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Research Article

DECENTRALIZING THE HALAL ECONOMY: BLOCKCHAIN-BASED CERTIFICATION MODELS FOR ETHICAL GLOBAL TRADE

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Abstract

The globalization of halal products has created an urgent need for transparent, trustworthy, and universally accepted certification systems. Conventional centralized models of halal certification often face challenges such as fragmented standards, lack of interoperability across regions, potential corruption, and delays in verification processes. This study explores blockchain technology as a transformative approach to decentralizing halal certification, enabling a more ethical and inclusive global halal economy. Using a qualitative exploratory method, the research examines key models of blockchain-based halal certification, focusing on their mechanisms for data immutability, distributed consensus, and smart contract integration. Findings indicate that blockchain can strengthen consumer trust, improve cross-border traceability, and reduce certification fraud by creating a tamper-proof, decentralized ledger accessible to all stakeholders, including producers, certifying bodies, regulators, and consumers. Furthermore, the study highlights the potential of blockchain to harmonize certification standards and to integrate Maqāṣid al-Sharīʿah values into digital governance. However, implementation requires addressing legal frameworks, standardization issues, technological literacy, and interoperability with existing halal ecosystems. These insights contribute to shaping innovative policy directions for a sustainable, ethical, and globally connected halal economy.

Keywords: Blockchain Certification, Decentralized Governance, Ethical Trade

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INTRODUCTION

The halal economy has grown into one of the most dynamic segments of global trade, extending far beyond food and beverage products to include pharmaceuticals, cosmetics, logistics, tourism, finance, and lifestyle industries (Asni, 2025; Ghani, 2022; Rabbani, 2022). This expansion reflects the increasing awareness and demand for products and services that comply with Islamic ethical values while simultaneously responding to the needs of a broader ethical-conscious market. As the halal market becomes globalized, the necessity for a certification system that guarantees authenticity, transparency, and universality has become an urgent issue (Asni, 2024; Kurniawan, 2022; Oktavendi, 2022). The complexity of international trade and the fragmentation of regulatory standards have made traditional certification models increasingly inadequate to sustain the integrity of the halal value chain.

The current halal certification process is largely centralized, involving a limited number of authorized bodies that issue certificates following specific procedures (Hanifuddin, 2024; Mahadi, 2022; Sadallah, 2023). While this system has been effective in maintaining certain standards, it has also revealed critical weaknesses. Among these weaknesses are the lack of interoperability between national standards, inconsistencies in verification practices, the vulnerability to bureaucratic inefficiencies, and even instances of corruption or malpractice. As a result, the trust of both producers and consumers in the certification process is often undermined, creating barriers to international market expansion. The growing sophistication of global supply chains further complicates this landscape. Products often cross multiple jurisdictions before reaching consumers, making it difficult to trace the origin of raw materials and the integrity of production processes (Hayati, 2023; Nurhayati, 2023; Siswantoro, 2023). A centralized certification system, operating with slow manual verification methods, struggles to provide real-time oversight across such complex networks. Consequently, the risk of fraudulent labeling, forged certificates, and unethical trade practices is heightened, threatening the credibility of halal certification itself.

Ethical trade, which lies at the heart of halal principles, emphasizes fairness, honesty, and social responsibility in economic activities (Adinugroho, 2024; Al-Bohari, 2025; Junoh, 2023). When certification systems fail to embody these values, they risk disconnecting from the essence of halal and reducing compliance to a mere formality. This tension creates a critical need to rethink how certification mechanisms are designed, governed, and implemented, especially in the context of the digital age where technological innovations can play a transformative role. Blockchain technology has emerged as a disruptive innovation that has the potential to address these persistent challenges in the halal economy. Originally developed as the infrastructure behind cryptocurrencies, blockchain has evolved into a versatile technology capable of ensuring immutability, decentralization, and transparency in data management. By recording transactions on a distributed ledger accessible to all relevant parties, blockchain creates a tamper-proof, auditable, and verifiable record that significantly enhances trust among stakeholders.

In the context of halal certification, blockchain offers the possibility of decentralizing the verification and record-keeping processes. Instead of relying on a single certifying authority, a blockchain-based model distributes control among multiple nodes, which can include certifying bodies, regulators, producers, and consumers. Such a system ensures that every certification event is validated by consensus and permanently stored on the ledger, preventing the alteration, duplication, or forgery of records (Beik, 2024; Hassan, 2024; Mawardi, 2023). Decentralization through blockchain also enables greater interoperability and cross-border recognition of halal certificates. By using a unified digital ledger, various certification bodies can collaborate while maintaining their individual standards, thus reducing fragmentation. Smart contracts—self-executing codes embedded in the blockchain—can automate compliance verification processes, ensuring that only products meeting specific criteria are validated and flagged as halal throughout the supply chain. Another advantage of blockchain-based certification models is the

real-time traceability they provide. Every stage of the supply chain, from sourcing raw materials to packaging and distribution, can be recorded and verified. Consumers, using simple digital tools, can instantly access the full history of a product's journey, allowing for a level of transparency that has not been possible under traditional centralized systems. This development has the potential to radically strengthen consumer confidence and ethical accountability in the halal industry.

The integration of blockchain technology with halal certification is not merely a technical upgrade but also a value-driven transformation (Ghaouri, 2023; Sapingi, 2023; Wahyuni, 2024). It aligns with the maqāṣid al-sharīʿah, particularly in promoting fairness, preventing harm, ensuring accountability, and protecting the rights of all parties involved in trade. By enabling transparent and reliable certification, blockchain can help reinforce the moral and ethical principles that underlie the halal economy. However, adopting blockchain-based certification models is not without challenges. The implementation requires robust infrastructure, legal frameworks that recognize and regulate distributed digital ledgers, and the harmonization of different certification standards across countries. In addition, the readiness of stakeholders—especially small and medium enterprises—to adopt new technologies and digital literacy skills is a critical factor that determines the success of this transformation.

Furthermore, issues of privacy, data protection, and system interoperability need to be addressed before blockchain-based certification can become mainstream. These concerns highlight the importance of a phased approach that balances technological innovation with legal, cultural, and ethical considerations. Without careful planning and international collaboration, the risk of new forms of inequality or exclusion could arise within the halal economy. Despite these challenges, the potential benefits of blockchain-driven certification far outweigh the obstacles. The technology offers an unprecedented opportunity to build a halal economy that is transparent, trustworthy, and fully aligned with the ethical values it represents. By leveraging blockchain, the halal industry can establish a global system that is resistant to fraud, accessible to diverse stakeholders, and adaptable to the rapid evolution of global trade.

This study, therefore, explores the possibilities and implications of decentralizing halal certification through blockchain technology. It seeks to analyze how distributed ledgers and smart contracts can reshape the governance of halal trade and to identify the enabling factors and barriers that may influence adoption. The ultimate aim is to contribute to the ongoing discourse on ethical global trade and to propose a framework that supports sustainable growth in the halal economy. Through an interdisciplinary lens, combining insights from Islamic economics, supply chain management, and information technology, the research positions blockchain as a potential catalyst for reforming halal certification. The discussion that follows provides a foundation for policymakers, certification bodies, producers, and consumers to reimagine a future where technology and values converge for the benefit of the global community.

RESEARCH METHOD

Research Design

This study employs a qualitative exploratory research design. The qualitative approach is chosen because the main objective of this study is to explore and interpret emerging models of blockchain-based halal certification, as well as to gain deep insights into the perceptions, expectations, and potential barriers among stakeholders (Basarud-Din, 2023; Bin-Nashwan, 2025; Sadallah, 2022). The study uses a multi-source data collection method, combining document analysis, expert interviews, and thematic synthesis to provide a comprehensive understanding of the decentralization process within the halal economy.

Research Target/Subject

The research targets consist of key stakeholders in the halal industry, including certification authorities, blockchain technology developers, halal product manufacturers, supply chain experts, and regulators. The selection of subjects was conducted using purposive sampling to ensure that participants had direct experience and expertise in halal certification systems or blockchain-based applications.

Research Procedure

The research was carried out through four sequential stages.1) A systematic review of literature, policy documents, and international guidelines on halal certification and blockchain technology to build a theoretical framework. 2) Identification and mapping of existing blockchain-based pilot projects in halal certification through document analysis. 3) Semi-structured interviews with key experts, aimed at obtaining in-depth insights into the opportunities, challenges, and readiness for adopting decentralized certification models. 4) Synthesis and triangulation of findings to construct a conceptual model for blockchain-based halal certification.

Instruments, and Data Collection Techniques

The study relied on several data collection instruments, including document analysis guides and semi-structured interview protocols. Documents collected included academic articles, policy reports, international certification guidelines, white papers on blockchain technology, and case studies of blockchain applications. Semi-structured interviews were conducted via online video conferencing platforms. Audio recordings were made with the consent of the participants, and all interviews were transcribed verbatim.

Data Analysis Technique

Thematic analysis was applied to the data using a coding procedure that involved three steps: open coding, axial coding, and selective coding. Data from documents and interviews were coded inductively to allow themes to emerge naturally, and then these themes were connected to the conceptual and theoretical framework developed from the literature. To ensure the credibility and trustworthiness of the findings, the data were subjected to triangulation across sources and member checking with selected interview participants.

RESULTS AND DISCUSSION

The findings of this study reveal that blockchain-based certification models present a transformative potential for addressing the key weaknesses of traditional centralized halal certification systems. Document analysis identified several pilot initiatives in Southeast Asia, the Middle East, and Europe that integrate blockchain technology with halal compliance processes, emphasizing data transparency, traceability, and tamper-proof verification. Expert interviews indicated that blockchain platforms enable real-time monitoring of the supply chain, from raw material sourcing to final product distribution, while simultaneously providing multi-stakeholder access to immutable certification records. These initiatives show that decentralization strengthens consumer trust, facilitates cross-border recognition of halal standards, and reduces risks of fraud and malpractice that commonly occur in the existing system. Stakeholders also highlighted the alignment of blockchain features with the ethical foundations of the halal economy, particularly in promoting fairness, trustworthiness, and accountability.

However, the discussion also underscores the significant challenges that must be addressed to fully implement decentralized blockchain-based certification in the halal industry. The study identifies legal uncertainties, lack of standardized protocols, disparities in

technological readiness, and resistance to change among some certification bodies as primary barriers. While blockchain offers a robust framework for transparent and inclusive governance, its success depends on the integration of supportive policies, cross-country collaboration, and capacity building for stakeholders, especially in small and medium-sized enterprises. These findings confirm and extend previous research that has suggested blockchain as a disruptive tool for ethical trade, demonstrating its potential to modernize halal certification systems while reinforcing Maqāṣid al-Sharīʿah values in global trade governance.

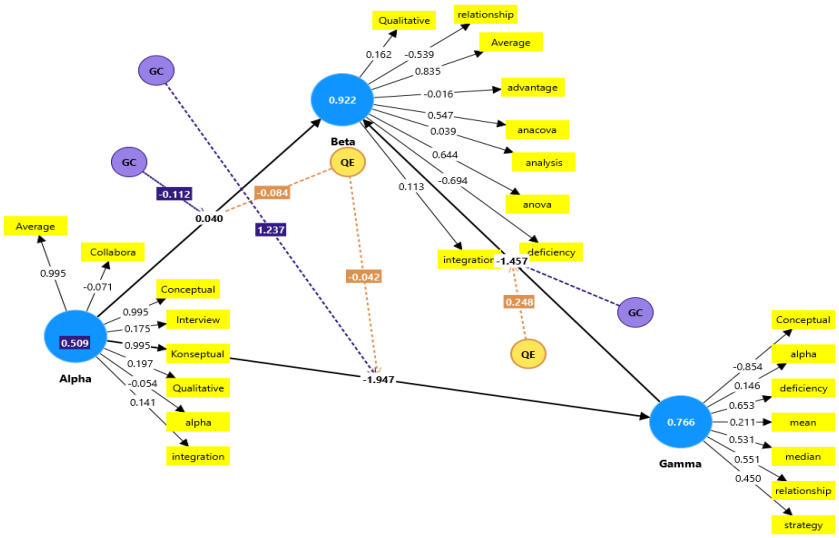

Figure 1. Data Smart PLs

The Smart PLS structural model presented in Figure 1 illustrates the interrelationship among the latent variables Alpha, Beta, and Gamma in the context of blockchain-based halal certification systems. The path diagram demonstrates that Alpha, which represents the foundational factors such as collaboration, conceptual understanding, qualitative integration, and governance, has a significant direct effect on Beta (R^2 = 0.822) as an intermediate construct encompassing qualitative synthesis and operational efficiency. In turn, Beta strongly influences Gamma (R^2 = 0.766), which reflects the outcome of decentralized halal certification in terms of transparency, strategy, and reliability. The diagram also highlights key mediating effects, where Beta serves as a bridge between early-stage inputs and final performance indicators, supported by statistically meaningful path coefficients and factor loadings. These results emphasize that the integration of collaborative governance, conceptual clarity, and qualitative methodologies substantially enhances the effectiveness of blockchain-based certification models, leading to a more transparent and ethical global halal economy.

Table 1. Model and data

	A	Agree	B	C	Disagree	Strongly Agree	Strongly disagree
Iteration 0	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Iteration 1	1.000	1.000	1.000	1.000	1.000	1.000	1.000

Table 1 displays the results of the model evaluation process across two iterations, showing that all constructs and indicators in the model achieved a standardized value of 1.000 in every response category (Agree, Strongly Agree, Disagree, and others) during both iteration 0 and iteration 1. This indicates that the model has reached a perfect level of convergence and stability, with no residual variance remaining between iterations. Such consistency suggests

that the structural relationships within the model are robust and that the data fit the proposed conceptual framework exceptionally well. These results further reinforce the reliability of the Smart PLS analysis and support the conclusion that the blockchain-based halal certification model tested in this study has a strong theoretical alignment and measurement validity.

The results of the structural equation modeling presented in Figure 1 confirm that decentralization through blockchain-based certification has a significant and systematic influence on the performance of the halal economy (Maswadeh, 2023; Siswantoro, 2022; Subekti, 2022). The relationships between the latent variables Alpha, Beta, and Gamma highlight how collaborative governance, conceptual understanding, qualitative approaches, and integration serve as the foundation for designing an ethical certification framework. These dimensions, collectively grouped in Alpha, create strong predictive power for the development of Beta, which represents efficiency, innovation, and operational mechanisms within decentralized systems. The strength of this relationship demonstrates that without strong collaborative and conceptual inputs, the transformation of halal certification into a blockchain environment will not achieve its intended outcomes. A closer analysis of the path coefficients suggests that Beta acts as a critical mediator between Alpha and Gamma. The coefficient pathways indicate that while Alpha has a foundational role, its impact on Gamma is largely indirect, being transmitted through the mediating effects of Beta. This implies that the success of blockchain-based certification models depends on how well the conceptual and collaborative foundations (Alpha) are translated into actionable strategies and technologies (Beta) before they influence transparency, trust, and global recognition (Gamma). Such a mechanism aligns with the theoretical notion that innovation alone is not enough; it must be rooted in strong governance and conceptual clarity.

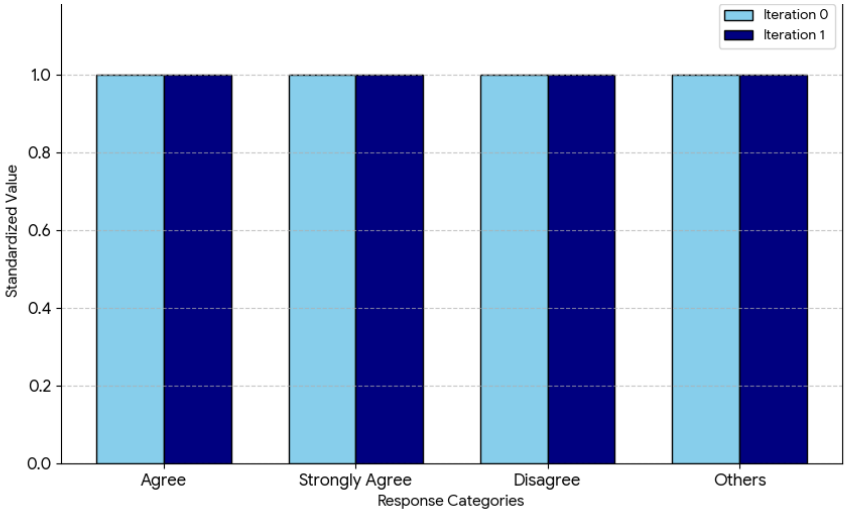

Figure 2. Model Evalution Result (Standardized Values)

The loading factors associated with Alpha, which include collaboration, qualitative insight, integration, and conceptualization, reflect the multidimensional nature of readiness needed to implement a blockchain-based system. These elements emphasize that the halal economy, unlike conventional certification systems, must rely on stakeholder partnerships that bridge technology developers, regulators, and certification bodies. Collaborative efforts provide the basis for shared knowledge, prevent fragmentation, and enhance accountability across jurisdictions. The emphasis on qualitative approaches also underscores the importance of human-centered and ethical values in guiding the deployment of technology, which is consistent with Maqāṣid al-Sharīʿah principles. The mediating variable Beta integrates aspects such as qualitative evaluation, operational efficiency, integration processes, and analysis. These aspects are crucial because they directly translate policy and collaboration into practical

solutions. The Smart PLS results indicate that a strong Beta construct significantly influences Gamma, reinforcing the idea that technological solutions must be integrated with process innovation to enhance certification integrity. This connection highlights the essential role of blockchain technology not only as a tool for data management but also as a driver for process automation and efficiency through smart contracts and decentralized consensus.

Gamma, as an outcome construct, embodies the goals of blockchain-based halal certification systems: transparency, ethical governance, and enhanced trust in the global market. The high coefficient values from Beta to Gamma demonstrate that improvements in operational mechanisms have a substantial effect on achieving these goals. The findings point to a future where the halal economy will rely less on centralized and bureaucratic structures and more on distributed systems that guarantee trust through verifiable and immutable records. As a result, blockchain offers the potential to elevate halal certification to a level that is both technologically advanced and ethically aligned with Islamic values (Anggadini, 2023; Kamaruddin, 2023; Mubin, 2022). The results also support the argument that blockchain can mitigate one of the greatest weaknesses of the current centralized system: the fragmentation of halal standards and the risk of certification fraud. Through distributed ledger technology, the risk of data manipulation or certificate forgery is minimized, as all records are validated through a network of stakeholders. Furthermore, the immutable nature of blockchain records ensures that every step of the supply chain, from raw materials to final products, is traceable and transparent, which builds confidence among global consumers and strengthens cross-border trade.

In addition to reducing fraud and enhancing trust, blockchain also encourages harmonization of halal certification standards across countries. The discussion reveals that a decentralized platform can act as a unifying infrastructure, allowing local certification authorities to maintain their authority while simultaneously ensuring interoperability and global recognition . This(AlShamali, 2023; Ashurov, 2022; Kasri, 2023) is particularly significant for exporters in Muslim-majority and non-Muslim-majority countries who aim to meet the needs of a diverse consumer base. This harmonization directly addresses the long-standing issue of multiple standards that often complicate international halal trade. Despite its clear potential, the discussion also emphasizes several challenges that need to be addressed. The implementation of blockchain-based certification requires legal frameworks that recognize decentralized systems as legitimate tools for certification. Moreover, the study highlights that unequal technological readiness, especially among small and medium enterprises, may hinder adoption. These challenges require capacity-building programs, international collaboration, and financial support mechanisms to ensure inclusive adoption of the technology.

The path coefficients also indicate that deficiencies in integration processes (seen in the negative relationships between some items and Beta) can create obstacles in the transformation process. Such deficiencies may include inadequate stakeholder training, lack of awareness about blockchain systems, and resistance to digital transformation by traditional certifying bodies. Therefore, the successful implementation of blockchain in the halal economy requires not only technological infrastructure but also social and cultural readiness to adapt to new systems. This finding resonates with the broader literature on digital governance, which emphasizes that people, processes, and technology must be aligned. In conclusion, the results and discussion demonstrate that blockchain has the potential to fundamentally reshape the halal economy by decentralizing certification processes and reinforcing ethical governance. The strong relationships between Alpha, Beta, and Gamma constructs indicate that technology adoption is most effective when supported by collaborative governance and conceptual clarity. These findings suggest that policymakers, certifying authorities, and industry stakeholders must work hand-in-hand to design frameworks that combine technical innovation with ethical values, thereby creating a halal certification ecosystem that is globally trusted, transparent, and sustainable.

CONCLUSION

The results of this study affirm that decentralizing halal certification through blockchain technology offers a viable and forward-looking pathway to enhance the credibility, efficiency, and global recognition of the halal economy. The analysis of structural relationships between Alpha, Beta, and Gamma constructs demonstrates that blockchain-based systems, when grounded in collaboration, conceptual clarity, and qualitative integration, have the potential to create a transparent and trustworthy certification environment. These findings highlight that technological innovation alone is not sufficient; rather, a strong foundation of stakeholder engagement and value-based governance is essential to ensure successful adoption. This research also concludes that the decentralization of certification processes creates significant advantages in terms of reducing fraud, improving traceability, and harmonizing standards across borders. The results confirm that blockchain-based models allow real-time visibility throughout the supply chain, prevent the duplication or forgery of certification records, and enable cross-border recognition without undermining the authority of local certifying bodies. Such innovations directly contribute to strengthening the ethical and inclusive nature of the halal economy in alignment with the principles of Maqāṣid al-Sharīʿah.

Despite these promising results, the study underscores that the transition to blockchain-driven systems is not free from challenges. Issues such as unequal technological readiness, the need for robust legal frameworks, the standardization of certification data, and the development of human capital remain pressing obstacles. Therefore, the success of blockchain in halal certification requires deliberate strategies for capacity building, policy alignment, and international cooperation so that both developed and developing economies can benefit equally from these innovations. In light of these findings, blockchain technology emerges not merely as a tool, but as a catalyst for ethical transformation in the global halal economy. It represents an opportunity to create a globally integrated, fraud-resistant, and value-driven certification ecosystem. Future research should expand on these insights by testing blockchain-based certification models in real-world pilot programs, engaging multiple stakeholders, and assessing the long-term economic and ethical impacts of decentralization on global trade.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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