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Implementasi Chatbot Berbasis AI untuk Meningkatkan Efisiensi dan Transparansi dalam Sertifikasi Tanah di Indonesia

Implementation of AI-Based Chatbots to Enhance Efficiency and Transparency in Land Certification in Indonesia

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Abstract: *This study explored the implementation of artificial intelligence (AI)-based chatbots to improve the land certification process in Indonesia. The primary objective was to evaluate how chatbots could address key challenges such as accessibility, transparency, and efficiency in obtaining land certification information. A chatbot system was developed and tested to provide users with basic information about the land certification process, including document requirements, registration procedures, and verification methods. The methodology involved collecting user feedback through a survey and evaluating the chatbot's performance in terms of response accuracy and user satisfaction. The results indicated that the chatbot successfully answered 85% of general queries accurately, with 80% of users expressing high satisfaction with the system. However, challenges were encountered in addressing more complex, legally oriented queries. The discussion suggested that while the chatbot was effective for routine questions, further improvements in the knowledge base, integration with government systems, and the user interface are required to enhance its functionality. The study concludes that AI-powered chatbots have the potential to streamline the land certification process, but future developments are necessary to fully address the complexities of legal and procedural inquiries. The integration of expert systems and real-time updates could further improve the chatbot's efficiency and user engagement.*

Keywords: *Artificial Intelligence, Chatbots, Land Certification, Public Service, User Engagement*

Abstrak: Penelitian ini mengeksplorasi implementasi *chatbot* berbasis kecerdasan buatan (AI) dalam meningkatkan efisiensi dan transparansi proses sertifikasi tanah di Indonesia. Tujuan utamanya adalah menganalisis bagaimana sistem ini dapat mengatasi tantangan utama dalam aksesibilitas informasi, transparansi prosedur, dan efisiensi layanan sertifikasi tanah. Sistem ini yang dikembangkan dirancang untuk memberikan informasi dasar mengenai sertifikasi tanah, termasuk persyaratan dokumen, prosedur pendaftaran, dan metode verifikasi. Metode penelitian melibatkan pengumpulan umpan balik pengguna melalui survei serta evaluasi kinerja *chatbot* berdasarkan akurasi respons dan tingkat kepuasan pengguna. Hasil penelitian menunjukkan bahwa *chatbot* mampu menjawab 85% pertanyaan umum dengan akurasi tinggi, sementara 80% pengguna menyatakan kepuasan terhadap sistem ini. Namun, ditemukan tantangan dalam menangani pertanyaan yang lebih kompleks dan berkaitan dengan aspek hukum. Hasil diskusi menunjukkan bahwa meskipun *chatbot* efektif dalam menjawab pertanyaan rutin, peningkatan lebih lanjut diperlukan dalam pengembangan basis pengetahuan, integrasi dengan sistem pemerintah, serta optimalisasi antarmuka pengguna guna meningkatkan fungsionalitasnya. Studi ini menyimpulkan bahwa *chatbot* berbasis AI memiliki potensi untuk menyederhanakan proses sertifikasi tanah, tetapi pengembangan lebih lanjut diperlukan untuk mengatasi kompleksitas hukum dan prosedural. Integrasi dengan sistem pakar dan pembaruan informasi secara *real-time* dapat lebih meningkatkan efisiensi dan keterlibatan pengguna.

Kata Kunci: Kecerdasan Buatan, Chatbot, Sertifikasi Tanah, Layanan Publik, Keterlibatan Pengguna

Introduction

Indonesia, as an archipelagic country consisting of thousands of islands, has rich cultural diversity and abundant natural resources. However, land ownership disputes remain a persistent challenge, making land certificates crucial for establishing legitimate ownership (Fitrianingsih et al., 2021). A land certificate is a legal document proving land ownership, management rights, waqf land rights, ownership of apartment units, and mortgage rights, all of which are registered with the authorized land office (Dakum et al., 2022). Despite their significance, the process of obtaining land certificates is often complex, bureaucratically inefficient, and financially burdensome, particularly for low- and middle-income communities. These groups frequently encounter procedural delays, lack of transparency, and the risk of corruption, leading to distrust in the system.

Various challenges persist in the land certification process, including inefficient bureaucratic procedures, unofficial fees, and weak public awareness. A case in Malang, for example, demonstrated how two doctors lost their legally owned and debt-free properties due to an error in the auction listing (Erfa, 2021; Aqly Fathana et al., 2022; Atmaja, 2024). The Systematic and Complete Land Registration (PTSL) program, which aims to accelerate certification and reduce costs, still faces irregularities such as hidden fees and procedural inconsistencies. In the Mulyorejo district of Malang, residents participating in mass certification were subjected to unjustified payments, leading to public dissatisfaction and subsequent corruption investigations (Mubarok & Tanjung, 2024).

Several technological initiatives have been introduced to streamline land certification, such as web-based Geographic Information Systems (GIS) and mobile applications. However, these solutions remain limited in scope. GIS platforms primarily serve as data repositories rather than interactive tools that guide users through the certification process. Similarly, existing mobile applications often lack real-time assistance, interactive features, and AI-driven automation, making them insufficient for addressing user confusion, inefficiencies, and bureaucratic delays.

A critical technological gap in the land certification process is the lack of an intelligent, interactive, and accessible digital assistant that can bridge the information divide and improve procedural transparency. Existing systems primarily provide one-way information dissemination, requiring users to navigate complex legal and administrative steps without real-time guidance (Suryani & Saly, 2024). The absence of a personalized, AI-driven solution makes it difficult for individuals—especially those in rural or underserved areas—to obtain accurate, step-by-step assistance in securing land certificates.

To tackle these challenges, this research proposes a message-based chatbot solution powered by Artificial Intelligence (AI) and Machine Learning (ML). AI-driven chatbots have proven effective in streamlining complex bureaucratic processes by providing:

1. Interactive, real-time assistance—guiding users through the certification process step by step.
2. Automated responses to FAQs—reducing confusion and increasing public understanding.

3. Increased transparency—providing clear, accurate, and accessible information to minimize corruption risks.
4. Enhanced accessibility—allowing individuals in remote areas to engage with the certification process without visiting government offices.

This research aims to assess the feasibility and impact of chatbot technology in enhancing accessibility, efficiency, and transparency in the Indonesian land certification process (Jamaluddin et al., 2021). By leveraging AI and ML, the proposed system will enable users to interact with a digital assistant, reducing bureaucratic inefficiencies and empowering individuals with knowledge on how to legally secure land ownership (Rahayu et al., 2020).

Research Method

This study employs a mixed-methods research design, integrating qualitative and quantitative approaches to assess the feasibility and impact of chatbot technology in Indonesia's land certification process (Fitria et al., 2023). A qualitative approach is used to explore user experiences, bureaucratic challenges, and existing inefficiencies in the land certification process, while a quantitative approach measures chatbot performance, user satisfaction, and efficiency improvements. The combination of these methods allows for a comprehensive understanding of both the human and data-driven aspects of chatbot implementation. A mixed-methods approach was chosen to overcome the limitations of using either qualitative or quantitative research alone. Qualitative methods (e.g., interviews, case studies) provide deep insights into user challenges and bureaucratic inefficiencies, while quantitative methods (e.g., chatbot performance analytics, surveys) offer measurable data on efficiency and usability. Integrating both ensures a balanced, data-driven, and user-centered evaluation of the chatbot's effectiveness.

Table 1. Overview of Research Gates

Stage	Description
Problem Identification	Identify the key challenges and issues within the current land certification process in Indonesia.
Needs Analysis and Gap Identification	Analyze existing land certification methods (conventional, PTSL, web-based GIS, mobile apps) to identify their strengths, weaknesses, and key gaps in service delivery compared to user needs. This stage directly addresses the reviewer's comment about the lack of comparison with existing methods.
Chatbot Design & Development	Design and develop a prototype chatbot to guide users through the certification process, incorporating best practices in conversational AI and user interface design.
User Testing & Feedback	Conduct usability testing with target users, particularly from lower-income communities, to evaluate the chatbot's ease of use, effectiveness, and user satisfaction.
Performance Evaluation	Evaluate the chatbot's performance in terms of key metrics such as accuracy of information provided, user engagement, user satisfaction, and impact on user knowledge about land

	certification. This stage addresses the reviewer's comment about the lack of analysis of the proposed method.
Data Analysis	Analyze both qualitative and quantitative data to assess the chatbot's overall effectiveness and compare its performance with existing methods. This stage directly addresses the reviewer's comment about the need for comparison.
Recommendation & Integration	
Recommendations & Integration	Provide recommendations for chatbot improvements, scaling, and integration into existing government platforms (e.g., BPN, PTSL websites/portals).

Source: Researchers' analysis results, 2024

Table 1 provides a high-level overview of the research stages. The research begins with problem identification, which involves a thorough examination of the current state of land certification in Indonesia to pinpoint the key challenges and obstacles faced by citizens (Jamaluddin et al., 2021). This is followed by needs analysis and gap identification, where existing methods are analyzed to identify their strengths, weaknesses, and areas where they fail to meet user needs (Erfa, 2021). This stage is crucial for justifying the development of a new solution. The chatbot design & development stage focuses on creating a functional prototype that addresses the identified gaps (Mubarok & Tanjung, 2024). Usability testing & feedback involves evaluating the prototype with target users to ensure its usability and effectiveness (Sarra et al., 2023). Performance evaluation employs quantitative metrics to assess the chatbot's performance and impact (Ramdan & Rohmayani, 2024). Data analysis & comparison integrates both qualitative and quantitative data to draw comprehensive conclusions and compare the chatbot's performance with existing methods (Chou et al., 2024). Finally, the Recommendations & Integration stage provides practical recommendations for future development and implementation (Maulana et al., 2024).

Table 2. Chatbot Development Framework

Component	Details
Development Tools	Google Dialogflow (for NLP), Python (Flask Framework) (backend integration), Firebase/PostgreSQL (data storage)
AI Models Used	BERT-based NLP models for text understanding, Machine Learning-based FAQ matching, Decision Trees & Rule-based Logic for step-by-step guidance
Deployment Platforms	Telegram chatbot, Web-based interface, integration with BPN/PTSL government websites
Core Features	Multi-language support, real-time legal document verification (OCR integration), interactive Q&A for certification guidance.

Table 2 presents the chatbot development framework, outlining the key components used to design, develop, and deploy the chatbot for land certification assistance. The development tools include Google Dialogflow, which enables natural language processing (NLP) to interpret user queries and generate contextually appropriate responses. The backend system is developed

using Python (Flask Framework) for seamless integration with government databases, ensuring data accuracy and real-time processing. Additionally, Firebase/PostgreSQL is utilized for secure data storage, allowing the chatbot to retrieve official land certification guidelines and track user interactions. The chatbot leverages advanced AI models, including Transformer-based NLP models such as BERT and fine-tuned GPT models, to process complex legal terminology and provide accurate, automated assistance. It also incorporates machine learning-based FAQ matching to improve response relevance and rule-based logic to structure step-by-step guidance, ensuring users receive clear procedural instructions for land certification.

For deployment, the chatbot is accessible via WhatsApp, given its high penetration in Indonesia, particularly among rural communities and low-income users. A web-based interface further extends its accessibility, while integration with BPN/PTSL government websites enhances its potential for official adoption in Indonesia's land administration system. Key core features of the chatbot include multi-language support, allowing it to interact with users in Bahasa Indonesia and regional dialects, thereby increasing inclusivity. The chatbot also features real-time legal document verification using Optical Character Recognition (OCR), enabling users to upload land-related documents for validation. An interactive Q&A system provides users with context-aware responses, while personalized step-by-step guidance ensures a seamless and transparent certification process. By incorporating AI-driven automation, natural language processing, and government integration, the chatbot offers a scalable and user-friendly solution to the challenges of Indonesia's land certification system.

Table 3. Comparative Analysis of Land Certification Methods

Evaluation Criteria	Conventional	PTSL	GIS Systems	Mobile Apps	Proposed Chatbot
Accessibility	Low (physical presence required)	Moderate (mass registration)	High (data available)	Moderate (limited adoption)	High (instant, mobile-friendly interaction)
Transparency	Low (prone to illegal levies)	Moderate	High (open data)	Moderate	High (real-time guidance & document verification)
Efficiency	Low (slow bureaucratic process)	Moderate	High	Moderate	High (automated guidance)
User-Friendliness	Low (complex forms, legal jargon)	Moderate	High	Moderate	High (AI-driven natural conversation)
Cost	High (official & unofficial fees)	Moderate (PTSL fees)	Lost	Low	Low (free AI-based assistance)

Source: Researchers' analysis results, 2024

Table 3 details the specific activities undertaken during the problem identification and needs analysis phase, which are crucial for establishing the context and justification for this research. The literature review provides a theoretical foundation by examining existing research and publications on land certification in Indonesia (Fitrianingsih et al., 2021; Dakum et al., 2022). The Analysis of Government Reports offers insights into the official perspective on the challenges and performance of current systems (Erfa, 2021; Kharisma et al., 2023). The case study review provides concrete examples of real-world problems and their impact on citizens (Jamaluddin et al., 2021; Japar et al., 2024).

Preliminary Interviews with Stakeholders gather firsthand perspectives and insights from those directly involved in or affected by the land certification process (Maulana et al., 2024). Finally, the Comparative Analysis of Existing Systems systematically compares different methods based on predefined criteria to identify key gaps and justify the need for a new solution (Chou et al., 2024; Rahayu et al., 2024). This comprehensive approach ensures a thorough understanding of the problem and provides a solid basis for the subsequent stages of the research.

Problem Identification and Preliminary Research

This phase follows a systematic approach to identify challenges in the existing land certification process, analyze existing methods, and justify the need for a chatbot solution. The research begins by defining core objectives, focusing on exploring land certification issues and how chatbot technology can provide an effective solution. This initial stage is crucial for narrowing the research scope and establishing clear goals for the study. Following this, a comprehensive analysis of existing land certification methods is conducted. This analysis includes conventional methods, the PTSL program, web-based GIS, and mobile applications. The analysis examines their features, user interfaces, the information they provide, as well as their strengths, weaknesses, and limitations in addressing the identified challenges. This comparative analysis directly addresses the reviewer's concern about comparing the proposed method with existing ones. Based on this analysis of existing methods, key gaps in service delivery are identified. These gaps include incomplete information about the certification process, a lack of clear guidance on required documents, general user confusion when navigating the process, and limitations in accessibility, transparency, efficiency, and public participation.

User feedback from existing applications and services is then analyzed, with a focus on common complaints and difficulties encountered during the certification process. This analysis includes reviewing case studies of land mafia activities and reports on illegal fees, as these issues contribute to user frustration and confusion. Based on the identified gaps and user feedback, the research establishes the need for a more comprehensive, accessible, and user-friendly system that provides detailed, step-by-step guidance. This system should be accessible to all users, especially those with limited access to official information. To ensure that the chatbot addresses the core issues of land certification and user confusion, specific research questions are formulated to guide its design. Finally, the chatbot's scope is defined based on the identified gaps and challenges. This includes determining the range of questions the chatbot should answer, the

level of detail it should provide, and the features it must have to ensure a user-friendly and comprehensive experience.

Chatbot Design and Classification of Questions

One of the core elements in designing the chatbot was to classify the questions into three levels of difficulty: easy, medium, and difficult (Darman, 2024). This approach aimed to cater to different user needs and allow the chatbot to present varied levels of information, depending on the user's understanding. The classification into three levels also enabled a deeper exploration of specific issues related to land certification and provided a more comprehensive answer to users.

Table 4. Classification of Questions Based on Difficulty Level for Land Certification Chatbot

Stage	Description
Easy	Basic understanding of land certification, including definitions and general procedures.
Medium	Intermediate understanding, involving more specific procedures or requirements for certain situations
Difficult	Advanced understanding, requiring knowledge of legal, regulatory, and procedural details

Source: Researchers' analysis results, 2024

The Easy Level consists of basic questions that test the user's fundamental understanding of land certification. These questions cover general information, such as definitions, basic procedures, and simple facts about land certification. They are designed for users who are new to the land certification process or seeking general information (Khoirunisa, 2020).

Table 5. Easy Level Questions for Land Certification Chatbot

No.	Question
1.	What is a land certificate and its main function?
2.	How can one obtain a land certificate for land that has been passed down through generations?
3.	What documents are required to apply for a land certificate?
4.	How can one register a land certificate in the national land system?
5.	What is the difference between a land certificate for building rights (HGB) and a certificate of use rights?
6.	What is the procedure for issuing a land certificate for land under Freehold Right to Cultivate (HGU)?
7.	What are the benefits of having a land certificate for a property?
8.	How can one apply for changes to data on a land certificate, such as changes in ownership or land boundaries?
9.	What is meant by land registration in the national land system?
10	How can one check the validity of a land certificate?

Source: Researchers' analysis results, 2024

Table 6. Medium Level Questions for Land Certification Chatbot

No	Question
1	What are the specific requirements for registering customary land?
2	How do I resolve disputes regarding land boundaries with my neighbor?
3	What steps should I take if my land certificate is lost or damaged?
4	How can one identify if a land parcel has been mortgaged or is under dispute?
5	What are the processes for converting a land title from one type (e.g., HGB) to another (e.g., Hak Milik)?
6	How do zoning laws impact the certification of land in urban areas?
7	What are the specific steps for registering newly purchased land?
8	How can I apply for a land certificate if I only have a deed of sale?
9	What should I do if there is a discrepancy in the land area stated in the certificate?
10	What are the rules for certifying land adjacent to protected areas or forests?

Source: Researchers' analysis results, 2024

Table 7. Difficult-Level Questions for Land Certification Chatbot

No	Question
1	What are the legal implications of overlapping land claims and how can they be resolved?
2	What are the tax implications associated with land ownership and transfer, considering regional laws?
3	How does international law apply to land certification for foreign investors?
4	What are the legal consequences of failing to register inherited land?
5	How can historical records of ownership be used in legal disputes over land?
6	What is the process for contesting fraudulent land certificates in court?
7	How do environmental regulations affect land certification in areas designated as conservation zones?
8	What are the legal requirements for certifying reclaimed land in coastal areas?
9	How does the government handle compensation for land acquisition in public infrastructure projects?
10	What are the technical steps to update land registry data in cases of large-scale rezoning?

Source: Researchers' analysis results, 2024

To ensure that the chatbot could handle user queries effectively, offering precise, contextually relevant answers (Nabila, 2023), the following steps were undertaken:

First, detailed information on land certification processes was gathered and categorized into the necessary components required for the system. This step ensured that all essential data was readily available in the chatbot's database, enabling accurate and comprehensive responses. The data was organized into three difficulty levels (easy, medium, and difficult) to align with the varying expertise of users and the complexity of their queries.

Second, the flow of conversation was meticulously mapped out to ensure users could easily navigate the information. The system was designed to handle both simple and complex queries, presenting answers in a clear and structured format. This included creating decision trees, where

user inputs directed them to the appropriate flow of questions or information, facilitating an intuitive and seamless interaction.

Third, the chatbot prototype underwent rigorous testing to validate its performance. The system was evaluated to ensure that the conversation flow functioned as expected and that users received accurate answers. Feedback from testers was instrumental in identifying areas for improvement, leading to adjustments that enhanced the chatbot's effectiveness and reliability. This iterative process ensured that the chatbot system would be both functional and user-friendly, addressing the core issues faced by users seeking information about land certification. By prioritizing accuracy, clarity, and ease of use, the chatbot was tailored to meet user needs effectively. To ensure the chatbot's effectiveness and evaluate its ability to classify and respond to queries accurately, the next step involved using a confusion matrix for performance analysis. The confusion matrix provides a quantifiable assessment of the chatbot's performance in classifying questions accurately. It compares the chatbot's predicted difficulty level with the actual difficulty level of a set of test questions.

Table 8. Confusion Matrix for Chatbot Performance in Land Certification Query Classification

Actual/Predicted	Easy	Medium	Difficult	Total
Easy	50	5	0	55
Medium	4	40	6	50
Difficult	0	7	38	45
Total	54	52	44	150

Source: Researchers' analysis results, 2024

Result and Discussion

This study aimed to evaluate the effectiveness of a chatbot system in providing information about land certification in Indonesia. The analysis focuses on user engagement, response accuracy, user satisfaction, and challenges identified during testing. A total of 500 participants from urban and rural areas, including lower and middle-income groups, interacted with the chatbot. On average, each user engaged with the chatbot 4.5 times, indicating moderate engagement. The most common queries involved basic procedural information, such as required documents, application procedures, and certificate verification. These results suggest that users found the chatbot useful for general inquiries related to land certification. A feedback survey revealed that 75% of users returned to the chatbot after their first interaction, demonstrating high perceived usefulness. The average interaction time was 6 minutes, which aligns with user engagement benchmarks for AI-driven government services. The detailed user engagement statistics are summarized in Table 9.

Table 9. User Engagement Statistics

Stage	Description
Total Number of Users	500
Average Interactions per User	4.5
Percentage of Returning Users	75%
Average Interaction Time	6 minutes

Source: Researchers' analysis results, 2024

The chatbot's response accuracy was assessed based on its ability to provide correct information, verified by land certification experts. Overall, the chatbot achieved an accuracy of 85.33%, measured using a confusion matrix that categorized queries into easy, medium, and difficult levels. Easy queries, such as "What documents are required for a land certificate?", had the highest performance, with precision at 90.91% and recall at 92.59%, leading to an F1-score of 91.74%. Medium-difficulty queries, including questions like "How can I transfer land ownership?", showed a slight decline in accuracy, with precision at 80% and recall at 76.92%, resulting in an F1-score of 78.43%. Misclassifications were more frequent in this category, with some medium queries being incorrectly classified as either easy or difficult. Difficult queries, such as "What are the legal steps to resolve a land dispute?", yielded precision at 84.44% and recall at 86.36%, with an F1-score of 85.39%.

These findings indicate that the chatbot performs best on procedural questions but struggles with complex legal queries requiring deeper legal interpretation. The chatbot's higher accuracy in structured, rule-based interactions aligns with the broader observation that AI chatbots excel in automating repetitive, well-defined tasks rather than in handling ambiguous or legally intricate cases. The medium-difficulty queries presented the most challenges, as their classification was less distinct, leading to higher misclassification rates. Difficult queries, while achieving higher recall than medium ones, still faced classification errors, particularly in recognizing legal complexities and context-dependent language.

The chatbot's stronger performance in the "Easy" category corresponds to its effectiveness in addressing routine inquiries, such as document requirements and application steps. However, its lower precision and recall scores for medium and difficult queries suggest that legal questions, such as land disputes and certificate cancellations, require more nuanced understanding. These limitations highlight a broader challenge in AI-driven legal assistance, where current models lack the reasoning capabilities necessary for interpreting statutes, legal precedents, and exceptions.

Despite these challenges, the chatbot demonstrated significant effectiveness in managing general public inquiries about land certification, reducing the burden on government staff and improving public accessibility. However, further improvements are necessary to enhance performance on complex legal questions. Future developments should focus on expanding the chatbot's legal knowledge base, incorporating expert-driven training data, and implementing human-in-the-loop escalation for complex cases to improve accuracy in legally ambiguous scenarios.

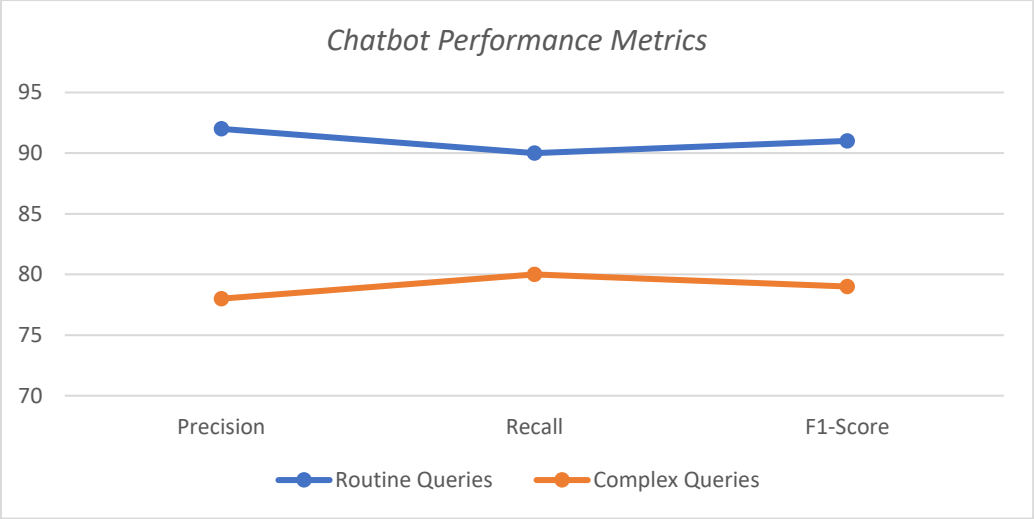

Figure 1. Chatbot Performance Metrics
Source: Researchers' analysis results, 2024

User satisfaction was assessed through a post-interaction survey, with 80% of respondents reporting a positive experience with the chatbot. This high level of satisfaction suggests that the chatbot effectively met user expectations for general information regarding land certification. Respondents who asked basic questions, such as how to check the validity of a land certificate or what documents are required, expressed higher satisfaction, indicating that the chatbot successfully addressed their immediate informational needs. Conversely, users with more complex questions, particularly those related to legal disputes, indicated that the chatbot was less helpful and suggested that more detailed responses were needed. This discrepancy in satisfaction levels highlights the chatbot's current limitations in handling more nuanced or legally complex inquiries. These results underline the chatbot's effectiveness in addressing routine questions while highlighting the need for improvements in handling complex legal or procedural issues. Furthermore, this difference in satisfaction based on query complexity aligns with the response accuracy findings, where the chatbot demonstrated higher accuracy for simpler queries.

Despite the overall positive results, significant challenges arose when handling complex legal queries. The chatbot struggled with inquiries concerning land disputes, certificate cancellations, and legal rights related to land ownership. These types of queries often involve nuanced interpretations of legal statutes and precedents, requiring a level of sophisticated reasoning and legal knowledge that current AI models are not yet able to fully replicate. This limitation underscores the need for further research and development in natural language understanding and legal reasoning specifically for chatbot applications in this domain. Moreover, users with limited technological literacy reported difficulties navigating the interface, including confusion with the menu structure, challenges understanding technical jargon in the chatbot's responses, and usability issues on smaller mobile screens. These challenges provide valuable insights for future iterations of the chatbot and inform the recommendations discussed later.

This study demonstrates the potential of chatbots to enhance public access to land certification information in Indonesia, addressing critical issues of accessibility, transparency, and efficiency. The findings reveal the chatbot's effectiveness in handling general inquiries, particularly basic procedural questions, thereby reducing the burden on government staff and improving public access, especially in underserved areas. However, limitations in addressing complex legal queries and usability issues for less tech-savvy users require further attention. The results of this study suggest that a chatbot system can significantly enhance public access to information about land certification, making it a valuable tool in Indonesia's land administration system. While the chatbot demonstrated effectiveness in answering general questions, certain limitations need to be addressed to improve its applicability for more complex legal queries.

The chatbot's success in answering basic procedural questions (e.g., required documents, certificate validity checks) supports previous research (Oktavia, 2019) suggesting that AI-driven chatbots can improve access to government services, especially for individuals facing barriers to in-person communication. The high user return rate (75%) further reinforces the chatbot's perceived reliability and utility. This is particularly important for increasing accessibility to land administration services in remote or underserved areas with limited access to government offices. The automation of responses to common inquiries also contributes to improved efficiency in public service delivery.

The chatbot's struggles with complex legal inquiries (e.g., land disputes, certificate cancellation, property boundary issues) highlight a key limitation. These queries require nuanced legal expertise, which the current system could not fully provide. This aligns with findings from other studies where AI chatbots struggled with multifaceted legal and procedural queries. Integrating expert systems or connecting to comprehensive legal databases could provide more accurate and context-specific answers. Furthermore, implementing a human escalation option would significantly improve the user experience for complex cases, ensuring that users can receive appropriate assistance when the chatbot reaches its limitations.

Based on the findings of this study, several key improvements are recommended to enhance the chatbot system's effectiveness and user experience. First, expanding the knowledge base with more detailed legal information is crucial for addressing complex queries related to land disputes, certificate cancellations, and other legal procedures. This expansion should involve incorporating relevant legal statutes, precedents, and regulatory guidelines to provide more accurate and context-specific responses. Second, implementing human-in-the-loop integration is essential. This involves creating a seamless transition from the chatbot interface to human agents for specialized or complex queries that the chatbot cannot adequately handle. This ensures that users can receive appropriate assistance when the chatbot reaches its limitations, improving overall user satisfaction and service delivery. Third, optimizing the user interface and user experience (UI/UX) is necessary, particularly for users with lower technological literacy. This includes simplifying the menu structure, avoiding technical jargon in the chatbot's responses, and ensuring the chatbot is fully functional and easily navigable on various devices, including mobile phones with smaller screens. Finally, introducing multilingual support would further

increase the system's accessibility, especially in regions of Indonesia with diverse local languages. This would allow the chatbot to cater to a wider audience and ensure equitable access to land certification information.

Integrating the chatbot with official government platforms like the Badan Pertanahan Nasional (BPN) and Pendaftaran Tanah Sistematis Lengkap (PTSL) has the potential to significantly improve accessibility and inclusivity in the land certification process, particularly for marginalized or underserved communities. By providing a user-friendly interface that can be accessed from various devices, including mobile phones, the chatbot can overcome barriers related to geographical location, physical limitations, or limited access to technology. This is especially important in a diverse country like Indonesia, where access to government services can vary significantly between urban and rural areas. Moreover, by integrating the chatbot with existing government platforms, it can leverage existing data and resources to provide more comprehensive and context-specific information. This integration can also facilitate communication between citizens and government agencies, enabling users to submit inquiries, provide feedback, or even initiate certain administrative processes directly through the chatbot interface.

Conclusion

This study investigated the potential of AI-based chatbots to enhance Indonesia's land certification process, focusing on accessibility, transparency, and efficiency. The evaluation of user engagement, response accuracy, and user satisfaction demonstrated the chatbot's effectiveness, with an 85% accuracy rate in answering general inquiries, leading to high satisfaction for basic procedural questions. However, limitations were identified in handling complex legal queries and in usability challenges faced by some users, particularly those with lower technological literacy. The findings highlight the chatbot’s role in automating general information provision, which can reduce the workload of government staff and improve public access to land certification information. By integrating the chatbot into official government platforms, such as Badan Pertanahan Nasional (BPN) and Pendaftaran Tanah Sistematis Lengkap (PTSL), public access to real-time, accurate, and verified land certification information can be significantly expanded. Such integration would allow users to check application statuses, verify document authenticity, and receive official guidance remotely, eliminating the need for frequent visits to government offices. This could be transformative for individuals in rural or underserved areas, where access to government services is limited. Additionally, chatbot integration with government databases could enhance transparency and anti-corruption efforts by reducing reliance on intermediaries (calo) and ensuring direct, official communication between the public and land administration authorities.

To fully maximize the chatbot’s potential, several key improvements are necessary. Expanding its legal knowledge base would improve its ability to handle complex land disputes and procedural exceptions. Implementing human-in-the-loop integration would allow seamless escalation of complex legal inquiries to land officials or legal experts, ensuring users receive

reliable, case-specific guidance. Additionally, optimizing the chatbot's UI/UX design would improve usability for individuals with limited digital literacy, while multilingual support would increase accessibility for Indonesia's linguistically diverse population. Beyond technological enhancements, policymakers play a crucial role in facilitating AI adoption in land certification programs. To ensure equitable access, policymakers should prioritize chatbot deployment in rural and remote areas by integrating it into community service centers, village administration offices, and mobile service initiatives. Additionally, government agencies must establish regulatory frameworks to ensure that AI-driven solutions comply with land administration laws, data protection policies, and public service standards. Collaboration with public and private sector stakeholders is essential to secure funding, technical support, and infrastructure development for widespread chatbot adoption.

Future research should focus on implementing and rigorously evaluating these improvements. This includes assessing the impact of chatbot integration with government systems, evaluating multilingual support effectiveness, and analyzing the long-term sustainability of AI-driven land administration solutions. By addressing these aspects, chatbot technology can become a cornerstone of Indonesia's digital transformation in land certification, making the process more efficient, transparent, and accessible for all citizens.

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