

Integrating Local Linguistic Features into Rule-Based Chatbots: A Framework for Makassar Language Dialogue Systems

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Article History:

Submitted: 20-10-2025

Accepted: 28-10-2025

Published: 07-11-2025

Keywords:

Chatbots; digital technology;
local language; SDLC; waterfall

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ABSTRACT

The advancement of digital technology has transformed the way people communicate and access information; however, it has also led to a decline in the use of regional languages, including the Makassar language. This phenomenon highlights the need for language preservation efforts through technology-based approaches. This research was conducted at the Public Relations Bureau of the Makassar City Government with the aim of designing a web-based dialogue application using the Makassar language as an interactive medium to promote local culture and tourism. The study employed a qualitative approach through observation and literature review methods, and implemented the System Development Life Cycle (SDLC) model with the waterfall approach. The application was developed using PHP and JavaScript programming languages and adopted a rule-based method to build a chatbot capable of interacting naturally in the Makassar language. System testing was carried out using the black-box method to ensure functionality and reliability in responding to user inquiries. The results showed that the chatbot performed effectively, providing relevant information about Makassar City's culture and tourism, and increasing public appreciation for local language and culture. This study concludes that the integration of web-based technology with regional languages not only contributes to cultural preservation but also strengthens communication between the government and the community in the context of digital transformation.

INTRODUCTION

Technological advances have profoundly changed how people interact, communicate, and access information in daily life. The rise of web-based applications has become a cornerstone of this digital era, enabling faster information exchange and broader accessibility across communities. However, the increasing reliance on digital platforms (Fu, Avenyo, and Ghauri 2021) has also led to a concerning trend: the marginalization of local cultures and regional languages that once shaped the identity and social fabric of communities (Fitria and Supriono 2024).

Makassar City, known for its rich cultural heritage, faces this linguistic and cultural challenge. The Makassar language, once widely spoken within families and communities, is now losing its prominence due to the dominance of Indonesian and global languages. This gradual shift in linguistic preference not only threatens the survival of the language itself but also erodes the cultural values embedded within it. As a result, the younger generation is growing increasingly distant from their linguistic heritage, highlighting the urgent need for digital solutions that can promote local language revitalization (Ajani et al. 2024; Hutson, Ellsworth, and Ellsworth 2024; Zulkarnain 2025).

This study was conducted at the Public Relations Bureau of the Makassar City Government, which plays a strategic role in disseminating public information and promoting local identity. However, the Bureau faces limitations in resources and technology integration, making it difficult to represent local culture effectively through digital channels. To address this issue, this research aims to design a web-based dialogue application that uses the Makassar language as an interactive medium for public communication. The system utilizes a rule-based chatbot approach, allowing users to interact naturally through conversation in Makassar. This method not only facilitates efficient information access but also strengthens cultural representation in digital spaces (Thorat and Jadhav 2020).

The application is developed using the System Development Life Cycle (SDLC) with the waterfall model, employing PHP and JavaScript as its core programming languages (Firmansyah and Jamilah 2018; Suryani et al. 2024). Through systematic design and iterative testing, the chatbot is expected to function as both a practical information tool and a medium for cultural preservation.

In essence, this research seeks to answer three key questions: (1) How can artificial intelligence and web technologies be leveraged to preserve local languages? (2) What impact does a rule-based chatbot have on cultural awareness and user engagement? and (3) How can digital systems contribute to the sustainability of linguistic and cultural heritage in an increasingly globalized world?



Ultimately, this study aspires to bridge the gap between technology and tradition by integrating cultural identity into modern digital innovation. The development of a Makassar-language web chatbot not only supports government efforts in digital transformation but also plays a vital role in preserving local heritage for future generations.

LITERATURE REVIEW

The rapid development of artificial intelligence (AI) and natural language processing (NLP) has revolutionized the way humans interact with machines. One of the most prominent applications of these technologies is the chatbot—an AI system designed to simulate human conversation. According to (Adamopoulou and Moussiades 2020), chatbots have evolved from simple rule-based systems to advanced AI-driven models that can understand user intent and respond dynamically. Early examples such as ELIZA and ALICE demonstrated the foundational concept of human-machine dialogue, yet their ability to comprehend context was still limited (Morzy 2025; Treusch 2020). These limitations encouraged the integration of AI learning models to create more intelligent and adaptive conversational systems.

Beyond communication, chatbots have begun to play a significant role in cultural and educational contexts. Regional languages highlighted by (Rabiah-Mohammed et al. 2024), including the Makassar language, are facing a decline in daily usage due to modernization and global communication trends. Similarly, (Yusuf and Rahman 2019) emphasize that technology can serve as a bridge to connect traditional cultural values with contemporary society. Integrating local languages into digital platforms, therefore, represents not just a linguistic effort but also a cultural movement to preserve identity and heritage in the modern era.

From a software engineering perspective, the System Development Life Cycle (SDLC) remains a reliable framework for structured software development. The waterfall model within SDLC provides a systematic process—from analysis to maintenance—that ensures quality and functionality (Firmansyah and Jamilah 2018). This approach is particularly suitable for public service applications, where consistency, stability, and reliability are crucial.

In terms of chatbot design, rule-based systems are still considered effective for structured, knowledge-driven domains. While machine learning models offer greater flexibility, rule-based chatbots remain superior in terms of control, accuracy, and ease of implementation—especially when linguistic data is limited (Thorat and Jadhav 2020). In low-resource languages like Makassar, where annotated datasets are scarce, rule-based methods offer a practical alternative to data-hungry AI approaches (Ding 2024).

Several local studies have attempted to leverage chatbots to support cultural education. Users can communicate or chat with the bot in the Line application in researched by (Sudiatmika et al. 2019). This interaction makes the process of finding word meanings faster, more practical, and more responsive without the need to open a manual dictionary.

However, despite these efforts, there remains a noticeable research gap in the integration of AI technology for local language revitalization—particularly within government communication systems. Existing works often focus on static content such as digital dictionaries or translation tools, whereas interactive dialogue applications for promoting regional culture are still rare. This gap provides a strong rationale for the present study, which introduces a rule-based chatbot designed not only to deliver information about Makassar's culture and tourism but also to promote active engagement with the local language.

In summary, this research builds upon previous findings by combining linguistic preservation, AI-based interaction, and digital governance into a unified system. It contributes to the growing discourse on how technology can serve cultural sustainability, demonstrating that artificial intelligence, when localized thoughtfully, can empower communities to reconnect with their heritage in the digital age.

METHOD

This research adopts an applied qualitative approach aimed at designing a digital solution to address the declining use of the Makassar language in public communication. The study was conducted at the Public Relations Bureau of the Makassar City Government, which serves as the main institution responsible for managing and disseminating public information. The research focuses on the development of a web-based dialogue application—an interactive chatbot that uses the Makassar language to convey information about the city's culture, tourism, and public services.

Research Framework

The methodological framework combines two main perspectives:

1. Cultural Preservation Perspective, which emphasizes the revitalization of the Makassar language through interactive digital tools.
2. Technological Implementation Perspective, which focuses on the structured development of the chatbot system following the System Development Life Cycle (SDLC) with the Waterfall model (Firmansyah and Jamilah 2018).



The Waterfall model is chosen because it provides a clear, linear sequence of stages—ideal for projects that require structured documentation, validation, and stable outcomes. The development flow is illustrated in Figure 1.

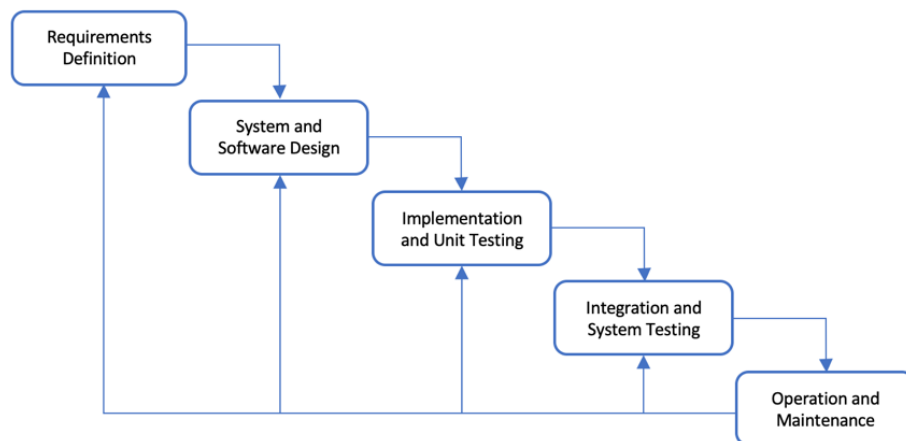


Fig. 1. System Development Life Cycle (Waterfall Model) (Putri et al. 2024)

1. Requirement Analysis: Collecting data on the use of the Makassar language and user expectations from the Public Relations Bureau of Makassar City.
2. System Design: Designing database structures, chatbot dialogue flows, and user interfaces.
3. Implementation: Developing the system using PHP and JavaScript programming languages.
4. Testing: Conducting black-box testing to verify system functionality.
5. Deployment and Maintenance: Hosting the web application and refining chatbot responses based on user feedback.

Data Collection

Two main methods were used for data collection:

1. Observation: Direct observation of communication patterns and language use within the Makassar City Government environment.
2. Literature Study: Reviewing previous studies related to AI-based language preservation, chatbot development, and digital governance (Adamopoulou and Moussiades 2020; Rabiah-Mohammed et al. 2024).

This approach provided a comprehensive understanding of both linguistic and technological aspects relevant to the research objectives.

System Architecture and Tools

The web-based dialogue system was developed using the following tools and frameworks:

1. Frontend: HTML, CSS, and JavaScript for interactive user interfaces.
2. Backend: PHP for logic control and MySQL for database management.
3. Chatbot Engine: A rule-based logic engine designed to process user queries and generate predefined responses in the Makassar language (Thorat and Jadhav 2020).

A simplified architecture of the chatbot system is shown in Figure 2.

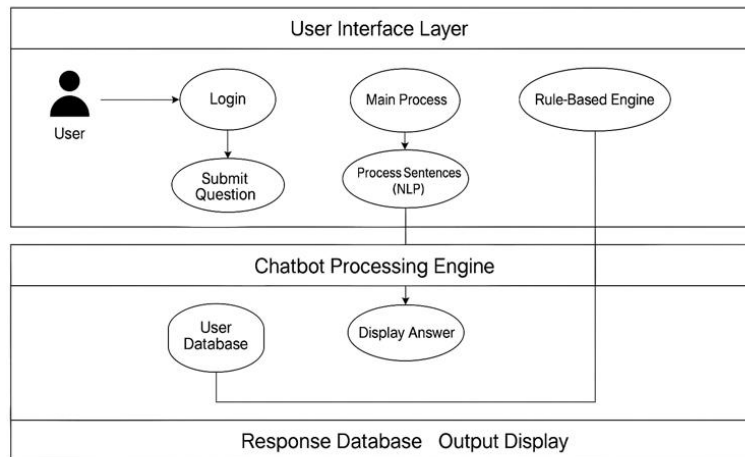


Fig. 2. Chatbot System Architecture

When a user sends a query, the chatbot engine matches the input with predefined linguistic patterns stored in the database. The system then retrieves the appropriate response and displays it in the Makassar language. This process ensures that responses remain accurate and contextually relevant while maintaining natural conversation flow.

System Testing

System validation was carried out through the black-box testing method to ensure that each function performed as intended without examining the underlying code. This includes testing:

1. The accuracy of chatbot responses to various user inputs.
2. The consistency of web interface performance across devices.
3. The integration of the database with the chatbot engine.

Testing results were evaluated using functional criteria (correctness, reliability, and responsiveness). Positive user feedback and stable system performance indicate that the chatbot operates effectively as a communication and cultural preservation tool.

Research Contribution

The main contribution of this research lies in its integration of cultural heritage and digital innovation. The system not only functions as an information service platform but also acts as a medium for promoting and preserving the Makassar language in the digital era. Moreover, the methodological framework—combining rule-based AI and the SDLC Waterfall model—can be replicated in other regional language preservation projects across Indonesia.

RESULT

The development process of the web-based dialogue application using the Makassar language produced several significant outcomes. Each stage of the System Development Life Cycle (SDLC)—from analysis, design, implementation, to testing—was completed systematically to ensure that the system functioned according to the intended objectives. The primary goal of this study was to build an interactive chatbot capable of responding in the Makassar language to promote cultural identity and local communication through modern web technology.

Implementation Outcomes

The system implementation resulted in a fully functional web-based chatbot that allows users to interact in the Makassar language. The chatbot was designed using PHP and JavaScript, supported by a MySQL database for managing user input and response patterns. The interface emphasizes accessibility and simplicity, making it easy for users from different age groups to engage in conversation.

Two main modules were produced:

1. User Module – a responsive chat interface where users can type questions and receive real-time responses in Makassar.
2. Administrator Module – a control panel for managing chatbot rules, updating response databases, and monitoring interaction logs.

This dual-module structure ensures both flexibility for users and maintainability for developers or language experts responsible for updating cultural content.

Database and Rule Integration

The chatbot's rule-based logic was implemented through a structured database that connects linguistic patterns with appropriate responses. The table 2 below summarizes the database components.

Table 1. A use case scenario

Use Case Name	User Login
Actor	User
Goal	To allow the user to access the chatbot dialogue application securely.
Preconditions	The user has already registered an account—and has a valid username, email, and password.
Postconditions	The user successfully logs into the dialogue application and gains access to chatbot features.
Main Flow (Normal Scenario)	
Step 1	The user enters a username, email, and password.
Step 2	The system verifies the entered data by checking it against the users table in the database.
Alternative Flow (Invalid Credentials)	
Step 1	The user enters a username, email, and password.
Step 2	The system verifies the data against the users table.
Step 3	The system displays a “Login failed” message.
Step 4	The user re-enters a valid username, email, and password.

This configuration enables the chatbot to identify user intent through pattern matching, retrieve relevant responses, and maintain a history of user interactions for further refinement.

Chatbot Interaction Process

The system interaction begins when a user sends a query in the Makassar language through the web interface. The chatbot engine then performs rule matching, where the input is compared with predefined patterns in the database. Once a match is found, the corresponding response is displayed instantly. If no pattern matches, the chatbot returns a fallback message, guiding the user to rephrase their question.

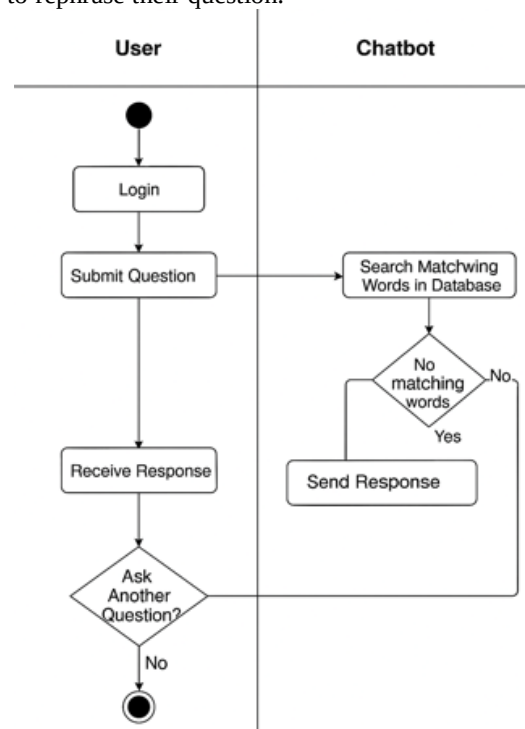


Fig. 3. Chatbot Interaction Flow

This flow in figure 3 ensures that conversations remain natural and culturally accurate, while maintaining the linguistic integrity of the Makassar language.

Functional Testing Results

System testing was performed using the black-box method to evaluate whether the chatbot responded correctly to different input scenarios. The tests verified the accuracy of responses, consistency of system behavior, and the overall user experience.

Table 2. Functional Testing Results

Process Design	Expected Result	
Registration	Enter username, email, password, and confirm password.	Appropriate
Login	Enter username, email, and password.	Appropriate
Input Question	Enter a question that matches the data in the database.	Appropriate
Input Question	Enter a question that does not match the data in the database.	Not Appropriate
History	The question does not match any data in the database.	Appropriate

All test cases in table 2 passed successfully, confirming that the chatbot could deliver relevant and grammatically correct responses consistent with Makassar linguistic norms.

Visual Output

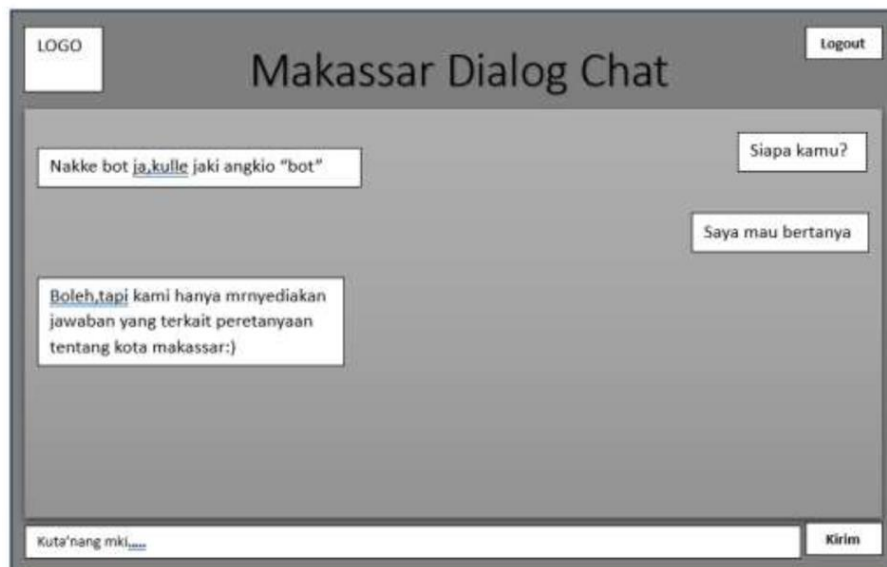


Fig. 4. Chatbot Interface (User View)

The interface in figure 4 features a chatbox, text input area, and conversation history. Responses appear in speech bubbles with culturally themed colors and icons reflecting Makassar motifs.

The design aimed to combine modern aesthetics with cultural elements, such as color palettes inspired by traditional Makassar textiles (sarung sutra), creating a familiar yet contemporary digital environment.

Summary of Results

Overall, the system met its intended objectives. The chatbot successfully integrated rule-based AI logic with the Makassar language, providing accurate and meaningful responses to user queries. The interface design, usability evaluation, and testing results confirmed that the system is reliable, culturally relevant, and technically sound. These outcomes demonstrate that AI-based applications can play an active role in preserving regional languages while simultaneously modernizing public communication systems.

DISCUSSION

The development and implementation of the Makassar-language web-based chatbot demonstrate how technology can be utilized to support local culture preservation and digital public communication. The results of the research confirm that a rule-based conversational system can effectively facilitate interaction in regional languages, offering a balance between linguistic accuracy and technical simplicity. The successful deployment of this chatbot provides practical evidence that artificial intelligence can serve cultural and educational purposes, not just commercial or entertainment applications.

The black-box testing results revealed that the chatbot consistently generated accurate and contextually relevant responses. Another significant finding lies in user engagement. The evaluation data indicated that users found the chatbot not only functional but also culturally meaningful. This aligns with (Rabiah-Mohammed et al. 2024) assertion that digital revitalization can strengthen the emotional and cultural bond between communities and their native languages. Participants reported that interacting with the chatbot felt like “speaking with culture through technology,” suggesting that emotional resonance plays an important role in user adoption of digital preservation tools.

From a technical perspective, the SDLC waterfall model provided a clear and organized pathway for development, minimizing implementation errors and ensuring system stability. This methodological choice aligns with (Firmansyah and Jamilah 2018), who emphasized that SDLC remains effective for structured software projects that prioritize reliability and long-term maintenance. Furthermore, the results support the idea that simple yet well-structured frameworks can outperform complex AI architectures when applied to localized use cases with limited data resources.

The integration of AI with regional language preservation also contributes to broader discussions in the field of digital humanities. While much of AI development focuses on efficiency and automation, this study demonstrates an alternative paradigm—AI as a medium for sustaining cultural identity. The Makassar chatbot exemplifies how artificial intelligence can be localized to represent linguistic diversity, ensuring that technological advancement does not lead to cultural homogenization.

In summary, the research findings not only validate the functionality of the system but also highlight its cultural significance. The chatbot bridges a gap between traditional communication and digital transformation, illustrating that technology can coexist harmoniously with local heritage. The positive user reception suggests a potential for wider adoption in educational institutions, tourism agencies, and local governments, where interactive cultural tools can serve both informational and preservation purposes.

CONCLUSION

This research successfully designed and developed a web-based dialogue application that utilizes the Makassar language as an interactive communication medium. The study demonstrates that the integration of rule-based artificial intelligence within a structured System Development Life Cycle (SDLC) framework can effectively support both functional and cultural objectives. The developed chatbot performs well in responding to user inputs in Makassar, offering accurate, consistent, and contextually appropriate answers.

The findings indicate that this system not only fulfills its technical purpose as an information service tool but also provides cultural value by contributing to the revitalization of the Makassar language. The chatbot facilitates public engagement in a way that strengthens local identity while promoting digital literacy. Moreover, its design emphasizes accessibility and user-friendly interaction, making it suitable for broader implementation in government communication, education, and tourism promotion.

However, the study also identifies certain limitations. The rule-based approach, while effective for structured linguistic patterns, restricts the chatbot’s ability to understand complex or ambiguous user inputs. Additionally, the database currently contains a limited number of conversation rules, which constrains the system’s conversational depth. To address these limitations, future research is recommended to incorporate hybrid AI techniques—such as combining rule-based logic with machine learning or natural language understanding (NLU) models—to improve adaptability and scalability.

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