

Mapping the Evolution of AI Chatbots in Indonesia (2021-2025): A PRISMA-Based Systematic Literature Review on Applications, Technologies, and Impacts

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Abstract – The rapid development of artificial intelligence has accelerated the adoption of chatbots in organizations in Indonesia. But there is no systematic synthesis of the development of this technology in Indonesian context. This research provides a systematic review of the development and implementation of AI chatbots in Indonesia in 2021–2025, with the aim of filling the research gap related to sectoral applications, technological trajectories, and contextual challenges. A systematic literature review was conducted following the PRISMA 2020 guidelines on the Scopus, Google Scholar and arXiv databases to collect 257 initial records. After duplicate removal and a multi-step screening process, 16 high-quality studies were included in the final synthesis. Thematic analysis identified four main findings: (1) AI Chatbots are found in higher education, healthcare, banking, public services, fintech, e-commerce, and SMEs; (2) The technology has evolved from rule-based approaches (AIML, TF-IDF) to machine learning (Seq2Seq LSTM, Rasa+IndoBERT) and the latest large language model integration (GPT-3.5, Vertex AI); (3) Reported impacts include improved user satisfaction (SUS scores 80.1), operational efficiency, and 24/7 service availability; and (4) Existing challenges include accuracy in Indonesian language processing, complexities in system integration, data privacy issues, and varied levels of digital literacy. This review is the first systematic mapping of Indonesia's AI chatbot landscape and makes evidence-based recommendations for the development of locally-adapted, culturally-sensitive

models. Results show that future chatbot development should emphasize Indonesian language datasets and hybrid architectures that combine automation and human oversight.

Keywords: AI chatbot; PRISMA 2020; digital services; conversational technology; digital transformation; Indonesia

I. INTRODUCTION

The advancements in artificial intelligence (AI) technology have brought significant changes in how organizations communicate and engage users and customers. One rapidly growing application of AI is chatbots or conversational agents, software systems that are designed to simulate human dialogues through text or voice (Setiawan et al, 2023). Worldwide, there is an increasing adoption of chatbots in the healthcare, education, banking, e-commerce, and public service sectors to improve operational efficiency, lower costs, and provide 24/7 service to users (Widjaja and Legowo, 2024). Sundjaja et al (2025) explain that chatbot disclosure can enhance the quality of chatbots.

ChatGPT started gaining adoption in Indonesia in 2021 due to the Covid-19 pandemic alongside the government pushing for the digitalization of public and business services, which subsequently led to a rapid digital transformation (Fadhlurohman et al., 2023). Customer experience, engagement, and loyalty are considered vital for the success and sustainability of a business (Felix & Rembulan, 2023). Various organizations such as universities, hospitals, banks, government agencies, and micro,

small, and medium enterprises (MSMEs) have started implementing chatbots to enhance service quality and operational efficiency (Nailussa'ada et al., 2025). The implementation of chatbots in Indonesia was also facilitated by the high penetration of smartphones and instant messaging applications like WhatsApp and Telegram, which made the integration of chatbots with messaging platforms readily available to the people of Indonesia (Assegaf et al., 2024).

Despite growing practical adoption, the academic literature lacks systematic synthesis of AI chatbot development in Indonesia. Previous reviews have focused either on specific sectors (e.g., banking, education) or analyzed the chatbots in the broader Southeast Asian context, without Indonesia-specific analysis. There are three big holes that are not filled. First, there is no systematic and comprehensive research mapping the development of AI chatbots in various sectors in Indonesia during the critical period of 2021-2025, especially on the application contexts, technological architectures, and reported outcomes. Second, some Indonesia-specific challenges like the linguistic complexity of Bahasa Indonesia with its regional variations, the relative scarcity of locally relevant training datasets, data privacy regulatory frameworks, and the heterogeneous digital literacy of archipelagic populations, remain underexplored in synthesized form (Khadija & Nurharjadm, 2022). Third, although some studies have investigated the implementation of individual chatbots, there has not been a systematic review that synthesizes the evidence to identify patterns, contradictions, or opportunities to develop chatbots that are culturally and linguistically aligned to the Indonesian context.

Filling the gaps is important from theoretical and practical view. Theoretically, this review contributes to our understanding of the adaptation of conversational AI technologies in linguistically diverse developing economy contexts, other than the Western-centric literature that dominates chatbot research. In practice, evidence synthesis across sectors can help to identify cross-cutting success factors and barriers, which can inform future implementation strategies for Indonesian organizations.

Thus, the purpose of this study is to conduct a systematic literature review (SLR) following the PRISMA 2020 method to comprehensively examine the use of AI chatbots in Indonesia from 2021 to 2025. The study is expected to provide the following benefits: (1) a systematic framework of context, objectives, and technologies used in AI chatbots in Indonesia; (2) the identification of impacts, challenges, and opportunities of developing AI Chatbots specific to Indonesia; and

(3) suggestions for developing chatbots closer to users' needs.

This study focuses on the two main research questions (RQ) below:

RQ1: What is the trend of the utilization of AI chatbot in Indonesia during the period of 2021-2025 in terms of context of application, purpose of use, and type of technology/features used?

RQ2: What are the key impacts, challenges, and opportunities reported regarding the utilization of AI chatbot in Indonesia for the users and the organizations during the period of 2021-2025?

II. METHODS

This research is based on the systematic literature review (SLR) method based on the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines in order to ensure the transparency, replicability and the quality of the review (Page et al., 2021). PRISMA 2020 is chosen here as it is recognized to be the international standard for undertaking systematic literature review.

2.1 Literature Search Strategy

The literature search was conducted in December 2025 across three academic databases: Scopus, Google Scholar, and arXiv. Scopus was selected as a major curated database indexing high-quality peer-reviewed literature; Google Scholar was included for its comprehensive coverage of Indonesian local journals and conference proceedings; arXiv was included to capture emerging research in AI and computational linguistics not yet published in traditional venues. Initially, major databases including Web of Science, IEEE Xplore and ACM Digital Library were considered. However, preliminary searches returned few Indonesia-specific results as per the regional focus of this review.

The search strategy was a combination of keywords related to chatbot technology and Indonesian context: ("AI chatbot" OR "conversational agent" OR "virtual assistant" OR "chatbot" OR "conversational AI" OR "dialogue system") AND "Indonesia" AND (service OR customer OR education OR health OR healthcare OR banking OR "public service" OR government OR "e-commerce" OR fintech OR UMKM OR SME).

Search strings were adapted to the syntax of each platform. The search was limited to publications from 2021-2025 to ensure the time relevance of the publications and there was no language restriction to include both Indonesian and English publications.

2.2 Inclusion and Exclusion Criteria

The identified articles are then screened based on the predefined inclusion and exclusion criteria. Inclusion criteria are as follows: (1) peer-reviewed articles as scientific journals or conference proceedings; (2) published within 2021–2025; (3) focus on the topic of AI chatbots, conversational agent, or virtual assistant; (4) has a context or focus on Indonesia as case studies, research subjects, or Indonesia as a focal point of the analysis; and (5) has the full text or has sufficient metadata for analysis.

Exclusion criteria are as follows: (1) articles that discuss AI in general without a specific focus on chatbot; (2) irrelevant to the context of Indonesia; (3) non-scientific articles (e.g. editorial, opinion piece, or book review); (4) duplicate articles or same version of a publication that has already been identified; and (5) articles without full text access or lacking sufficient information for analysis.

2.3 Study Selection Process

The selection process followed PRISMA 2020 four-phase flow (identification, screening, eligibility, inclusion). Two reviewers independently screened titles and abstracts against inclusion criteria, with disagreements resolved through discussion or third reviewer consultation. Inter-reviewer agreement was assessed with Cohen's kappa ($\kappa = 0.84$) indicating strong agreement.

The first search in the identification phase yielded 257 records from databases: Scopus ($n=78$), Google Scholar ($n=142$), arXiv ($n=37$). Duplicates ($n=155$) were removed and 102 unique records were then screened on title and abstract ($n=68$ records not meeting inclusion criteria). The remaining 34 full-text articles were assessed for eligibility, and 18 were excluded for reasons outlined in the PRISMA flow diagram. The reasons were as follows: no specific focus on chatbots ($n=7$), lack of Indonesian context ($n=5$), non-peer reviewed source ($n=3$), duplicate content ($n=2$), and insufficient methodological quality ($n=1$). The final corpus comprised 16 articles meeting all criteria.

Quality assessment of included studies was conducted using adapted Critical Appraisal Skills Programme (CASP) checklists relevant to the methodology of each study. Each study was assessed using 10 criteria (score 0-2) and the total scores were classified as high quality (16-20), moderate quality (11-15) and low quality (0-10). All 16 studies scored moderate to high; no studies were excluded from the synthesis based on quality assessment to ensure full coverage, but quality ratings informed interpretation of the synthesis.

The complete study selection process is illustrated in the PRISMA 2020 flow diagram

(Figure 1), which documents the number of records identified, screened, assessed for eligibility, and included in the final synthesis, following the standardized reporting guidelines proposed by Page et al. (2021).

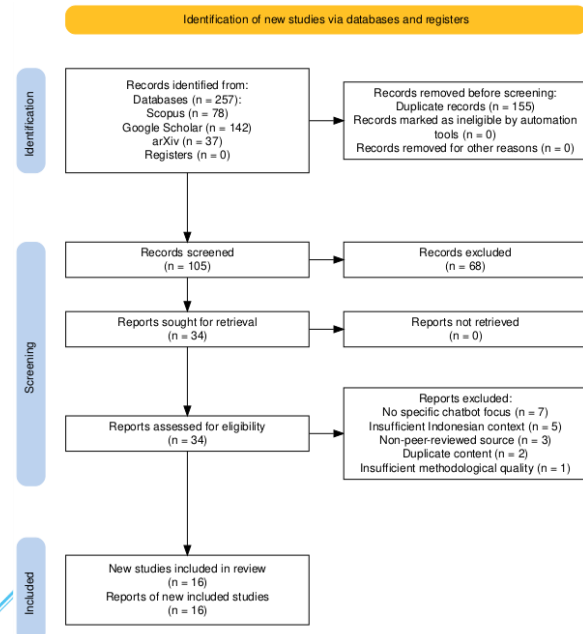


Figure 1. PRISMA 2020 Flow Diagram of Study Selection Process

2.4 Data Extraction and Analysis

Data from the 16 selected articles were extracted systematically using a standardized form that captures the following information: author(s) and year, title, publication source, sector/context, purpose of the chatbot, technologies/features, research methodology, key findings on impact/effectiveness, reported challenges and recommendations/opportunities.

Data analysis was conducted using thematic synthesis, following Braun and Clarke's (2006) six-phase framework: (1) familiarization with extracted data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; (6) producing the report. Themes were classified into research question categories: application contexts, purposes, technologies, impacts, challenges, and opportunities. Validity was strengthened by triangulation of findings across studies and support through direct quotations and evidence.

III. RESULTS AND DISCUSSION

3.1 Overview of Selected Studies

A total of 16 scientific articles were identified and analysed through systematic selection following the PRISMA 2020 guidelines (Page et al., 2021) as depicted in Figure 1. Table 1 gives a

comprehensive review of these studies, summarizing their main characteristics such as authorship, publication year, sector, methodology and main technologies used.

Table 1. Summary Characteristics of Included Studies (n=16)

Characteristic	Category	n	%
Publication Year	2022	5	31.3
	2023	3	18.8
	2024	5	31.3
	2025	3	18.8
Publication Type	Journal Article	11	68.8
	Conference Proceeding	5	31.2
Sector/Application Context	Healthcare	4	25.0
	Higher Education	3	18.8
	Banking/Finance	3	18.8
	Public Services	3	18.8
	Library Services	1	6.2
	Private Sector	1	6.2
	Fintech	1	6.2
Research Methodology	System Development/Tech nical Evaluation	7	43.8
	Implementation Case Study	8	50.0
	User Satisfaction/Accept ance Study	5	31.3

The distribution over time shows a concentration of articles published in 2022 and 2024 (5 articles, 62.6% of the corpus), implying an increasing research interest in AI chatbots during these periods. From a methodological standpoint, the corpus displays a balanced representation of implementation case studies (50%) and papers on technical development (43.8%), which demonstrates the multi-dimensionality of the chatbot research, that is, both technical innovation and organizational implementation. Technical assessments were often supplemented with user satisfaction studies (31.3%) for a more holistic assessment.

3.2 Context of AI Chatbot Application in Indonesia

The analysis of 16 studies shows the different sectoral applications of AI chatbot technology in Indonesia. Healthcare applications are the largest group (n=4, 25%) as shown in Table 1, followed by higher education (n=3, 18.8%), banking/finance (n=3, 18.8%), and public services (n=3, 18.8%). The distribution reflects a strategic focus on sectors where automated conversational interfaces can address critical service delivery challenges, such as healthcare information access in underserved regions (Setiawan et al., 2023) and administrative

service efficiency within government agencies (Nailussa'ada et al., 2025). Innovative applications like mental health chatbots address social stigma by offering anonymous and accessible platforms embedded within popular messaging services (Assegaf et al., 2024; Arief et al., 2025).

3.3 Objectives of Using AI Chatbots

The four main categories that emerge across industries are: (1) customer service and FAQ automation; (2) consultation and clinical support; (3) public information dissemination; and (4) educational support. The majority of applications in higher education are related to FAQ automation and administrative support (Amrullah et al., 2022; Hikmah et al., 2022), while in healthcare they are mainly focused on consultation and information provision (Setiawan et al., 2023; Assegaf et al., 2024). Chatbots in the public sector are mainly used for disseminating information and improving transactional efficiency (Fadhluhman et al., 2023; Fauzi & Sutabri, 2025). These objective patterns are consistent with international chatbot implementation trends, but are also tailored to Indonesia-specific needs, especially to address the geographical accessibility challenges across the archipelago.

3.4 Technological Evolution

Table 2 synthesizes the technological progression observed across the 2021-2025 period, illustrating the evolution from simple rule-based systems toward sophisticated large language model integration.

Table 2. Technological Evolution of AI Chatbots in Indonesia (2021-2025)

Period	Technology Generation	Representative Technologies	Key Characteristics	Example Studies
2021 - 2022	Rule-based Systems	AIML, TF-IDF, Cosine Similarity	Pre-defined conversation scripts; keyword matching; high accuracy within narrow domains	Amrullah et al. (2022); Hikmah et al. (2022)
2022 - 2023	Machine Learning & Deep Learning	Seq2Seq LSTM, Bi-LSTM	Generative response capabilities; improved contextual understanding; requires substantial training data	Khadija & Nurharjamo (2022); Arief et al. (2025)
2023 - 2024	NLP Frameworks & Transformer Models	Rasa, Dialogflow, IndoBERT, DIET architecture	Intent classification (F1 up to 0.93); Indonesian language optimization; rapid deployment capabilities	Fadhluhman et al. (2023); Nailussa'ada et al. (2025)
2024 - 2025	Large Language	GPT-3.5 Turbo,	Natural, contextual	Assegaf et al. (2024);

e Model Integrati on	Vertex AI, Dual-AI architectur es	conversations; integration with popular platforms (WhatsApp); enhanced safety mechanisms for sensitive domains	Arief et al. (2025)
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This technological path reflects Indonesia's alignment with global AI progress, as well as local adaptations. The adoption of IndoBERT (Fadhluhman et al., 2023) is a significant progress in handling the complexity of Bahasa Indonesia language. The F1-scores of 0.93 for intent classification. Recent developments in large language models (Assegaf et al., 2024) and dual-AI structures that combine emotion classification with generative models (Arief et al., 2025) indicate a future of more sophisticated, context-aware systems.

3.5 Impacts of AI Chatbot Implementation

The implementation of AI chatbots provides the positive impact on both user and organizational level in Indonesia sectors. At the user level, the satisfaction increases are always reported. Studies have reported positive User Acceptance Test results and also high satisfaction scores due to the fast response times and easy access to information (Amrullah et al., 2022; Nailussa'ada et al., 2025). Service availability is a lot better, especially with 24/7 availability that breaks down geographical and time barriers. Setiawan et al. (2023) noted a System Usability Scale score of 80.1 for their public health chatbot, while Assegaf et al. (2024) showed that WhatsApp-based mental health chatbots offer emotional support without geographical boundaries, filling the accessibility gaps in underserved regions.

Chatbots also have good performance metrics. Info quality has also gotten better. Setiawan et al. (2023) obtained an accuracy of 93.1% for answering health questions, and Fadhluhman et al. (2023) obtained an F1 score of 0.93 for intent classification in the JAKI public service chatbot, showing the ability to understand and respond to user questions accurately. Similarly, Nailussa'ada et al. (2025) mentioned 92% comprehension accuracy in administrative services at the kelurahan level. Mental health applications have shown unique social impact by providing anonymous support avenues that reduce stigma-related obstacles to seeking help (Assegaf et al., 2024; Arief et al., 2025).

Widely reported are gains in operational efficiency at the firm level. Chatbots address routine queries, reducing administrative staff workload and allowing them to focus on higher-value tasks (Amrullah et al., 2022; Maskur et al., 2022). There are cost savings across sectors, as

Ridha and Maharani (2022) noted the potential for operational cost reduction in fintech customer service and Almustaqim and Toscani (2022) reported cost efficiency in private sector implementations. Scalability of the service has improved significantly as chatbots can handle multiple conversations simultaneously without a loss of quality. The JAKI chatbot can handle high volume inquiries by Jakarta residents (Fadhluhman et al., 2023), and kelurahan chatbots can serve multiple citizens at the same time with zero wait time (Nailussa'ada et al., 2025). Customer satisfaction in the banking industry has improved with the optimal application of AI in service delivery (Mulyono & Sfenrianto, 2022; Widjaja & Legowo, 2024).

3.6 Challenges in AI Chatbot Implementation

Positive impacts of AI chatbots in Indonesia are accompanied by some technical and non-technical challenges in its implementation. From a technical standpoint, processing of Bahasa Indonesia remains problematic, due to linguistic complexity, including regional variation, abbreviations, and slang, which reduces accuracy when not present in training data (Hikmah et al., 2022). Although models such as IndoBERT based on transformers reach F1-scores of 0.93 (Fadhluhman et al., 2023) continuous optimization is required. This problem is compounded by limited local datasets; most implementations rely on translated or foreign-language corpora that fail to capture Indonesian cultural and linguistic nuances (Khadija & Nurharjadmo, 2022; Arief et al., 2025). Another barrier is system integration, particularly in banking and public services, where the existing legacy infrastructure requires a lot of customization (Mulyono & Sfenrianto, 2022; Purwaningwulan & Christina, 2024).

Non-technical challenges are equally important. Trust is an important factor for user adoption in sensitive domains such as healthcare and finance, and it depends on information quality and transparency (Mulyono & Sfenrianto, 2022; Widjaja & Legowo, 2024). Data privacy also becomes an issue in adopting cloud-based LLMs to comply with Indonesia's personal data protection regulations (Assegaf et al., 2024). The chatbots' usability scores are high but the effectiveness of chatbots varies greatly among users due to their digital literacy (Setiawan et al., 2023; Nailussa'ada et al., 2025). Finally, social stigma, especially around mental health, affects acceptance and requires well-defined pathways to human help for complex cases (Arief et al., 2025).

3.7 Opportunities for Future Development

The literature review suggests a lot of potential for AI chatbots to be improved in Indonesia. Most

importantly is to develop locally-adapted models with Indonesian language and cultural context. IndoBERT's success in state-of-the-art intent classification (Fadhlurohman et al., 2023) shows potential for expansion to cover regional variations and informal communication styles, thus reducing dependence on translated datasets (Arief et al., 2025).

Combining different AI technologies in hybrid architectures could help to improve response safety, especially in sensitive areas. Dual-AI strategies merging emotion classifiers and LLMs (Arief et al., 2025) offer a way to balance conversational naturalness with domain-specific reliability for healthcare, finance, and government services.

The public service scalability is a significant opportunity in the successful implementation of JAKI and kelurahan (Fadhlurohman et al., 2023; Nailussa'ada et al., 2025). The expansion to other government institutions can create integrated digital government ecosystems (Fauzi & Sutabri, 2025). The MSME sector is still underdeveloped but has a lot of potential because of its dominance in the economy. Cheap, customisable chatbot solutions could bring productivity gains across Indonesia's business landscape.

Technology integration with voice interfaces can also help overcome digital literacy barriers (Setiawan et al., 2023) while augmented reality integration can offer innovative service delivery models. Research opportunities include longitudinal effectiveness studies (Setiawan et al., 2023), cross-demographic acceptance analyses (Arief et al., 2025), and holistic evaluation frameworks that assess social and economic impacts beyond technical metrics.

IV. CONCLUSION

This systematic literature review collected data from 16 studies in various sectors on the development and implementation of AI chatbots in Indonesia from 2021-2025. The results show that AI chatbots are used in healthcare, education, banking, public services, fintech, e-commerce, and SMEs for four key reasons: customer service/FAQ automation, consultation support, dissemination of public information, and educational support.

Development of chatbots in Indonesia has evolved from rule-based (AIML, TF-IDF) to machine learning (Seq2Seq LSTM), NLP frameworks (Rasa+IndoBERT), and recently the integration of large language models (GPT-3.5, Vertex AI). This path is a reflection of global technological progress, including local adaptations such as Indonesian language models such as IndoBERT. The reported impacts include improved user satisfaction, improved service accessibility,

operational efficiencies, and cost savings for organizations. But there are still major challenges like accuracy in linguistic processing, limitations of local datasets, complexities of system integration, user trust issues, data privacy requirements and variable digital literacy across Indonesia's diverse population.

4.1 Research Implications

This study implies four key contributions to research and practice:

First, theoretically, this review contributes to conversational AI literature by providing a record of technology adaptation patterns in the context of a linguistically-diverse, developing economy. Findings challenge the notion of seamless transfer of chatbot technologies developed in the West and highlight the vital adaptation needs for linguistic complexity of Bahasa Indonesia and socio-cultural diversity of Indonesia.

Secondly, methodologically, the study shows the utility of systematic synthesis for finding cross-sectoral patterns not apparent in individual implementation studies. The thematic framework developed here (contexts, technologies, impacts, challenges, and opportunities) provides a structured approach for future reviews in similar contexts.

Third, practically, the evidence synthesis offers empirically-grounded guidance for the implementation of chatbots to Indonesian organizations. Key factors documented for implementation include the importance of optimizing local languages, hybrid architectures for sensitive domains, and considerations around user digital literacy. Public sector agencies need to leverage Jakarta and Surabaya's proven success to scale chatbot services nationally.

Fourth, for policymakers, the findings point to the need for investments in Indonesian language datasets, digital literacy programs, and clear regulatory frameworks for AI-enabled public services. Mental health chatbot applications demonstrate potential to meet sensitive social needs with opportunities for public health integration.

4.2 Limitations and Future Research

The present review has some limitations. First, although the database selection was comprehensive for Indonesia-focused research, it may have excluded relevant studies indexed only in regional Indonesian databases that were not covered. Secondly, the time period 2021-2025, although ensuring up-to-dateness, may miss earlier studies that provide the basis for the present advances. Third, the omission of non-peer-reviewed grey literature may mean that we do not capture implementation insights from industry practice.

Future research should tackle these limitations by broadening the database coverage, incorporating

Indonesian-language local journals, and carrying out supplementary primary research to explore chatbot effectiveness via user studies and longitudinal designs. Acceptance studies across demographics would reveal barriers to adoption across the many different segments of Indonesia's population. Finally, a study on regulatory compliance and ethical frameworks for AI chatbots in the Indonesian context is still urgently needed as technology adoption speeds up.

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