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The Implementation and Impact of AI Chatbots in Academic Library Services

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Abstract

This study explores how Artificial Intelligence (AI) chatbots are being used to improve academic library services in African universities. Using a systematic review of 42 peer-reviewed studies published between 2019 and 2024, together with regional policy reports, the paper examines both how chatbots are currently applied and the broader issues that shape their adoption. Five major chatbot platforms, ChatGPT, Gemini, Rasa, Claude, and Copilot, were compared using a context-aware evaluation model that considered cost, data privacy, language support, and infrastructure needs. The results show that while generative AI tools offer strong multilingual and conversational abilities, Rasa stands out as the most affordable, secure, and practical option for many African institutions facing bandwidth limitations and budget constraints. Building on these insights, the paper proposes a Hybrid AI Chatbot Framework that combines Rasa's open-source NLU capabilities with secure generative AI extensions for handling more complex queries. This approach enhances data privacy, lowers operational costs, and supports bilingual English–Swahili interaction. It is also designed to align with key policies such as Tanzania's Personal Data Protection Act (2022), the African Union Data Policy Framework (2022), and UNESCO's AI Ethics Recommendation (2021). Although AI chatbots have the potential to expand access, improve responsiveness, and enhance user satisfaction, their adoption is still challenged by infrastructure gaps, policy inconsistencies, and ethical concerns such as bias and informed consent. The paper concludes with a practical roadmap and governance guidelines to support responsible, secure, and scalable chatbot deployment in African academic libraries.

Keywords: Artificial Intelligence; Chatbots; Academic Libraries; Africa; Data Protection; Generative AI; Rasa; Hybrid Model; ICT Policy

1. Introduction

Artificial Intelligence (AI) is becoming a core driver of digital transformation in the education sector, reshaping how universities deliver learning support, manage resources, and communicate with their communities. Academic libraries, central hubs in university knowledge systems, are increasingly turning to AI tools such as chatbots to improve service accessibility, reduce routine workloads, and offer more

personalized assistance to users.

Across Africa, however, the pace of AI adoption in libraries varies widely due to persistent infrastructural, financial, and skills-related constraints (Abayomi et al., 2021; Molaudzi & Ngulube, 2024). A 2023 Tanzania Education Network report, for example, found that more than 70% of students struggle to access library services beyond official working hours. This gap highlights the growing need for digital solutions that can extend library support beyond traditional boundaries.

AI-powered chatbots, driven by Natural Language Processing (NLP) and Machine Learning (ML), offer scalable and innovative ways to transform library services (Winkler & Kiszl, 2021). Yet despite their promise, there remains limited systematic guidance on how African academic libraries can deploy these tools ethically, cost-effectively, and in ways that are sensitive to local contexts.

This study seeks to bridge this gap by conducting a comprehensive review and proposing a practical framework for AI chatbot adoption in African academic libraries. The specific objectives are to:

- i. Examine the current state of AI chatbot implementation across academic library services in Africa.
- ii. Compare major chatbot platforms - ChatGPT, Gemini, Rasa, Claude, and Copilot, in terms of their suitability for African institutional contexts.
- iii. Develop a hybrid AI chatbot framework that reflects local policy requirements, infrastructural conditions, and the continent's rich linguistic diversity.

2. Methodology

The study adopted a systematic literature review (SLR) combined with a comparative analysis approach. Relevant publications were retrieved from Google Scholar, Scopus, and Web of Science using Boolean search strings such as: ("AI chatbot*" OR "virtual assistant") AND ("academic library*" OR "university library*") AND ("Africa" OR "Tanzania" OR "Global South").

From an initial pool of 128 publications, 42 studies met the inclusion criteria: peer-reviewed works published between 2019 and 2024 that focused on AI chatbot applications, ethical considerations, or library-specific use cases. Studies lacking educational relevance or contextual grounding were excluded. A PRISMA-style screening and thematic synthesis revealed four dominant themes; accessibility, infrastructure, ethics, and sustainability.

For the comparative component, the study applied a rating-based SWOT matrix to assess the performance of major chatbot tools in key areas such as cost, data privacy, support for Swahili and other local languages, and compatibility with typical African ICT infrastructure.

3. Literature Review

Existing research shows a clear global shift toward using AI technologies to enhance academic library services. In many universities around the world, chatbots are helping libraries respond more quickly to user inquiries, offer round-the-clock support, and improve overall service efficiency. Studies consistently report that these tools reduce routine workloads for librarians, allowing them to focus more on specialized tasks such as research support and information literacy training (Kaushal & Yadav, 2022).

In the Global South, similar benefits are emerging, but with a stronger emphasis on practicality and affordability. Research from India and Brazil, for instance, highlights the importance of low-cost and bandwidth-friendly chatbot systems, solutions designed to work even in environments where internet connectivity is unreliable or institutional budgets are limited (Kumar & Singh, 2022; Silva et al., 2023). These

experiences show that effective AI adoption in developing regions requires technologies that adapt to the realities of local infrastructure.

Within Africa, interest in AI chatbots is growing steadily. Recent studies report early success in improving access, user engagement, and the general visibility of library services (Zondi et al., 2024; Bakiri et al., 2023). However, the literature also makes it clear that African institutions still face notable challenges, including inconsistent internet access, staff shortages in technical skills, concerns over data security, and limited policy guidance to support responsible AI use. These constraints often lead to slower adoption and highlight the need for approaches that balance innovation with feasibility.

Altogether, the literature suggests that while AI chatbots hold great promise for transforming academic libraries in Africa, their success depends on systems that are affordable, privacy-conscious, multilingual, and aligned with local regulatory and infrastructural conditions. Developing solutions that reflect these realities is essential for ensuring equitable, ethical, and sustainable AI adoption across the continent’s higher learning institutions.

4. Comparative Review of Chatbot Tools

Five chatbot platforms were assessed using a 1–5 rating scale across four key criteria: cost, data privacy, language support, and adaptability to existing infrastructure. On this scale, 1 represents poor performance and 5 indicates excellent performance.

Table 1: Comparative Review of Chatbot Tools

Tool	Type	Cost	Privacy	Language Support	Infrastructure Suitability
ChatGPT	Generative AI	2	3	4	3
Gemini	Multimodal AI	3	3	4	2
Rasa	Open-source NLU	5	5	3	5
Claude	Constitutional AI	3	4	3	3
Copilot	Enterprise LLM	2	5	2	4

4.1. Cost

Rasa (5) stands out as the most cost-effective option because it is fully open-source and does not require licensing fees; expenses are mainly tied to hosting and initial technical setup. Gemini (3) and Claude (3) fall in the mid-range, offering reasonable affordability but still carrying subscription or usage-based costs depending on the chosen tier. In contrast, ChatGPT (2) and Copilot (2) are the most expensive due to subscription plans, API pricing, and in the case of Copilot, enterprise licensing requirements.

Implication:

For academic libraries working with limited budgets, Rasa provides the most financially sustainable solution.

4.2. Privacy

Rasa (5) and Copilot (5) offer the strongest privacy protections. Rasa allows full on-premise deployment, giving institutions complete control over user data, an advantage for universities governed by strict data protection laws. Copilot also provides robust enterprise-grade security aligned with corporate compliance standards. Claude (4) performs well in this area too, benefiting from its “Constitutional AI” approach to responsible data handling. In comparison, ChatGPT (3) and Gemini (3) provide moderate privacy guarantees, but their reliance on cloud processing may raise concerns for institutions required to store or process data

locally.

Implication:

Libraries prioritizing data security, especially those aligning with regulations such as Tanzania's PDPA (2022), will find Rasa and Copilot the most suitable options.

4.3. Language Support

ChatGPT (4) and Gemini (4) scored highest for language support, offering strong performance in multilingual environments, including workable support for Swahili and other African languages. Rasa (3) and Claude (3) provide moderate flexibility; Rasa can be customized to support additional languages, but doing so requires technical expertise. Copilot (2) scored lowest because it focuses heavily on English, with limited adaptability for multilingual users.

Implication:

For institutions serving linguistically diverse student populations, ChatGPT and Gemini offer the most user-friendly and accessible interaction experiences unless custom language models are developed for Rasa.

4.4. Infrastructure Suitability

Rasa (5) is the most adaptable to African infrastructure realities, as it can run entirely offline or on-premise and functions well even in low-bandwidth conditions. Copilot (4) also integrates effectively in enterprise environments, particularly in institutions already using Microsoft systems. ChatGPT (3) and Claude (3) offer stable performance but depend on reliable internet connectivity for optimal use. Gemini (2) scored lowest, as it tends to require stronger bandwidth and may not perform consistently in environments with limited connectivity.

Implication:

For libraries with unstable internet access or limited ICT infrastructure, Rasa provides the most reliable and resilient deployment option.

The evaluation of the five chatbot platforms revealed notable differences across cost, privacy, language support, and infrastructure suitability. Rasa consistently emerged as the strongest option for African academic libraries, primarily due to its open-source nature, which eliminates licensing fees and allows institutions to host the system locally. This not only makes it highly cost-effective but also offers the highest level of data privacy and control, aligning well with regulatory frameworks such as Tanzania's PDPA (2022).

In terms of language support, ChatGPT and Gemini outperformed the other tools by providing strong multilingual capabilities, including better support for Swahili, although their reliance on subscription models and cloud processing makes them costlier and less privacy-friendly.

Claude demonstrated balanced performance, especially in responsible data handling, while Copilot excelled in enterprise-grade security and integration within Microsoft-based environments, though both tools showed limitations in language adaptability.

Infrastructure suitability further strengthened Rasa's position as the most context-appropriate solution, as it can operate on-premise and remains functional under low-bandwidth conditions, an essential requirement for many African institutions. Overall, the results indicate that while generative AI tools such as ChatGPT and Gemini offer superior conversational quality, Rasa provides the most practical, secure, and

sustainable foundation for academic library chatbot deployment in resource-constrained settings.

5. Conceptual Framework: Hybrid AI Chatbot for African Academic Libraries

The proposed hybrid model integrates Rasa’s open-source NLU engine with a secure connection to a generative AI service such as ChatGPT for complex queries. This design enables local control of data (ensuring compliance with data protection laws) while leveraging advanced reasoning from generative AI. The system processes routine queries internally and routes complex or research-oriented ones externally via anonymized APIs.

Key components include:

- i. Knowledge Repository: Digitized FAQs, catalogs, and institutional repositories.
- ii. Language Corpus: Bilingual (English-Swahili) datasets, carefully curated to minimize algorithmic and linguistic bias.
- iii. Ethical Safeguards: User consent, encryption, and audit trails.
- iv. Performance Monitoring: Feedback loops and satisfaction tracking.

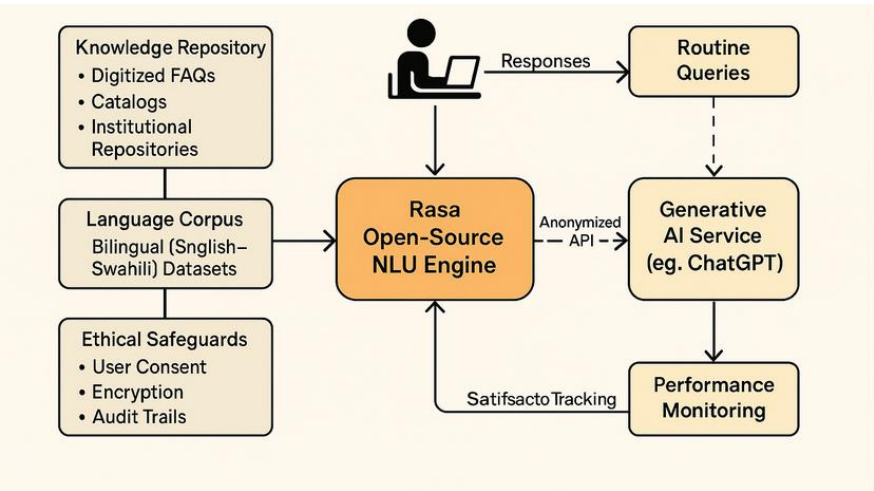


Figure 1: Conceptual Framework: Hybrid AI Chatbot for African Academic Libraries

Figure 1 presents a clear picture of how the proposed hybrid chatbot system works. At the center is the Rasa open-source NLU engine, which acts as the main brain of the system. When a user sends a question, Rasa first tries to handle it using information stored locally within the library.

On the left side of the diagram are the three major inputs that support Rasa’s decision-making. The Knowledge Repository contains digitized FAQs, library catalogs, and institutional documents that help answer common inquiries. Below it, the Language Corpus provides bilingual English–Swahili datasets to ensure the chatbot understands and responds better in local languages. The Ethical Safeguards box highlights essential protections such as user consent, data encryption, and audit trails, showing that privacy and responsible use are part of the system’s foundation.

If the user’s question is more complex, such as a research-related query, the system routes it securely to a Generative AI service (like ChatGPT) through an anonymized API. This ensures that sensitive user information remains protected while still benefiting from advanced reasoning and deeper responses. The generated answer is then sent back to the user.

At the bottom right, the Performance Monitoring component collects feedback and tracks user satisfaction, helping the library continuously improve the chatbot over time.

Overall, the diagram shows a balanced system where routine queries are handled locally for speed, privacy, and compliance, while more complex tasks are escalated to generative AI. This hybrid setup is designed to meet the unique needs, policies, and infrastructure realities of African academic libraries.

6. Implementation and Governance Roadmap

Table 2: Implementation and Governance Roadmap for the Hybrid AI Chatbot

Phase	Description	Key Actions
Phase 1: Governance Setup	Establish oversight structures to guide ethical and responsible AI use.	Form AI governance & ethics committees
Align institutional policies with national and international AI regulations		
Phase 2: Data Preparation	Build a strong, locally relevant dataset for chatbot training.	Curate institutional FAQs, catalogs, repository content
Develop and refine English–Swahili language datasets		
Phase 3: Prototype Deployment	Implement and test a foundational Rasa-based chatbot.	Deploy Rasa NLU engine
Conduct pilot tests with library users		
Improve accuracy using user feedback		
Phase 4: Secure AI Integration	Connect the system to generative AI tools via secure, anonymized APIs under strict privacy controls.	Integrate anonymized API connections (e.g., to ChatGPT)
Implement secure gateways and encryption protocols		
Phase 5: Evaluation & Scaling	Strengthen capacity and expand system use across institutions.	Conduct performance evaluations
Provide continuous staff training		
Scale through inter-institutional collaboration		

Table 2 outlines a five-phase roadmap for implementing a hybrid AI chatbot in African academic libraries. It begins with establishing AI governance and ethics committees, followed by preparing local datasets, including English–Swahili resources. A Rasa-based prototype is then developed and tested before integrating secure generative AI connections through anonymized APIs. The final phase focuses on evaluation, staff training, and scaling through collaboration across institutions. A supporting governance section aligns the roadmap with key policies such as Tanzania’s PDPA (2022), the African Union Data Policy Framework (2022), and UNESCO’s AI Ethics Recommendation (2021), ensuring ethical and compliant deployment.

7. Ethical and Policy Alignment

Ensuring ethical use of AI in libraries means finding the right balance between leveraging new technologies and maintaining strong accountability. Libraries must commit to transparency, obtain clear user consent, and ensure fairness in how AI systems make decisions. Adhering to the Personal Data Protection Act (2022) is essential for protecting user information, while aligning with broader frameworks such as the EU’s GDPR

and UNESCO's 2021 AI Ethics principles helps situate local practices within international standards. Equally important is building ethical literacy among both librarians and users, so they understand how the technology works and can engage with it confidently and responsibly.

However, obtaining meaningful informed consent for AI interactions remains a challenge, often reduced to a passive 'click-through' agreement. Furthermore, ensuring fairness requires continuous auditing of the chatbot's responses to prevent the reinforcement of societal biases, which is particularly important when dealing with limited or imbalanced training data for local languages

8. Conclusion

AI chatbots present a timely and practical opportunity to strengthen academic library services across Africa, especially in environments where limited staffing, bandwidth challenges, and growing student demand restrict traditional service models. This study shows that while generative AI tools such as ChatGPT and Gemini bring powerful conversational and multilingual capabilities, Rasa provides the most realistic foundation for African institutions due to its low cost, strong privacy controls, and ability to function reliably in low-resource settings.

The proposed Hybrid AI Chatbot Framework demonstrates how combining Rasa with secure generative AI extensions can deliver a balanced, context-appropriate solution, one that respects data protection laws, supports linguistic diversity, and enhances both accessibility and service efficiency. However, realizing these benefits requires more than technology alone. Sustainable adoption depends on clear governance structures, ethical safeguards, continuous staff capacity building, and alignment with national and international policy frameworks, including Tanzania's PDPA (2022), the African Union's data governance guidelines, and UNESCO's AI ethics principles.

Ultimately, AI chatbots should be seen not as replacements for librarians but as supportive tools that extend service hours, reduce repetitive work, and create more equitable access to knowledge. By investing in hybrid AI systems, regional collaborations, and ongoing digital literacy, African universities can position their libraries as innovative, inclusive, and future-ready hubs of learning and research.

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