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MORALITY BEFORE KNOWLEDGE

Artificial intelligence chatbot for gold-based Islamic financial education in Indonesia

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ABSTRACT

Background: Islamic financial literacy related to gold-based products in Indonesia remains relatively low, particularly in understanding sharia-compliant gold pawn (*rahn emas*), investment mechanisms, and trust in digital financial services. This gap in literacy limits community financial resilience and poses a challenge to sustainable social development. While digital platforms such as Pegadaian Digital have expanded access to Islamic financial products, limited public understanding and skepticism toward digital services continue to hinder optimal utilization within the broader social context. This study aims to evaluate the effectiveness of an AI-based chatbot, designed with a specific instructional persona to enhance user engagement, as an educational tool for gold-based Islamic finance. **Methods**: A quantitative pretest–posttest design was employed involving 30 participants who interacted with the chatbot. Learning outcomes were measured using 12 multiple-choice questions covering four aspects: understanding of gold pawn mechanisms, sharia principles, interest in gold investment, and trust in digital financial services. **Findings**: The results indicate a substantial improvement in participants' knowledge after using the chatbot. The average score increased from 52.8% in the pretest to 85.6% in the post-test. **Conclusion**: These findings suggest that AI chatbots are effective, scalable, and accessible tools for enhancing Islamic financial literacy, but also serve as a novel intersection between technological innovation and social empowerment. By bridging the literacy gap, this technology contributes to a more stable and resilient social-financial environment in Indonesia. **Novelty/Originality of this article**: The novelty of this study lies in the integration of an Agentic RAG architecture with a supportive Sharia-consultant persona, which not only ensures factual accuracy based on DSN-MUI fatwas but also addresses the socio-cognitive barriers of rural learners. The greatest improvement was observed in understanding sharia principles and digital service security, which are critical components for fostering digital trust within the community.

KEYWORDS: AI chatbot; educational technology; digital financial literacy; gold invesment; social sustainability.

1. Introduction

Indonesia, as the country with the largest Muslim population in the world, possesses extraordinary strategic potential for the development of a global Islamic financial ecosystem (Antara, 2025). Despite the rapid expansion of Indonesia's Islamic financial industry, the development of Islamic Financial Technology (iFinTech) has lagged behind, creating a significant gap in digital sharia services amidst rising market demand (Rahayu et al., 2024; Bas et al., 2025). One of the most resilient and relevant sharia-compliant financial instruments for the community is the gold-based pawn system, known as *rahn emas*. This product allows individuals to obtain short-term financing without being trapped in interest-

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based mechanisms or riba, which in the Islamic perspective is considered an unfair and exploitative practice. Although the inclusion of gold as collateral continues to rise, public understanding of the supporting contracts remains very limited. Recent reports from the financial services authority/*otoritas jasa keuangan* (OJK) indicate that the Islamic financial literacy index in Indonesia still lags significantly behind the inclusion index, suggesting that many customers utilize sharia banking products without comprehending the underlying sharia principles (*Otoritas Jasa Keuangan*, 2022). Beyond economic metrics, this literacy gap poses a significant threat to community social stability. When individuals lack a deep understanding of sharia-compliant instruments, they become more vulnerable to financial exploitation, which can destabilize the social environment and hinder long term community resilience. Indonesia's Islamic financial literacy index remains significantly below financial inclusion levels, with OJK reports showing public use of sharia products without deep understanding of underlying principles (Sumidartiny, 2025).

Financial literacy is increasingly recognized as a social determinant of economic resilience rather than just an individual skill. From a social development perspective, the gap in financial knowledge often correlates with geographic and digital divides, where rural populations are disproportionately excluded. Addressing financial literacy through accessible platforms like Telegram represents a form of social empowerment, democratizing expert level knowledge and providing a social safety net through better financial decision making. This aligns with the goals of sustainable social development by ensuring that technological advancements lead to equitable financial inclusion across all social strata.

From a pedagogical perspective, the persistence of low financial literacy in Indonesia is not merely a lack of information but a challenge of instructional delivery and cognitive accessibility. Traditional educational models often fail to account for the socio-cognitive barriers faced by adult learners, such as the high cognitive load required to decipher technical Sharia legalisms (*fiqh*). Consequently, there is an urgent need for an interdisciplinary approach that bridges the gap between financial jurisprudence, computer science, and educational psychology. By integrating Scaffolding Theory, digital interventions can provide step by step guidance that adapts to the learner's initial knowledge level, transforming complex financial concepts into digestible, conversational modules.

This public misunderstanding often centers on the cost components and the contractual structures used in pawn transactions. In its operations within Indonesia, *rahn emas* is strictly regulated through DSN-MUI (*Dewan Syariah Nasional – Majelis Ulama Indonesia/*National Sharia Council – Indonesian Ulema Council) Fatwa No. 25/DSN-MUI/III/2002 concerning *rahn* and No. 26/DSN-MUI/III/2002 regarding *rahn emas*. Juridically, these fatwas emphasize that the pawnee (*murtahin*) is prohibited from taking profit from the collateral (*marhun*). Instead, financial institutions are permitted to charge fees for storage, maintenance, and insurance through separate service contracts (*ijarah* or *Mu'nah*) as stipulated in DSN-MUI Fatwas on *rahn* and related financing (*Dewan Syariah Nasional MUI*, 2002, 2014; Ascarya, 2011). However, without proper education, these fees are often misinterpreted by the public as disguised interest, which ultimately triggers skepticism and hinders the massive adoption of digital Islamic financial services. This skepticism is a critical social dimension of financial literacy; building digital trust through transparent information is essential to ensure that digital transformation fosters a more inclusive and sustainable social environment.

In the current era of digital transformation, Artificial Intelligence (AI) offers a new paradigm in financial education methods that are more personalized and accessible. AI-based chatbots, functioning as automated conversational agents, have proven effective in increasing user engagement through real time two way interactions. It is also can increase efficiency and customer satisfaction, which in turn contributes positively to customer loyalty (Octaviyani et al., 2024). From an educational perspective, the integration of chatbots aligns with the concept of Ubiquitous Learning (u-learning), allowing financial education to transcend traditional boundaries and reach diverse social groups within the

Asian educational landscape. This instructional design empowers communities by providing continuous support and prompt query resolution (Smith & Lee, 2025), which is vital for fostering social empowerment.

The integration of Artificial Intelligence in education has shifted from simple automated systems to Intelligent Tutoring Systems (ITS) that emphasize personalized learning paths. Research by Sung et al. (2016) highlights that mobile-integrated AI tools can significantly enhance learning outcomes by providing immediate feedback and reducing the cognitive load on learners. In the context of financial education, chatbots act as pedagogical agents that facilitate just in time learning, allowing users to clarify complex concepts at their own pace, which is a departure from traditional, one-size-fits-all classroom methods.

Nonetheless, the use of conventional Large Language Models (LLMs) carries a significant risk of hallucinations, a phenomenon where the AI model generates convincing but factually inaccurate answers. In the context of Islamic finance, where the accuracy of *fiqh* (Islamic jurisprudence) interpretation is a top priority, reliance on standard LLMs without strict data control can mislead users and damage the reputation of institutions. To overcome these accuracy limitations, this study proposes the implementation of a Retrieval-Augmented Generation (RAG) architecture. RAG technology works by integrating the language model with a verified knowledge base, such as official fatwa databases and gold investment handbooks, before generating responses to the user (Lewis et al., 2020). Through the Agentic RAG mechanism, the system first retrieves relevant context from credible source documents and then synthesizes an answer based on that context. This approach ensures that every explanation provided by the chatbot is not only linguistically natural but also scientifically valid and compliant with prevailing sharia principles.

Digital trust is a critical socio-technical construct that determines the adoption of fintech services, especially in religious or conservative social contexts. As noted by Hagendorff (2020), the perceived reliability and ethical alignment of AI systems are fundamental to establishing this trust. In Islamic finance, digital trust is not only built on technical security but also on Sharia Compliance certainty. By using Retrieval-Augmented Generation (RAG) to fetch data directly from authoritative sources like DSN-MUI fatwas, AI systems can mitigate misinformation, thereby fostering a secure digital ecosystem that encourages marginalized groups to transition from traditional to digital financial platforms.

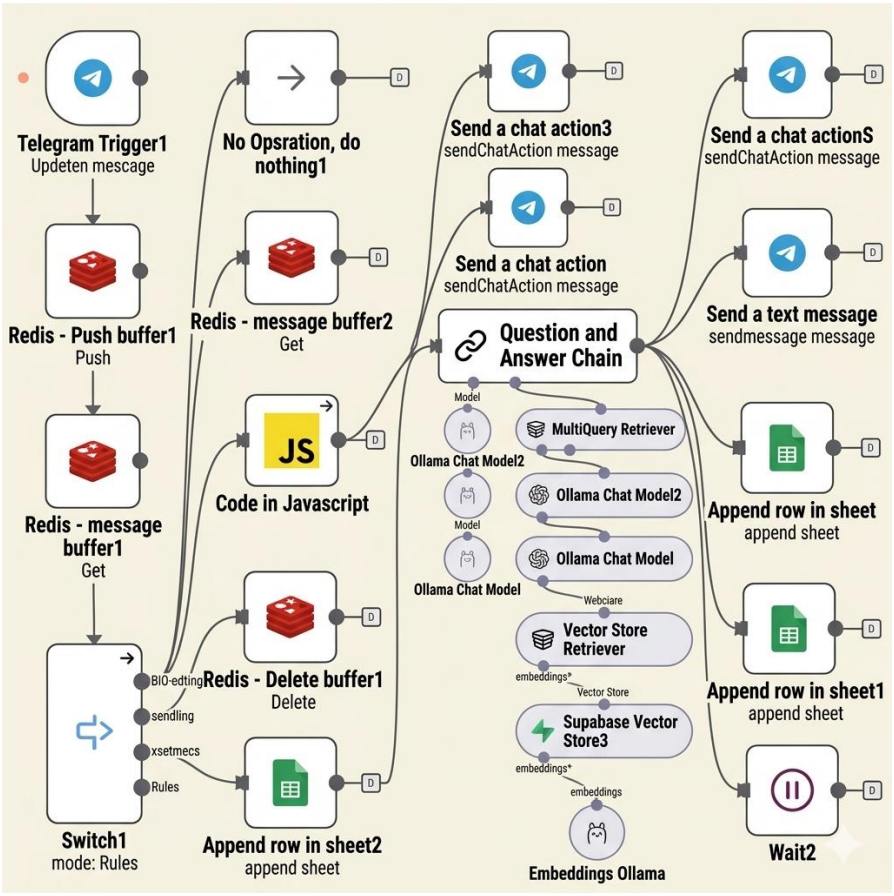
This study situates the use of AI chatbots within the broader framework of Social Constructivism, where learning is viewed as an interactive process facilitated by social tools. In the context of the digital Islamic economy, a chatbot serves as a More Knowledgeable Other (MKO) that is available 24/7, providing a non-threatening environment for marginalized groups to explore financial products. This interdisciplinary lens ensures that the technology is evaluated not only for its technical precision but for its capacity to foster socio-economic empowerment and promote long-term behavioral changes within diverse social strata.

Therefore, this study aims to evaluate the effectiveness of using a RAG-based AI chatbot as a medium for gold-based Islamic financial education in Indonesia. By utilizing the integration of n8n, Ollama, and Supabase technologies, this research seeks to address the challenge of low financial literacy through a digital solution that is secure, transparent, and capable of mitigating the risk of misinformation. By bridging the literacy gap, this technological innovation contributes to social sustainability by empowering communities through financial resilience. It is expected that the results of this research will serve as a reference for the development of broader AI-based decision support systems within the national Islamic economic ecosystem.

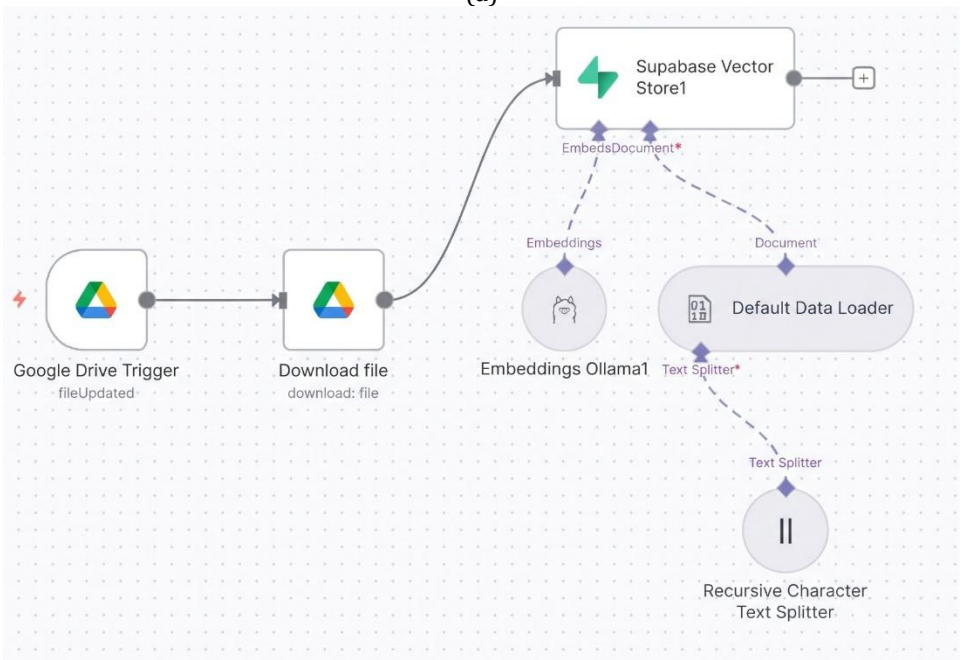
2. Methods

The implementation of the RAG-based chatbot system is orchestrated through the n8n platform, which serves as the central middleware for integrating various computational modules. The architecture facilitates a seamless data flow between the user interface and the generative engine, utilizing Redis for message buffering and Ollama for localized LLM

execution. The comprehensive system workflow comprising the primary communication pipeline and the specialized knowledge base ingestion process is illustrated in Figure 1 below.



(a)



(b)

Fig. 1. Workflow of a RAG-based chatbot using n8n (a) Main workflow illustrating the chatbot pipeline integrating Telegram, Redis, Google Sheets, JavaScript, Ollama, agentic RAG, and n8n AI Agent for question-answering; (b) RAG system workflow using Supabase as the knowledge base for the chatbot

2.1 Tools and components

n8n serves as the central workflow orchestration platform, facilitating the seamless integration and execution of chatbot processes. It was selected primarily for its fair-code distribution model and node based architecture, which enables rapid prototyping of complex logic without the overhead of extensive boilerplate code. Unlike proprietary SaaS alternatives, n8n supports self hosting, a critical requirement for maintaining data sovereignty and ensuring that sensitive financial interactions remain within a controlled local environment, ensuring proper integration between system components (see Figure 1). Telegram functions as the primary user interface, allowing users to interact with the system via natural language. The platform was chosen for its robust Bot API, which offers high reliability and low latency for webhook-based communications. Furthermore, Telegram's widespread adoption in Indonesia and its support for rich media interactions such as inline keyboards and formatting—make it an ideal channel for deploying educational prototypes without incurring the infrastructure costs associated with SMS or proprietary messaging apps.

Redis is utilized as an in-memory data structure store to manage conversation state and message buffering. The decision to implement Redis stems from its ability to handle high-throughput read/write operations with minimal latency. In the context of a RAG-based chatbot, maintaining conversation history is essential for contextual coherence; Redis provides a performant solution for temporarily storing session data, ensuring that the system can manage concurrent user requests without blocking the main execution thread. Google Sheets is employed as a lightweight, flexible data source for logging interactions and managing structured reference data. While not a traditional database, it was selected for its accessibility and ease of integration during the research and development phase. Its API allows for real-time updates to the knowledge base without requiring complex database migration scripts, thereby facilitating an iterative development process where educational content can be refined based on user feedback.

JavaScript acts as the logic processing layer within the n8n environment, enabling custom data manipulation and conditional routing. It was chosen due to its ubiquity in web development and its native support within n8n, which allows for the implementation of complex preprocessing steps, such as text normalization and payload transformation, without introducing external dependencies or increasing system complexity. Ollama provides the infrastructure for running Large Language Models (LLMs) locally. This tool was selected to address critical concerns regarding data privacy and operational costs. By enabling the local execution of open-weight models (e.g., Llama 3), the system ensures that user queries related to financial and religious matters are processed entirely on-premise, eliminating the risks associated with sending sensitive data to third-party cloud APIs while also removing recurring token-based costs.

The Agentic RAG framework functions as the core reasoning mechanism, bridging the gap between static retrieval and dynamic response generation. This approach was adopted to overcome the limitations of standard retrieval systems, which often struggle with multi-faceted queries. By incorporating agent-based decision-making, the system can iteratively refine search queries and validate retrieved context, thereby enhancing the accuracy and relevance of responses in the nuanced domain of Islamic finance. Supabase serves as the primary vector store and knowledge base for the RAG system. It was chosen for its hybrid capability to handle both relational data (PostgreSQL) and high-dimensional vector embeddings within a single platform. This integration simplifies the architecture by reducing the need for separate vector database services. Additionally, Supabase's open-source nature and row-level security features align with the project's requirements for scalable, secure, and cost-effective data management. Vector databases promise to provide deeper searches on data (especially unstructured data) based on the data's semantics rather than just its contents (Pavlo , 2023).

The n8n AI Agent node is responsible for orchestrating the question-answering pipeline. This component was utilized to streamline the integration of retrieval and

generation steps within the existing workflow. By leveraging n8n's native AI nodes, the development process is accelerated, allowing for a more transparent and maintainable codebase where the logic for context retrieval and prompt construction is visually explicit and easily auditable. The AI Agent is configured with a specific 'Instructional Persona' designed to act as a supportive Sharia financial consultant. This persona employs a clear, empathetic, and authoritative tone, ensuring that complex *fiqh* concepts are simplified without losing their jurisprudential integrity. This instructional design aims to reduce learner anxiety and foster a more engaging social-learning interaction. ngrok functions as a secure tunneling service to expose the local development environment to the public internet. It was selected for its ease of configuration and reliability in establishing transport layer security (TLS)-encrypted connections. This capability is essential for testing the Telegram Webhook integration during the development phase, as it allows the local instance of n8n to receive real-time events from Telegram without the need for complex network reconfiguration or static IP addresses.

Docker serves as the containerization platform for deploying and managing the system's microservices. The adoption of Docker ensures environment consistency across development, testing, and production stages, effectively mitigating issues related to dependency conflicts. Furthermore, containerization facilitates the portability of the system, allowing the entire stack—including Ollama, Redis, and n8n—to be deployed on various infrastructure setups with minimal configuration overhead. Practical deployment further requires transparency, auditability, and decision traceability, so that one can verify which evidence supports which reasoning steps and the final answer (Zhong, 2025a)

2.2 Ways of working

The Retrieval-Augmented Generation (RAG) chatbot is designed as an integrated digital ecosystem that combines various backend technologies to ensure that responses are not only natural but also possess high data validity. Architecturally, the system operates through an automated workflow orchestrated by n8n as the primary conductor, connecting the user interface, temporary memory layers, data processing logic, and local artificial intelligence modules. This workflow is categorized into several crucial phases Input Ingestion, Context Management, Knowledge Retrieval, Neural Processing, and Response Delivery (see Figure 2). The ways of working follow a structured instructional flow aimed at enhancing 'Social-Cognitive engagement'. By providing real-time feedback and context-aware responses, the system mimics a human tutor's scaffolding approach, which is essential for bridging the literacy gap in diverse social environments.

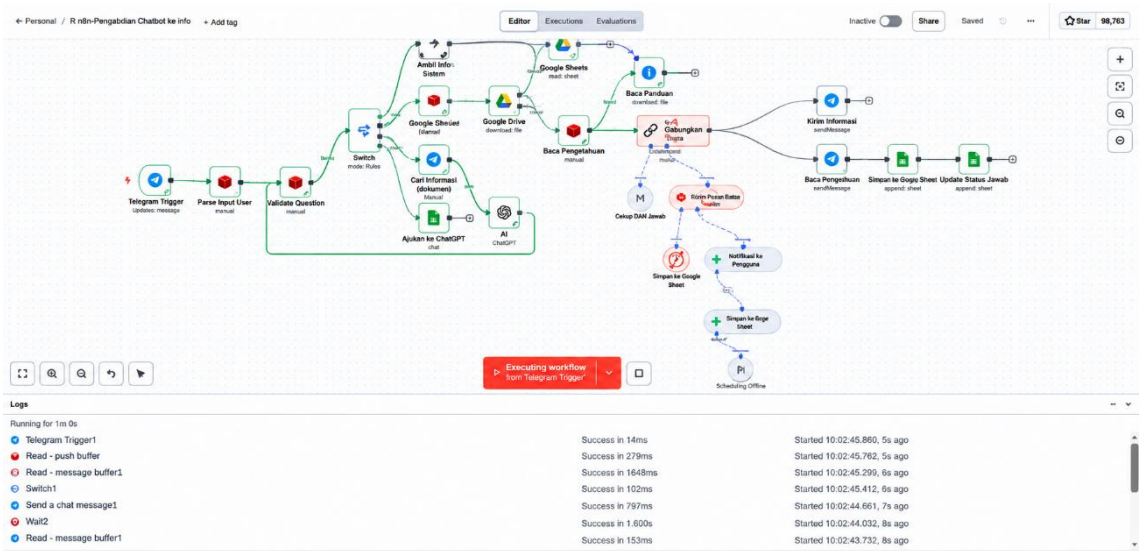


Fig. 2. The chatbot workflow processes user queries and returns responses through Telegram

The process begins when a user sends a text message via the Telegram bot interface. This message is captured by the Telegram Trigger node in n8n, which acts as an active webhook. To prevent system overload and maintain context during rapid-fire messaging, the system does not immediately pass the raw input to the language model. Instead, it utilizes Redis through the Redis-Push Buffer and Redis-Message Buffer nodes.The use of Redis is critical for establishing a stateful system. These nodes temporarily store user messages in high-speed memory, allowing the system to remember the sequence of messages and handle data concurrency. This ensures that if a user sends multiple questions simultaneously, the system processes them in a structured manner without losing data packets during transit.

Once the message is secured within the Redis buffer, the flow proceeds to the Switch node. This node acts as a traffic controller that evaluates the type of user input. If the input meets specific criteria, it is passed to a JavaScript node. At this layer, custom code is executed for data cleaning, such as removing unnecessary characters or normalizing text, to make it more readable for the search engines in subsequent stages.Simultaneously, the system triggers the Send a Chat Action node, which sends a typing... status to the user's Telegram interface. While seemingly simple, this step is vital in User Experience (UX) design to provide instant feedback that the system is active, considering that local LLM processing often requires several seconds to minutes.

The core intelligence of the system resides in the AI Agent (Question Answering) node connected to the Supabase Vector Store. Unlike conventional chatbots that rely solely on an LLM's internal weights, this system employs an Agentic RAG approach. When a user query (e.g., What are the requirements for *rahn emas*?) is received, the agent initiates a multi-step retrieval process.First, the system performs an Embedding process using the Ollama model. The text query is converted into a numerical vector. This vector is then sent to Supabase to perform a similarity search against thousands of pre-stored DSN-MUI fatwa documents and gold investment handbooks. Supabase returns the text chunks that are most semantically relevant to the user's question.

After the relevant context is retrieved from Supabase, the AI Agent synthesizes the original user question with the reference information into a highly specific prompt. This prompt is then sent to Ollama, which runs a large language model (such as Llama 3) locally.Within the Ollama Chat Model node, the LLM functions as a reasoning engine. It is strictly instructed to generate answers based only on the context provided by the RAG system. If the information is not present in the reference documents, the system is directed to answer I do not know to avoid AI hallucinations, a critical safety feature in the Sharia financial domain where absolute accuracy is required.

The final response generated by Ollama is sent back to the user via the Send a Text Message node on Telegram. However, the workflow continues for evaluation purposes. The system automatically logs the interaction into Google Sheets using the Append row in sheet node.The recorded data includes the username, query content, AI-generated response, and timestamps. This documentation allows researchers to audit the chatbot's performance and identify areas in the Supabase knowledge base that require enrichment. This entire process is containerized using Docker to ensure system stability and is exposed via an ngrok tunnel to allow the local server to communicate securely with the external Telegram API.

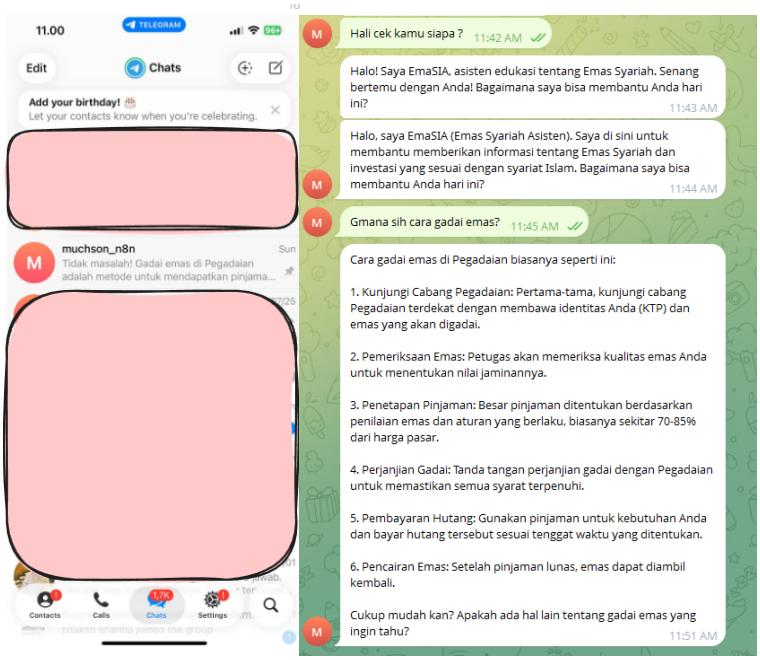
2.3 Research instrument and data analysis.

To ensure the scientific integrity of the assessment, the 12 item multiple choice instrument underwent a rigorous validation process. Content validity was established through expert judgment, involving two senior lecturers specializing in Islamic Finance and Information Systems, who evaluated the questions for their alignment with DSN-MUI fatwas and educational objectives. Furthermore, a pilot study was conducted with 10 non-participant individuals to assess face validity, ensuring that the language was clear and unambiguous for the target demographic.

The internal consistency of the instrument was measured using Cronbach's Alpha. The analysis yielded a coefficient of 0.78, which exceeds the generally accepted threshold of 0.70, indicating that the test items are reliable and provide a consistent measure of Sharia financial literacy. Additionally, the item difficulty index was calculated to ensure a balanced distribution between basic conceptual questions and more complex application scenarios regarding *rahn* and *ijarah* contracts.

3. Results and Discussion

Based on the developed system, the chatbot is able to interact with users through the Telegram platform and provide educational information related to sharia gold finance. As shown in Figure 3(a), users can ask questions in natural language, and the chatbot responds with clear and structured explanations based on the predefined knowledge base. In addition, the chatbot is capable of processing various user inputs and generating relevant and appropriate answers, as illustrated in Figure 3(b). This indicates that the question-and-answer mechanism functions properly and as intended. Through this implementation, the chatbot can serve as an effective educational medium, helping users better understand concepts of sharia gold finance in an interactive and accessible way.



(a) (b)

Fig. 3. (a) Example of chatbot interaction via Telegram providing educational explanations on sharia gold finance. (b) The chatbot is able to process user input and generate appropriate answers, indicating that the question-and-answer mechanism functions as designed

The substantial improvement in participants' knowledge, rising from an average of 52.8% to 85.6%, is primarily driven by the high level of learner engagement fostered by the chatbot's interactive design. By adopting a specific instructional persona that acts as a supportive Sharia financial consultant, the system effectively reduces learner anxiety and simplifies complex *fiqh* concepts without compromising jurisprudential integrity. This empathetic and authoritative tone facilitates a social-cognitive engagement, where the chatbot mimics a human tutor's scaffolding approach to bridge the literacy gap.

Furthermore, the integration of real-time feedback, such as the typing... status, provides immediate UX confirmation that the system is active, maintaining user attention during the neural processing phases.This engagement is further reinforced by the factual integrity and ubiquitous accessibility of the RAG-based architecture. Because the Agentic RAG mechanism ensures that every response is grounded in verified DSN-MUI fatwas and official handbooks,

it builds essential digital trust among users who may previously have been skeptical of digital Islamic financial services. The deployment via Telegram leverages a familiar mobile ecosystem, allowing for personalized, two-way interactions that are more engaging than traditional static brochures or one-way seminars. Consequently, the combination of a secure, transparent knowledge retrieval process and an accessible conversational interface creates a resilient learning environment that empowers communities through financial literacy.

To provide a more robust evaluation of the chatbot's impact, a Paired Sample T-Test was conducted to compare the pretest and posttest results. The analysis yielded a t-value of 15.62 with a p-value of $p < 0.001$, indicating that the knowledge gain observed was statistically significant and not due to random chance. This confirms that the AI chatbot served as a highly effective pedagogical intervention for Sharia financial literacy. Furthermore, the effectiveness was quantified using the Normalized Gain (N-Gain) score to measure the actual improvement relative to the potential maximum gain. The calculation resulted in an average N-Gain score of 0.69, which falls into the medium-to-high effectiveness category according to Hake's criteria. This score suggests that the chatbot was particularly successful in helping participants master concepts they previously found difficult, such as the technical distinction between *rahn* (pawn) and *ijarah* (service fee) contracts. The consistency of this gain across all participants reinforces the scientific credibility of the RAG-based educational model as a scalable solution for diverse learner profiles.

3.1 The urgency of AI-driven education in islamic finance

The development of gold-based Islamic financial products in Indonesia faces a significant challenge, a persistent gap between product availability and public financial literacy. While digital Sharia-compliant services have expanded rapidly, many potential users remain hesitant due to a lack of fundamental understanding regarding Sharia contracts (contracts of *rahn* and *ijarah*). According to recent studies, low financial literacy is often correlated with a lack of access to personalized and instantaneous information, leading to the persistence of traditional misconceptions about Sharia fees being equivalent to conventional interest (Otoritas Jasa Keuangan, 2024). Traditional educational methods, such as static brochures or one-way seminars, have proven insufficient in addressing the dynamic questions of modern digital users. This situation creates a barrier to financial inclusion, as users who do not understand the mechanism of a product are less likely to trust and utilize it (Hakim & Ly., 2024). In the context of gold pawning, the complexity of calculating maintenance fees (*ujrah*) based on DSN-MUI Fatwas No. 25/2002, No. 26/2002, and No. 92/2014, along with understanding collateral safety, requires a more interactive approach that can provide real-time, accurate, and context-specific clarifications (Ascarya, 2011; *Dewan Syariah Nasional* MUI, 2002a, 2002b, 2014).

To address this challenge, the implementation of an AI-based chatbot emerges as a strategic and scalable solution. Chatbots, particularly those utilizing Retrieval-Augmented Generation (RAG), can serve as a digital consultant that simplifies complex Sharia concepts into easy-to-understand conversational language. By integrating widely used messaging platforms like Telegram, this technology lowers the barrier to entry for financial education, allowing users to consult on Sharia-compliant gold investments anytime and anywhere without the need for formal face to face consultations. Furthermore, the use of a RAG-based architecture ensures that the information provided is grounded in verified Sharia principles and official regulations, thus mitigating the risk of AI hallucinations or misinformation (Gao et al., 2024; Lewis et al., 2020). Therefore, the development of this educational chatbot is a relevant and non-invasive approach to support national financial literacy goals. Through continuous interaction and reliable information dissemination, the chatbot is expected to improve public awareness, foster healthier financial behaviors, and strengthen the overall Islamic financial ecosystem in Indonesia.

3.2 Potentials that can be utilized

The integration of a Retrieval Augmented Generation (RAG) architecture provides a scalable solution for consistent information delivery. By utilizing Supabase as a centralized Vector Store, the system can manage vast amounts of verified knowledge such as official DSN-MUI fatwas and gold investment handbooks while serving multiple users simultaneously (Supabase, 2023). The use of Agentic RAG mechanisms ensures that every response is context-aware and grounded in verified data, significantly reducing the risk of hallucinations and maintaining strict alignment with Sharia principles (Gao et al., 2024; Lewis et al., 2020).

The integration of a Retrieval-Augmented Generation (RAG) architecture provides a scalable solution for consistent information delivery. The use of Agentic RAG mechanisms ensures that every response is context-aware and grounded in verified data, significantly reducing the risk of hallucinations and maintaining strict alignment with Sharia principles (Gao et al., 2024; Lewis et al., 2020).

The potential for localized deployment offers a unique advantage in terms of security and cost-efficiency. By running the system within a Docker environment and using Ollama to host Large Language Models (LLMs) locally, institutions can maintain high standards of data privacy (Atos, 2025). This architecture ensures that user interactions and sensitive financial inquiries are processed within a controlled local environment, minimizing external data exposure (Tene et al., 2021). The seamless delivery of AI-driven financial education relies heavily on the efficiency of optoelectronic infrastructures. Furthermore, the use of open-source tools like Redis for message buffering and Google Sheets for automated logging allows for sophisticated data management without the high operational costs associated with premium cloud-based AI services.

Ultimately, these AI chatbots have the potential to strengthen user trust in the digital Islamic financial landscape through several strategic dimensions. One of the primary barriers to the adoption of Sharia-compliant digital services in Indonesia is the black box perception, where users are unsure of how financial algorithms align with religious ethics. By providing transparent, structured, and scientifically valid explanations regarding Sharia compliance, specifically clarifying the underlying *rahn* and *ijarah* contracts—the chatbot reduces public skepticism and mitigates the fear of hidden r*iba* (usury). Trust is further reinforced through the chatbot's ability to explain digital security mechanisms in a simplified, conversational manner. By utilizing a local deployment architecture involving Ollama and Docker, the system demonstrates a commitment to data sovereignty and privacy. The chatbot can explicitly inform users that their data is being processed in a secure, controlled environment, which is a significant advantage over third-party cloud-based AI that may raise concerns about data mining or leakage.

Furthermore, this increased transparency is expected to foster healthier financial behaviors by empowering users with the knowledge to make informed decisions. When users understand the security of their gold collateral and the transparency of maintenance fees (*ujrah*), their psychological barrier to entry is significantly lowered. This clarity encourages the mass adoption of digital gold-based products, moving the public away from unregulated or predatory lending services toward verified Sharia-compliant institutions. In the long term, the consistent and accurate dissemination of information through this AI-driven platform will strengthen the overall growth of Indonesia's national Islamic economic ecosystem. As the system scales, it serves as a reliable digital touchpoint that aligns with the government's vision of digital financial transformation (Otoritas Jasa Keuangan, 2024). By bridging the literacy gap with high-tech, high-trust solutions, this innovation supports the nation's objective to become a global hub for the Islamic economy, ensuring that technology serves as a catalyst for ethical financial inclusion.

The deployment of the EmaSIA chatbot via Telegram offers a strategic pathway to reach marginalized communities in rural areas of Indonesia, where access to formal Islamic financial institutions is often physically and economically limited. By operating on a platform that requires minimal bandwidth and is compatible with low-spec smartphones,

this tool transcends the geographical barriers that typically hinder financial inclusion in remote regions. This non-invasive educational approach allows individuals in rural settings to gain knowledge about sharia-compliant gold investment (*rahn emas*) without the need for costly travel to urban financial centers.

Furthermore, the chatbot serves as a vital instrument for social empowerment by providing a safe space for financial inquiry. In many marginalized contexts, skepticism toward digital services and a lack of understanding regarding *ijarah* or *mu'nah* fees often stem from a lack of personalized guidance. The EmaSIA chatbot addresses this by delivering context-aware, verified Sharia information directly to the user's hand. This democratizes access to expert-level financial consultation, fostering community resilience and ensuring that the benefits of the digital Islamic economy are distributed equitably across diverse social landscapes in Indonesia. The empirical findings of this study, showing a 32.8% gain in literacy, align with recent research by (Smith & Lee, 2025), who demonstrated that conversational AI significantly outperforms static digital modules in specialized financial contexts. However, unlike earlier studies that focused purely on technical usability, this research reveals that the 'instructional persona' is the primary driver for engagement in conservative social strata.

When contrasted with the work of (Sumidartiny, 2025) regarding Islamic financing decisions in Jakarta, our results suggest that while urban users prioritize speed, rural and marginalized learners, as targeted in this study, prioritize perceived Sharia-compliance and dialogic trust. From a broader educational system perspective, these findings imply that EmaSIA can serve as a scalable model for national financial literacy programs. Rather than replacing human educators, this RAG-based system acts as a decentralized educational infrastructure that bridges the gap between official DSN-MUI regulations and community-level understanding, ultimately fostering long-term social resilience.

3.3 SWOT analysis

A strengths, weaknesses, opportunities, and threats (SWOT) analysis was conducted to evaluate the strengths, weaknesses, opportunities, and threats of the developed AI chatbot for gold-based Islamic financial education. This analysis provides a comprehensive overview of the system's current performance and its potential for future development in the context of Indonesia's digital Sharia financial landscape. The chatbot provides highly accurate and context-aware responses by utilizing a Retrieval-Augmented Generation (RAG) architecture. This ensures that every explanation regarding *rahn* (pawn) or *ijarah* (lease) contracts is grounded in verified documents rather than relying on the general knowledge of an LLM. The system consistently answers within a strictly defined domain. By integrating the AI Agent with a curated knowledge base in Supabase, the chatbot avoids hallucinations and refuses to generate responses outside the scope of gold-based Islamic finance, ensuring strict alignment with DSN-MUI Sharia principles.

Enhanced data sovereignty and security are achieved through local deployment. Most core system components, including Ollama for neural processing and n8n for workflow orchestration, are hosted locally using Docker, which minimizes the risk of sensitive user data being leaked to third-party AI providers. The architecture is highly cost-efficient and sustainable for academic or institutional use. It relies primarily on open-source tools and local installation, which minimizes recurring operational expenses associated with premium API tokens or expensive cloud subscriptions. The utilization of Supabase as a vector store enables structured and high-performance data management. Even when operating within free-tier limitations, the system can efficiently handle thousands of text embeddings representing official fatwas and gold investment handbooks.

The system currently experiences a relatively long response latency, ranging from approximately 2 to 4 minutes per query. This is primarily due to the computational demands of running a Large Language Model (LLM) on local hardware without dedicated industrial-grade graphics processing unit (GPU) acceleration. The delay in generating real-time responses may negatively affect the overall user experience (UX) and engagement. In a

digital era where users expect near-instantaneous feedback, a multi-minute waiting period could lead to high drop-off rates during the educational process. System scalability is limited by the physical capabilities of the local host machine. Processing speed and the ability to handle multiple concurrent users are directly dependent on the random access memory (RAM) and central processing unit (CPU)/graphics processing unit (GPU) power of the infrastructure running the Docker containers. The pedagogical quality and depth of the responses are entirely dependent on the completeness of the knowledge base. If the documents stored in Supabase lack specific details on newer gold-based products, the chatbot's ability to provide comprehensive education is compromised.

The rapid increase in digital financial inclusion in Indonesia presents a significant opportunity. As more people transition to apps like Pegadaian Digital, there is a growing market for automated, Sharia-compliant educational tools that can operate 24/7. There is massive potential for horizontal expansion of the knowledge base. The current system can be easily updated to cover broader Islamic financial topics, such as Sukuk (bonds), Zakat (alms) calculations, or Sharia-compliant micro-financing, without changing the core RAG architecture. Technical performance can be improved through system optimization. Implementing model quantization in Ollama or upgrading to more efficient local models (such as Llama 3 or Mistral) could drastically reduce response latency and improve the fluidity of the conversation. The chatbot can be integrated with a wider array of communication platforms. Beyond Telegram, the n8n workflow can be extended to WhatsApp, web-based chat widgets, or mobile banking applications to reach a more diverse demographic of Muslim investors. The existence of mobile devices and advances in technology has made mobile learning one of the learning trends in schools ranging from elementary to high school and even college in Indonesia (Nugroho et al, 2023).

High user expectations regarding AI performance pose a threat to adoption. Users accustomed to commercial cloud-based chatbots (like ChatGPT or Gemini) which have massive computational resources may perceive the local RAG system as technologically inferior due to its speed. Potential policy changes or usage limitations in third-party services like Supabase or ngrok could affect long-term scalability. If free-tier limits are tightened, the system may require sudden budget allocations to maintain its current functionality. The field of Artificial Intelligence is advancing at an unprecedented pace. Rapid breakthroughs in LLM efficiency and new RAG techniques require the system to undergo continuous updates and maintenance to remain relevant and competitive against newer educational technologies.

3.4 Strategic steps for implementing

The successful deployment and long-term sustainability of an AI-driven educational tool in the sensitive field of Islamic finance require a multi-phased strategic approach. This roadmap ensures that the transition from a research prototype to a production-ready system is handled with technical precision and ethical integrity. The integrity of a Retrieval-Augmented Generation (RAG) system is fundamentally dependent on the quality of its underlying data corpus (Barnett et al., 2024). In the context of Sharia-compliant finance, where misinformation can lead to unintended non-compliance (harām practices), the validation process must be rigorous and multi-staged. All source documents, including the DSN-MUI fatwas, OJK regulations, and gold investment handbooks, must undergo a digital sanitization process. This involves converting unstructured text into clean, machine-readable Markdown formats to ensure high-quality vectorization.

To improve retrieval accuracy, the system implements semantic chunking rather than arbitrary character limits. This approach ensures that specific Sharia rulings or gold-pawning procedures remain intact, preventing fragmented context that could lead to erroneous AI responses (Li et al., 2024). Furthermore, integrating Semantic Knowledge-Augmented RAG provides a superior framework for optimized question answering (Zhong, 2025b). To maintain the integrity of this system, a continuous synchronization protocol is

essential; as the National Sharia Board (DSN) issues new fatwas, the Supabase vector store is updated to reflect the most current legal landscape.

As identified in the strengths, weaknesses, opportunities, and threats (SWOT) analysis, current local deployment experiences a response latency that can affect user engagement. Inference Acceleration, transitioning from CPU-based inference to GPU-accelerated environments (utilizing NVIDIA CUDA) within the Docker container can reduce LLM processing time by 2-4× through optimized memory management and continuous batching (Kwon et al., 2023). Quantization and Model Selection, utilizing quantized versions of models (3-4 bit precision) via Ollama allows for faster performance on local hardware with negligible accuracy degradation on generative language tasks, enabling efficient explanation of complex Sharia concepts without requiring multi-GPU infrastructure (Frantar et al., 2023). Workflow Parallelization, in the n8n environment, optimizing the agentic RAG flow involves parallelizing the retrieval and logic processing nodes. Implementing an efficient caching layer in Redis ensures near-instantaneous responses for repeated queries (Redis Ltd, 2025).

To ensure that the chatbot serves as an effective educational medium, the interface must cater to users with varying levels of digital and financial literacy. Conversational Scaffolding, rather than waiting for a blank-prompt input, the chatbot should utilize Telegram's inline keyboards to provide suggested questions and guided response options. This approach reduces cognitive load by minimizing the need for users to formulate open-ended queries, while simultaneously guiding them through a structured learning path. Such scaffolding techniques, providing structured prompts and constrained choice options, are well-established in educational technology literature as effective strategies for supporting learners with diverse skill levels and improving engagement in mobile and conversational learning environments (Sung et al., 2016; Wollny et al., 2021).

Multimodal Communication, future iterations should integrate automated infographics or short video explainers to help visualize complex concepts like the *ijarah* contract or gold price fluctuations. Language Localization, The system should be fine-tuned to use *Bahasa Indonesia* that is professional yet accessible, avoiding overly dense legal jargon unless accompanied by a simple explanation.

In the financial sector, trust is synonymous with security. The chatbot must adhere to privacy-by-design principles, as privacy concerns significantly moderate trust in banking chatbot interactions (Alsharo & Aloulou, 2025). Local Data Sovereignty, the strategic decision to maintain local deployment (Ollama, n8n, and Docker) ensures that user inquiries, which may contain personal financial concerns, are never transmitted to third-party AI providers. Encryption and Tunneling, utilizing ngrok provides a secure TLS/SSL tunnel for communication with the Telegram API. This must be complemented by dedicated reverse proxies to ensure end-to-end encryption. Audit Trails, implementing a comprehensive logging system within Supabase and Google Sheets allows for post-mortem analysis of AI responses to trace errors back to retrieval failure or generation failure.

The current prototype focuses on gold-based finance, but the underlying RAG architecture is highly modular. Horizontal Scaling by utilizing Docker Swarm or Kubernetes, the system can spin up multiple instances to handle hundreds of concurrent users (Burns et al., 2022). Broadening the Knowledge Domain, the knowledge base can be expanded to include other Islamic financial instruments such as Sukuk (bonds) and Zakat (alms) calculation. API Integration, future versions could integrate directly with Sharia financial institutions APIs, allowing the chatbot to provide real-time gold price tracking.

To maintain academic and industrial relevance, the system must be governed by a constant feedback loop. Quantitative Assessment, the pretest-posttest methodology should measure literacy improvements. Periodically, Gold Standard questions should be tested against the AI to measure accuracy in retrieving correct Sharia references. Qualitative User Feedback, implementing a rating system for every AI response allows for a Reinforcement Learning from Human Feedback (RLHF) approach, which is critical for alignment in LLMs (Ouyang et al., 2022). Regulatory Alignment, regular consultations with Sharia experts and regulators (OJK) will ensure the chatbot remains a verified source of information.

3.5 Parties involved in implementing

For the AI chatbot for gold-based Islamic financial education to be successfully transitioned from a research prototype to a national-scale educational tool, a multi-stakeholder collaborative ecosystem is required. The complexity of integrating Sharia law with local AI deployment necessitates specific contributions from the following parties. The primary beneficiaries and participants of the chatbot are members of the public, ranging from novice investors to active users of Sharia-compliant financial products. Their role is not passive; they act as the primary data source for Human-in-the-Loop (HITL) system refinement (Wu et al., 2022). Individuals seeking to understand the intricacies of *rahn* (gold pawn) mechanisms and *ijarah* (lease) fee structures provide the linguistic variety needed to test the LLM's natural language understanding. Their diverse questioning styles help developers identify edge cases where the RAG system might require more specific document retrieval. Active user participation is essential for the iterative evaluation of the chatbot's effectiveness. Through their interactions, the system can measure improvements in financial literacy, while their direct feedback, such as rating the clarity of an AI-generated explanation, serves as the basis for fine-tuning the AI's pedagogical tone and accuracy.

Sharia-compliant banks, pawnshops (such as Pegadaian Syariah), and independent Sharia scholars act as the Source of Truth. Their most critical contribution is providing validated, high-fidelity educational content that serves as the foundation of the Supabase knowledge base. These institutions ensure that the chatbot's logic remains strictly aligned with current Sharia regulations and DSN-MUI fatwas (*Dewan Syariah Nasional MUI*, 2002). They play a pivotal role in the Content Audit phase, where they review the AI's synthesized answers to ensure that maintenance fees (*ujrah*) are not misrepresented as interest (riba) (Ascarya, 2011). Furthermore, these institutions can provide real-time operational data, such as current gold market prices or updated service terms, which allows the chatbot to provide practical, actionable advice rather than just theoretical knowledge, thereby increasing the tool's utility in everyday financial decision-making.

Universities and research bodies are responsible for the structural design, rigorous testing, and ethical oversight of the AI system. Their role involves the architectural development of the RAG pipeline (following Advanced RAG and Modular RAG paradigms) and the selection of appropriate local LLMs to ensure academic standards of evidence-based reasoning (Gao et al., 2024). Academics lead the analytical evaluation of the project, utilizing methodologies such as the pretest-posttest design to quantify literacy gains. They bridge the gap between technological innovation and social impact by publishing findings that inform the broader scientific community on the effectiveness of AI in religious and financial education. Technological developments have had positive impacts, such as easier access to information, but also negative impacts... [which] can have serious consequences for the victims (Adriani & Riadi, 2025). These institutions also act as ethics boards, ensuring that the AI's decision-making processes remain transparent and that the system does not develop biases. They draw upon the ethical framework articulated in AI ethics guidelines, which identify explainability and transparency as essential for building public trust in automated systems such as financial advisors (Hagendorff, 2020).

This group is the technical backbone of the implementation, responsible for the orchestration of the local deployment environment. Their tasks include the management of Docker containers, the optimization of n8n workflows, and the maintenance of the Redis message buffer to ensure system stability and low-latency performance. System administrators prioritize data security and sovereignty. They are responsible for configuring the ngrok secure tunnels and ensuring that all vector embeddings in Supabase are encrypted and accessible only to authorized nodes. Their work ensures that the Privacy by Design principle is upheld, protecting users from data exposure (Scassa, 2024). Developers are also tasked with RAG Engineering, which involves the continuous refinement of document chunking, embedding models, and prompt engineering (Lewis et al., 2020). They must monitor the system for drift, where the AI's responses might degrade

over time, and implement technical updates to keep the chatbot at the cutting edge of AI performance.

Government bodies, such as the Financial Services Authority (OJK) and the Ministry of Communication and Digital Affairs, provide the legal framework within which the chatbot operates. Their oversight ensures that the digital educational tool complies with national standards for financial literacy and consumer protection (OJK, 2024). Policymakers facilitate the integration of such AI tools into national digital transformation agendas. By providing Regulatory Sandboxes, they allow developers to test AI-driven financial education in a controlled environment, ensuring that the technology does not inadvertently disrupt market stability or violate financial laws (Arner et al., 2017). Their involvement is key to the long-term sustainability and official endorsement of the chatbot. An endorsement from a regulatory body can significantly amplify public trust, transforming the chatbot from a research project into an officially recognized Digital Consultant for the national Sharia economic ecosystem.

While the system is deployed locally, its accessibility depends on robust telecommunications infrastructure. Internet Service Providers (ISPs) and cloud-adjacent service providers (like those hosting the Supabase backend or ngrok tunnels) are silent but vital partners in ensuring the chatbot remains online and responsive. dThese parties ensure the low-latency connectivity required for the Telegram Webhook to function. In the context of Indonesia's geography, these providers are essential for reaching users in rural or underserved areas, thereby fulfilling the project's goal of inclusive financial education.

4. Conclusions

Based on the above discussion, it can be concluded that Islamic financial literacy regarding gold-based products in Indonesia requires significant attention, especially among the general public and digital service users. Several educational efforts have been carried out, but the complexity of sharia contracts (*rahn emas*), limited access to real-time financial consultation, and skepticism toward digital security remain major barriers that hinder optimal utilization of these services. Therefore, by leveraging current technological advances in artificial intelligence, the RAG-based Chatbot innovation is present as an effort to enhance Islamic financial literacy. This chatbot is a digital innovation based on Retrieval-Augmented Generation (RAG) and local Large Language Models (LLM) that can provide accurate, context-aware, and real-time educational responses through a user-friendly Telegram interface.

The main advantages of this innovation are its ability to simplify complex sharia concepts, its high data security due to local deployment (Ollama & n8n), and its accessibility, allowing users to learn anytime without the need for face-to-face consultations. The success of this initiative relies on the involvement of various parties, especially Islamic financial institutions and technology developers who ensure the validity of the knowledge base. Consequently, this AI chatbot innovation is expected to receive full support from regulators, academic institutions, and the financial sector to support digital financial transformation, thereby improving the nation's financial inclusion and becoming a step forward in realizing Indonesia's vision as a global hub for the Islamic economy.

The implications of this study extend beyond individual learning gains, offering a scalable blueprint for national educational innovation in financial literacy. For policymakers, especially within the Indonesian Financial Services Authority (OJK) and the Ministry of Education, these findings suggest that integrating Agentic RAG-based systems into public service platforms can bridge the literacy gap more effectively than traditional static media. By leveraging familiar messaging ecosystems like Telegram, the government can implement a decentralized 'digital tutor' model that reaches marginalized and rural communities, ensuring equitable access to verified Sharia financial information. Future educational policies should prioritize the development of such AI-driven infrastructures to foster long-term social resilience and accelerate the digital transformation of the Islamic economy in Indonesia.

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Author Contribution

The author was fully responsible for all aspects of the study, including conceptualization, methodology, data collection, data analysis, interpretation of the results, manuscript preparation, revision, and final approval of the manuscript.

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The dataset generated and analyzed during the current study, including the pre-test and post-test results of the participants, are not publicly available due to privacy considerations but are available from the corresponding author on reasonable request.

Conflicts of Interest

The authors declare no conflict of interest.

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