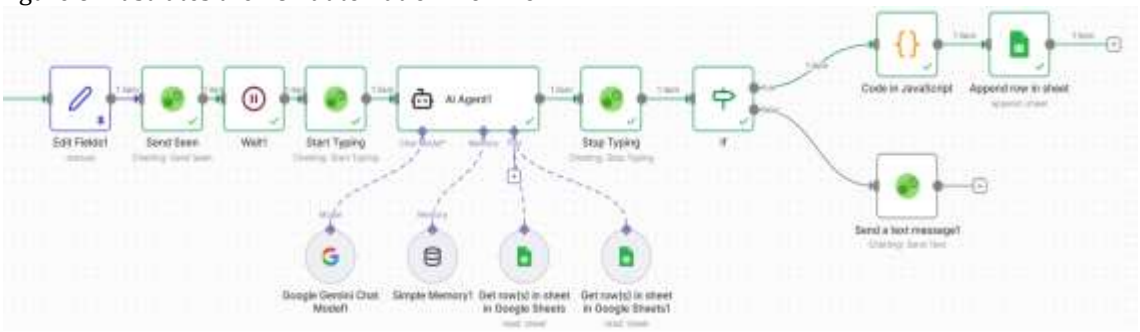

Figure 6. n8n automation workflow.

5. Testing.

The system testing phase is conducted to ensure that the developed chatbot functions as designed and meets user needs, both functionally and in terms of user satisfaction. This testing is divided into two stages: functional testing using the Black Box Testing method and user acceptance testing using User Acceptance Testing (UAT). Black Box testing is conducted to determine whether the chatbot system functions according to the designed functional specifications without considering the program code within it.

In this study, testing was conducted on chatbots based on WAHA, n8n, Gemini AI, and Google Sheets to ensure all features function as intended, from greeting users to providing product information and HP service.

The responses obtained from users are then processed using the following satisfaction level calculation formula (1):

$$Presentase\ Skor = \frac{Actual\ Score}{Ideal\ Score} \times 100\% \quad (1)$$

User Acceptance Testing (UAT) was conducted to determine the level of user acceptance and satisfaction with the AI Agent Chatbot system developed via WhatsApp. This testing aimed to ensure that the system truly met user needs and provided a fast, accurate, and easy-to-use interaction experience.

The UAT process was conducted directly through the chatbot. Each user who received product or service information was asked to rate their satisfaction through an automated question sent by the chatbot at the end of the conversation. The question read: "How satisfied are you with the assistance of the Citra Karya Gemilang Store Virtual Assistant Chatbot? Please rate it by sending a number from 1 to 5 (1 = very dissatisfied, 5 = very satisfied)?" Each user then provided a response with a number between 1 and 5, which was sent directly via WhatsApp message. All rating data was automatically saved in a Google Sheets connected to the system, allowing it to be analyzed to determine the level of user acceptance of the chatbot.

6. Implementation.

The maintenance phase is the final stage of the AI Agent Chatbot system development process on WhatsApp. It aims to ensure that all system components continue to operate optimally, stably, and accurately in providing information services to customers. This phase is carried out continuously after

the system has been successfully implemented and tested, in an effort to maintain performance and improve the quality of chatbot interactions with users.

System maintenance is carried out by regularly monitoring all involved integrations, including WAHA (WhatsApp API Gateway), n8n Workflow Automation, Gemini AI, and Google Sheets, which acts as a dynamic database. Monitoring is performed through the n8n dashboard to ensure each node in the workflow is functioning as intended, from receiving messages to sending automatic replies. If issues are encountered, such as delayed responses, undelivered messages, or integration issues between components, repairs and reconfigurations are made to the affected node.

In addition to system monitoring, the maintenance process also includes regular updates to the data used by the chatbot. Store administrators regularly update pricing, stock, and product descriptions in Google Sheets to ensure that the information provided to customers always reflects the latest store conditions. These data updates are directly and automatically integrated into the system without requiring technical modifications to the workflow, as any changes to Google Sheets are immediately read by the chatbot through the n8n integration node.

From an artificial intelligence (AI) perspective, Gemini AI's response performance is evaluated. Maintenance is performed by adjusting system prompts and conversation parameters if responses are found to be irrelevant or inappropriate to the context of customer interactions. The goal is to ensure the chatbot continues to provide friendly, informative responses that align with the communication characteristics of the Citra Karya Gemilang store.

In addition to functional and data maintenance, infrastructure and server maintenance are also crucial in this phase. The cloud servers used to run WAHA and n8n are monitored to ensure resources such as CPU, memory, and network connectivity remain stable. Data backups are also performed regularly to prevent loss of critical information due to system disruptions or technical errors.

Maintenance is also performed on the automated User Acceptance Testing (UAT) feature integrated into the workflow. Rating data collected from users is continuously monitored through Google Sheets to ensure each assessment result is recorded correctly. From these results, developers can analyze user satisfaction levels and make system improvements if a pattern of declining satisfaction is identified. This way, the evaluation and maintenance processes of the system can run simultaneously automatically, without requiring manual data collection. Overall, this maintenance activity ensures that the Citra Karya Gemilang store's WhatsApp chatbot continues to operate at optimal performance, provides accurate information, maintains high-quality interactions with users, and is ready for further development.

Based on the research results and discussion outlined in the results section, several key findings related to the development and implementation of a WhatsApp-based AI Agent Chatbot system at the Citra Karya Gemilang Store can be summarized as follows.

1. First, during the needs analysis phase, this research identified key issues within the research object: delayed responses to customer messages, difficulty in quickly checking stock, and the lack of an automated communication system capable of providing basic service information and spare part pricing. These findings served as the basis for designing the functional and non-functional requirements for the chatbot system.
2. Second, during the system design phase, a structured design was produced, including flowcharts, use case diagrams, system architecture, and a database. This design demonstrates that the integration of WAHA (WhatsApp API Gateway), n8n Workflow Automation, Gemini AI, and Google Sheets is capable of creating an interconnected chatbot system that supports real-time automated communication.
3. Third, the system implementation results showed that the AI Agent Chatbot was successfully integrated and capable of performing all key functions, such as answering customer questions, displaying spare part pricing and stock information, providing initial consultations on phone damage, and providing 24/7 customer service via WhatsApp. The system was also able to maintain conversational context and provide natural and contextual responses.
4. Fourth, the system testing results using the Black Box Testing method showed that all chatbot features functioned according to the designed functional requirements. Meanwhile, User Acceptance Testing (UAT) results showed a user satisfaction rate of 92%, which falls into the Very

Satisfaction category. This indicates that the system not only performs technically but is also well-received by users.

DISCUSSION

This discussion section aims to review the implementation results of an artificial intelligence (AI)-based chatbot system developed through WhatsApp, while also comparing them with previous research findings to demonstrate the research's contributions and novelty [21][22]. The main focus of the discussion is how the developed system integrates various technological components such as WhatsApp Gateway (WAHA), Google Sheets, Gemini AI, and the workflow automation tool n8n to create a more dynamic, adaptive, and user-centric chatbot system. The implementation results demonstrate that the developed chatbot system is capable of responding to customer inquiries automatically and contextually, accessing real-time product and service data from Google Sheets, and evaluating the user experience through the User Acceptance Testing (UAT) feature [23][24].

The use of the workflow automation tool n8n in this study aligns with previous research, which also utilized n8n as a liaison between the WhatsApp Business API, AI Agent, and Google Sheets within the chatbot system. However, the implementation of n8n in others study is still limited to the basic functions of data integration and automated message delivery. In contrast, in this study, n8n was developed as the main control module that dynamically manages the entire conversation flow, including simulating human activity (typing status, pause time, and message readability), managing conversation context, and automatically collecting user feedback data through the UAT feature. Thus, the use of n8n in this study provides a higher level of automation, improved system efficiency, and supports data-driven evaluation of chatbot service quality, a feature not found in previous research [25][26].

Furthermore, when compared to existing research over the past two years that developed chatbots for academic consultation using Natural Language Processing (NLP) and Artificial Neural Network (ANN) algorithms, this research stands as a reinforcement and development [27].

Previous research demonstrated that NLP-based chatbots are capable of providing interactive services that facilitate communication between students and lecturers without the constraints of time and space. However, these systems still operate separately between the NLP engine and the user application and lack cross-platform integration capabilities.

Overall, this study reinforces related research findings that NLP-based chatbots are indeed effective in providing interactive services [19][23]. It also demonstrates that with the implementation of more sophisticated AI models and automated integration systems, chatbot capabilities can be enhanced to become more responsive, contextual, and user-experience-oriented. The integration of Gemini AI, n8n, and WAHA enables the system to understand the context of user conversations more naturally and provide a communication experience closer to human interaction [28].

Meanwhile, a related study at the Irba grocery store also developed a WhatsApp-based chatbot, but it was still rule-based, relying on fixed commands such as #menu, #list, or #location. The system proved to function well, but user interaction was limited and it could not understand variations in natural language [10][15][27]. This study expands on this approach by implementing AI and intelligent automation technologies that can understand users' natural language and provide a more dynamic and personalized conversational experience. This research also connects the system to Google Sheets, which can be updated in real time. This makes the chatbot more flexible, able to learn from interactions, and provide more natural and relevant responses to the conversational context.

Furthermore, the results of this study also show that the implementation of an AI-based chatbot through the WhatsApp platform successfully increased the effectiveness and efficiency of customer communication at the Citra Karya Gemilang Store.

These results reinforce similar findings, which prove that AI chatbots on WhatsApp are able to improve user experience and customer engagement through fast, responsive, and personalized interactions. However, unlike previous studies that only analyzed user perceptions, this study adds a new contribution in the form of a direct implementation of a technically integrated chatbot system using the WAHA API Gateway, n8n Workflow Automation, and Gemini AI.

CONCLUTIONS

Based on the formulated research objectives and the results of the development and testing of the WhatsApp-based AI Agent Chatbot system at the Citra Karya Gemilang Store, the following conclusions can be drawn.

1. First, this study successfully implemented an AI Agent Chatbot on the WhatsApp platform, capable of providing fast and accurate responses to customer messages. This was demonstrated by Black Box Testing results, which demonstrated that all chatbot features ran according to functional requirements without error, and the chatbot was able to respond to customer messages automatically and in real time.
2. Second, the developed chatbot system successfully facilitated the process of checking stock, pricing, and ordering cellphone spare parts through integration with Google Sheets as a real-time database. This feature allows customers to obtain product availability and pricing information directly without having to wait for a manual response from the store administrator.
3. Third, the implemented chatbot is also capable of providing initial consultation services for cellphone damage complaints, providing initial analysis and follow-up suggestions before the customer visits the store. This feature helps expedite the initial communication process between customers and the store, particularly regarding cellphone service.
4. Fourth, the results of User Acceptance Testing (UAT) involving 20 respondents showed a user satisfaction rate of 92%, with a rating of "Very Satisfied." These results demonstrate that the chatbot system is not only technically functional but also well-received by users due to its ease of use, speed of response, and accuracy of the information provided.

Overall, it can be concluded that the implementation of a WhatsApp-based AI Agent Chatbot at the Citra Karya Gemilang Store has successfully improved customer service effectiveness, overcomes the limitations of manual communication, and supports the automated and continuous sales process for spare parts and mobile phone service consultations, in line with the stated research objectives.

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F.S, I.S. Writing, Programming, Design, I.S. Conceptor.

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