Journal of Halal Science and Research (JHSR)
Vol. 6, No. 2, Month September, Year 2025, Page 186 – 196
doi: 10.12928/jhsr.v6i2.12022

P-ISSN: 2715-6214
E-ISSN: 2964-4909

Review article: Blockchain as an innovative solution for halal verification of food products in global supply chains

Nira Nur Fitriani[1*], Zulfa Eliza[1]
[1]Master of Food Science Study Program, Department of Food Science and Technology, Faculty of Agriculture Technology, Institut Pertanian Bogor University, Jl. Raya Dramaga, IPB Postgraduate School Building, Kampus IPB Dramaga, Bogor, West Java, 16680, Indonesia
**Corresponding author: nira.fitriani@apps.ipb.ac.id*

ABSTRACT
Blockchain technology is an innovative solution to improve transparency, traceability, and security in the halal supply chain. With its decentralized and immutable nature, blockchain enables end-to-end product tracking, increasing consumer confidence in the halalness of products. The purpose of this paper is to discuss the concept of blockchain, its implementation in halal verification, advantages such as efficiency and data security, and challenges faced. The research method used is a literature review with a qualitative and explanatory approach, utilizing primary and secondary sources through a literature study. Data was analyzed through stages of data display, data reduction, and conclusion verification, making this study observational in nature to describe and analyze practices and challenges in blockchain adoption for halal verification. The results show that blockchain has great potential to address the issue of uncertainty and improve compliance with halal standards, but requires collaborative efforts from all stakeholders to overcome challenges in its implementation. The conclusion highlights that blockchain integration in the halal supply chain can significantly enhance transparency, traceability, and security, minimize fraud, and increase consumer trust. However, barriers such as high costs, technological complexity, regulatory limitations, and industry resistance must be addressed. With further development and collaboration, blockchain has the potential to become a key solution in ensuring the integrity and sustainability of the global halal supply chain.

Article History
Submitted: November 19, 2024
Revised: September 14, 2025
Accepted: September 23, 2025
Published: September 30, 2025

Keywords
Blockchain technology, Halal certification, Halal supply chain, Smart contracts, Transparency, Traceability.

INTRODUCTION

In recent years, the demand for halal products has grown rapidly worldwide. With a growing global Muslim population and consumer awareness of the importance of ethical and safe consumption, the demand for halal products has increased sharply, not only in Muslim-majority countries but also in international markets. Halal products now cover a wide range of sectors, including food, cosmetics, pharmaceuticals, and financial services, making it a recognized global standard for ensuring product quality and integrity (Alamsyah et al., 2022). Along with the increasing consumer awareness of safe and halal-certified products, the halal industry trend in the world is growing and becoming one of the dynamic market segments in the world.

Based on the high public demand for the certainty of the halalness of a product, starting from the procurement of ingredients, production, equipment, to the distribution system, it becomes an important area of discussion (Novianti et al., 2020). The complexity of the global supply chain is often a major challenge in ensuring the authenticity and halalness of food products from upstream to downstream (Tan et al., 2022). Uncertainty regarding the halalness of a product is a serious problem, mainly due to

P-ISSN: 2715-6214
E-ISSN: 2964-4909

the lack of transparency in the production and distribution process, which makes consumers doubt the halalness of the products they buy (Singh & Sharma, 2023).

One of the most challenging issues in the halal industry is food supply chain integrity. Cross-contamination is a major problem that can jeopardize the integrity of the food supply chain (Sumarliah et al., 2023). Consumers who choose halal food will hesitate if there is no transparency of information about the origin and processing of these products (Rohmah et al., 2019).

Blockchain technology is currently attracting significant attention in various sectors, with its potential to increase efficiency and transparency in global supply chains (Handayani et al., 2023). Blockchain technology is emerging as an innovative solution that offers transparency, security, and accountability in the halal verification process (Dewi & Hakiki, 2023). With its decentralized and immutable nature, blockchain enables more effective tracking, minimizes the risk of counterfeiting, and provides greater trust to consumers (Akbar et al., 2022). This allows consumers to trace the origin and processing of products more easily, providing a more reliable guarantee of halalness in every supply chain involved.

RESEARCH METHOD

Methods

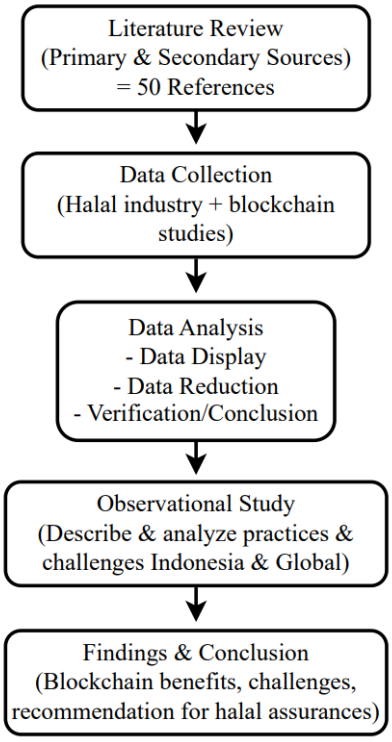

Figure 1. Process of research methods.

The research method applied in this study, shown in Figure 1, begins with a literature review that aims to assess the current state of blockchain utilization in the food industry, particularly in relation to halal assurance. Conducting a literature review is crucial to identifying both challenges and opportunities associated with the application of blockchain in ensuring halal compliance. This type of research is categorized as qualitative and explanatory, focusing on providing a deeper understanding of how blockchain can be applied to guarantee the halal status of food products while also mapping potential benefits and barriers to adoption. Data collection relies on primary and secondary sources obtained through a literature study approach. Based on the References section, this paper cites over 50 references published between 2018 and 2024, which include journal articles, conference proceedings, and regulatory documents covering blockchain technology, halal certification, supply chain

P-ISSN: 2715-6214
E-ISSN: 2964-4909

management, and the food industry. These resources provide a comprehensive foundation to analyze existing knowledge, theoretical frameworks, and practical experiences regarding blockchain adoption.

The data gathered from the literature were analyzed systematically through three stages: data display, data reduction, and conclusion or verification. This structured approach allows the researchers to organize findings, filter the most relevant information, and draw reliable interpretations aligned with the study objectives. Furthermore, this research is observational in nature, aiming to describe and analyze current practices, opportunities, and challenges faced by the halal industry in Indonesia and globally in adopting blockchain technology. By integrating literature review, qualitative explanatory analysis, and observational techniques, this method provides a holistic framework for exploring the role of blockchain in improving transparency, traceability, and security in halal food supply chains. Ultimately, this approach not only contributes to theoretical understanding but also offers practical insights for stakeholders seeking to enhance halal assurance through digital innovation.

RESULT AND DISCUSSION

Blockchain concept and technology

Table 1. Benefits and challenges of blockchain implementation in the halal supply chain.

Aspect	Key Findings	References
Transparency & Traceability	Blockchain enables stakeholders (slaughterhouses, distributors, retailers, consumers) to trace halal meat products end-to-end, reducing information asymmetry.	(Alamsyah et al., 2022)
Performance & Competitiveness	A survey of 178 halal food/beverage manufacturers in Indonesia shows that blockchain adoption significantly improves halal supply chain performance and firm competitiveness.	(Hendayani & Fernando, 2023)
Sustainability & Certification	Blockchain integration enhances traceability, reliability, and global credibility of halal certification, supporting long-term sustainability.	(Ghali-Zinoubi, 2022)
Digital Logistics	A case study in Indonesian halal logistics shows blockchain with IoT improves operational effectiveness, but barriers remain (infrastructure & expertise).	(Nurhayati, 2023)
Halal Food Industry Challenges	The halal supply chain faces major issues such as inconsistent certification standards across more than 300 authorities, weak regulation of halal raw materials, and complex supply chains that are difficult to monitor.	(Chandra et al., 2019)
MSMEs Adoption Barriers	Malaysian MSMEs report blockchain potential but face high costs, limited awareness, and technological barriers.	(Hassam et al., 2025)

Blockchain technology has become a promising solution in providing transparency, traceability, and security in global supply chains, particularly in food safety. Blockchain can be thought of as a secure distributed ledger that can record information about transactions between two parties. All records stored in the blockchain can be easily verified and cannot be altered, so the integrity of all records is maintained (Effendi et al., 2023). Blockchain makes data and transactions transparent because data is stored in a distributed network and can be accessed by anyone who has access to the network (Kafeel et al., 2023). Blockchain technology provides structured information in a chain of blocks, where each block stores encrypted and chronologically linked transaction information (Abidin & Perdana, 2020). The working mechanism of blockchain uses peer-to-peer decentralized computer networks and distributed algorithms to assist in solving database synchronization problems. Once verified, data is recorded in blocks that are then added to the chain of previous blocks, forming a history of data that cannot be changed or manipulated (Casino et al., 2021).

Table 1 shows that several studies have highlighted the benefits of blockchain technology for halal verification of food products in global supply chains. Liu et al. (2022), stated that the utilization of blockchain technology enables direct monitoring of food safety from its point of origin throughout

P-ISSN: 2715-6214
E-ISSN: 2964-4909

every stage of the supply chain until it reaches the end consumer. This monitoring capability enhances credibility, efficiency, and overall safety. Halal supply chain traceability has a positive impact on consumers, producers, and the government (Masudin et al., 2022). Halal supply chain traceability can provide benefits, for example, consumers can be more confident that the halal products they consume meet halal requirements (Ali et al., 2021).

In its application, blockchain can be divided into three main classifications that have different advantages and functions in ensuring product halalness. The choice of blockchain type affects the effectiveness of the system, especially in terms of security, accessibility, and data control. The following is an explanation of the three main classifications of blockchain in halal products according to Joshi et al. (2018):

1. Public Blockchain

   In this type of blockchain, everyone in the network can validate transactions and participate in consensus, making it fully decentralized. Every transaction is recorded and synchronized to every node in the network, ensuring security and transparency. In the context of halal products, public blockchain enables full transparency for consumers to browse information regarding halal certification, supply chain, and production process. The main advantages of public blockchains are transparency and security, but the challenge is the openness of data that may not always be desired by all parties in the supply chain. Public blockchains are also slower and more expensive than private blockchains, but they remain more efficient than traditional accounting methods.
2. Private Blockchain

   Private blockchains can only be accessed by certain authorized parties. These blockchains have strict control over data access within the network. Not all nodes can participate in the verification and validation of transactions. In halal products, private blockchains are usually used by certain companies or organizations to monitor and manage the supply chain internally. For example, manufacturers, suppliers, and halal certification bodies can use private blockchains to share data related to raw material origins, certification processes, and halal compliance without opening full access to the public. These blockchains offer more control and privacy, but sacrifice a little transparency for consumers. Because it presents a more secure, efficient, and fast technology, private blockchains are more likely to be accepted by companies in the government or private sector that require central authority.
3. Blockchain Consortium

   Consortium blockchains are a combination of public and private blockchains, so they are partially decentralized. In halal products, consortium blockchains allow multiple companies or organizations in the same industry to share data with mutual oversight. For example, a global halal supply chain can use consortium blockchains to share supply chain data between manufacturers, distributors, and certification bodies, but still have strict oversight and privacy. These blockchains create a balance between privacy and transparency that is often needed in the halal industry. Consortium blockchains provide many benefits similar to private blockchains, such as efficiency and privacy in transactions, but without placing complete control in a single company or organization.

Blockchain Implementation in Halal Verification

Currently, every halal industry is constantly developing business trends around the world. Not only do Muslim countries claim to be halal producers, but currently, many non-Muslim countries have also claimed to be halal producers in each specific field. Indonesia has targeted to become the world's halal center in 2024 by making efforts to encourage halal certification for business actors. Even the government has issued regulations, Law Number 33 of 2014 concerning Halal Product Guarantee, and Government Regulation Number 31 of 2019 concerning Implementation of Halal Product Guarantee (Aziz et al., 2019). The regulation states that every product that will enter, circulate, and be traded in Indonesia must have a halal certificate (Sup et al., 2020). Therefore, there is a need for blockchain integration in the halal supply chain. The integration of blockchain technology, as shown in Figure 2, into the halal supply chain is one of the significant advances with the aim of increasing transparency, traceability, and sustainability.

P-ISSN: 2715-6214
E-ISSN: 2964-4909

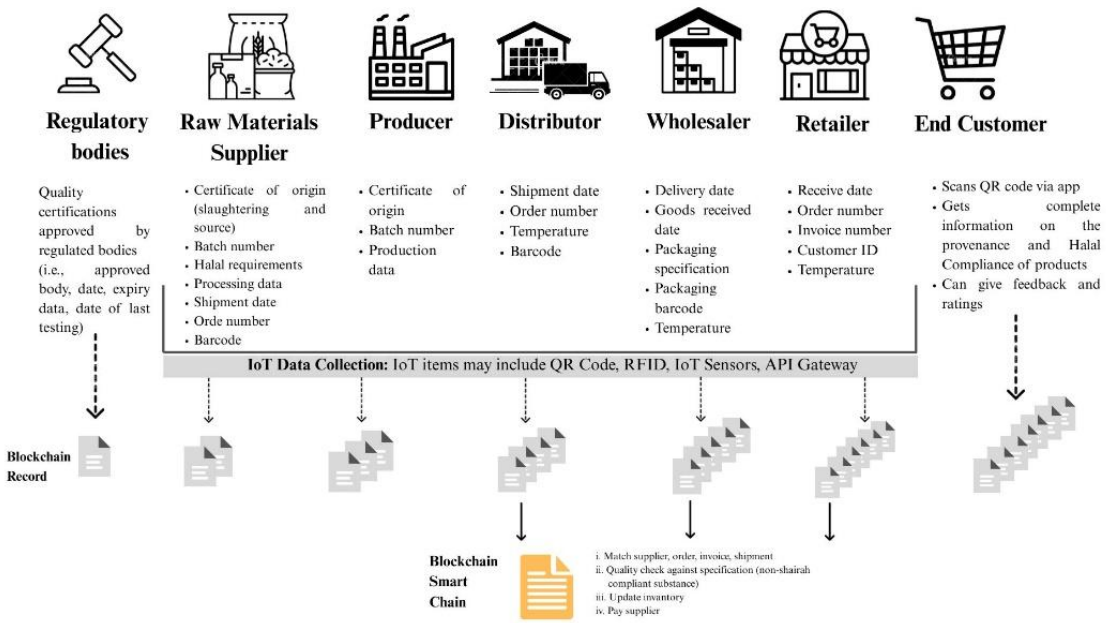

Figure 2. Blockchain technology in the halal supply chain (Chandra et al., 2019).

So there are several key aspects of how blockchain is integrated into the halal supply chain, as follows (Qanita et al., 2024):

1. Documentation and Traceability

   Blockchain has offered a centralized and distributed database that greatly enables all stakeholders in the halal supply chain to access and add information without the ability to delete it. This feature will help to protect accurate documentation and traceability of halal products throughout their production and distribution process (Rahim, 2023).
2. Increased Transparency

   By utilizing blockchain, the halal assurance system (HAS), which aims to ensure that products produced and circulated are guaranteed halal to consumers, will create a more transparent environment. This transparency will minimize fraudulent activities in halal product management, so that it will increase consumer confidence in halal product certification (Sidarto & Hamka, 2021).
3. Halal Sustainability Control

   Blockchain has a control system to ensure that halal sustainability can be maintained when it has obtained halal certification. This proves that even after certification, the processes involved in halal production can be monitored and verified to prevent negligence of business actors (Rosli et al., 2024).
4. Overcoming Human Error

   One of the challenges in the halal supply chain is human error, as it can greatly affect the integrity and ethical practices of the individuals involved. Blockchain integration will minimize the problem due to the availability of a reliable system that can reduce reliance on manual documentation and processes (Vanany et al., 2021).
5. Regulatory Compliance

   In the current era, the government has strongly pushed for halal certification regulations. Blockchain can streamline the process of meeting these regulatory requirements by ensuring that all necessary documentation is available and verified to facilitate a smoother certification process for businesses (Bawafie et al., 2024).

P-ISSN: 2715-6214
E-ISSN: 2964-4909

6. Sharia Maqashid Perspective

According to the Sharia Maqashid perspective, the integration of blockchain into the Halal Assurance System (HAS) can support five important elements derived from maqashid dharuriyyah, such as the protection of religion, life, intelligence, lineage, and property. Such customization can determine the ethical and religious significance of maintaining halal standards throughout the supply chain (Yudhianto et al., 2024).

The use of smart contracts can be implemented on blockchains to automatically execute agreements without the need for intermediaries. Smart contracts are computer programs or codes that can be executed automatically when predetermined conditions are met (Wu et al., 2022). Smart contracts have been designed to automate most of the contracting process, where performance, such as monitoring and enforcing contractual agreements, is done independently without any central authority or human involvement at the cost of monitoring different actors. The integration of smart contracts with IoT (Internet of Things) devices will enable continuous monitoring of the supply chain and ensure that all transactions related to halal certification will be recorded in real-time, thus providing transparency and traceability throughout the supply chain (Sahai & Pandey, 2020; Sookhak et al., 2021). Before any transaction is approved, smart contracts will ensure that the quality assurance of raw materials and products has been verified by regulatory authorities. This will add a level of security and trust to the certification process as only compliant products can move forward in the supply chain. Smart contracts can help to safeguard and segregate halal and non-halal products by using QR codes linked to smart contracts, shown in Figure 3, where the system will ensure that products are classified accordingly and their halal status is maintained throughout the supply chain. Using smart contracts will contribute to enormous transparency in the halal food supply chain (Younus & Younus, 2021). Stakeholders will be able to trust that the products they have received meet the required halal standards due to the mechanization of the certification process and the provision of clear records of all transactions (Sarah & Bergmans, 2021).

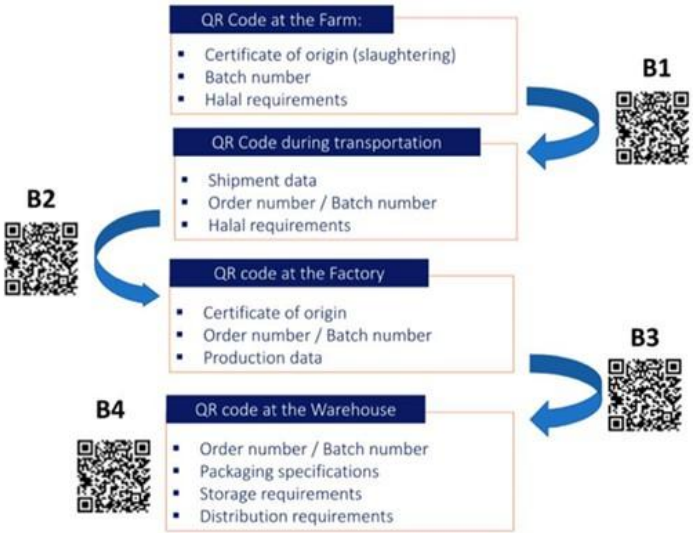

Figure 3. Blockchain smart contract with QR codes for the halal food supply chain (Tan et al., 2022).

Advantages of Blockchain in Halal Supply Chain

Blockchain technology can provide complete control to consumers from raw materials, factories, to the hands of consumers. Blockchain technology also guarantees faster and more secure transactions (Mahsun et al., 2023). One example is that blockchain-enabled applications improve information sharing among different partners across the food supply chain network without compromising privacy and security. The significant benefits of adopting blockchain-enabled applications in food supply chain traceability can relate to data interoperability, cost reduction, transparency, auditability, integrity, and authenticity (Sarah & Bergmans, 2021).

P-ISSN: 2715-6214
E-ISSN: 2964-4909

Several aspects of blockchain technology's advantages in the halal supply chain that can improve system integration and transparency, including:

1. Data transparency and accessibility
   Blockchain gives all parties involved in the system the opportunity to access all information regarding the halalness of the product. Everything recorded on the blockchain, from raw materials to the final product, is permanent and cannot be changed.
2. Efficiency
   With the blockchain system automating data through smart contracts, it can complete the transaction process quickly and efficiently due to its thorough traceability.
3. Data Security
   All transaction processes recorded in the blockchain are encrypted and stored in a distributed network, making it difficult for unauthorized parties to access or manipulate.
4. Search
   Every step in the supply chain can be tracked thoroughly and in detail. This can make it easier to identify the source of raw materials as well as all production processes in compliance with established halal standards. Traceability and tracking systems can be used to track information about products, whether they are halal, who the supply chain actors are, and the production process (Rejeb et al., 2020).

With the many advantages of blockchain technology, blockchain can help prevent fraud or errors in the halal certification process, because transaction records are transparent and immutable, reducing the potential for fraud in the supply chain. This can protect the integrity of halal products from fraudulent practices that can harm consumers.

Challenges and Limitations

The application of blockchain technology in the halal industry will face several barriers, such as high implementation costs, technological complexity, regulatory limitations, and industry resistance. These challenges will hinder the adoption of blockchain solutions that can improve transparency and traceability in the halal certification process. The costs incurred in making a halal certificate using blockchain technology will cost around US $20,035 or IDR 313,948,450 (Villanuev, 2021). The amount of costs incurred may be prohibitive for small businesses or producers who operate with strong margins and will find it difficult to justify these costs for certification. Maintaining a blockchain system will incur ongoing costs, including network fees for transactions, server fees for hosting nodes, and fees for regular maintenance and security measures. For businesses to always be able to utilize blockchain technology effectively, there will inevitably be a need to train staff as well as educate stakeholders about the new system, which could involve additional costs (Agung et al., 2022).

The next challenge in implementing blockchain is the complexity of technology. Integrating blockchain with halal certification processes and systems means that many organizations have legacy systems that are not compatible with blockchain technology, requiring significant customization and investment to ensure seamless integration (Li et al., 2020). Scalability issues exist because, as demand for halal products increases, blockchain systems must be scalable to handle the increase in transactions without sacrificing speed or efficiency, which makes effectively developing blockchain solutions while maintaining performance a significant technological hurdle. It can be stated that blockchain technology has shown promise for improving the halal certification process, where its implementation is fraught with technological complexities that need to be addressed to ensure successful adoption and operation in the halal industry (Mohaiyadin et al., 2024).

Regulatory limitations in the halal industry also present significant challenges for blockchain adoption. The lack of a standardization framework is a major challenge for halal certification as it results in confusion and inconsistency in how blockchain is applied across different regions and organizations, making it difficult to establish a reliable system for traceability and certification of halal food (Yudhianto et al., 2024). The absence of a universally accepted certification authority for halal products where such inconsistencies exist will hinder the adoption of blockchain technology, as businesses may be hesitant to invest in a system that lacks clear regulatory support and recognition.

P-ISSN: 2715-6214
E-ISSN: 2964-4909

The successful implementation of blockchain in the halal industry requires significant innovation and cooperation between various stakeholders, including local authorities, industry associations, and consumers. The existence of regulatory limitations will result in barriers to such cooperation, which makes it difficult to develop and implement effective blockchain solutions (Bux et al., 2022).

Industry resistance is a challenge in implementing blockchain in the halal industry due to a lack of awareness and understanding. The large number of stakeholders in the halal industry who may not fully understand blockchain technology and its benefits, with this lack of knowledge, will result in skepticism about its effectiveness in ensuring halal integrity and traceability. Without appropriate education and training, stakeholders will resist adopting new technologies that they do not understand. In the halal industry, where many organizations have established systems to track and certify halal products, the challenge of integrating blockchain using existing systems will create resistance as stakeholders may fear disruptions in their current operations and processes. Making the transition to a new system will require time, resources, and a willingness to change (Munawar & Mugiono, 2024).

Case Study

The case study found in the application of blockchain is the adoption of blockchain in the halal food industry using the Technology Organization Environment (TOE) framework and Failure Mode and Effects Analysis (FMEA) analysis, which will identify and analyze a major obstacle in the adoption of blockchain technology. In addressing the case study, we started by conducting an exploratory study involving surveys and interviews with ten industry professionals involved in the adoption of blockchain technology in the halal food industry. Such an approach will provide real-world insights into the challenges that will be faced by the sector's stakeholders. This case study targets the halal food industry, which has unique requirements due to its compliance with Islamic law. This allows for a detailed examination of how blockchain is being applied to ensure compliance and increase transparency in the halal food supply chain. This case study will highlight three main challenges in adopting blockchain technology: data integration, stakeholder management, and data availability. Data integration is the difficulty of integrating blockchain with existing systems and processes. Stakeholder management is due to the complexities involved in managing the relationships between various stakeholders in the halal supply chain. Data availability requires accurate and timely data to support the blockchain system.

To address the case study on the three main challenges in adopting blockchain technology, it is necessary to use the Failure Mode and Effects Analysis (FMEA) framework to assess the risks associated with blockchain adoption. The Failure Mode and Effects Analysis (FMEA) framework can identify significant risks, including team competency, data unavailability, and unstable adoption practices, which in turn can provide an organized approach to understanding potential failure points in blockchain adoption (Rosli et al., 2024).

The ability of blockchain to address halal verification issues is that it has a transparent ledger where all transactions are recorded. These transactions allow all stakeholders in the halal supply chain, such as farmers, processors, and retailers, to access real-time information on the halal status of products. The use of blockchain can perform detailed product tracking. Each product will be traced back to ensure that it meets halal standards throughout the process. Halal certification can be monitored in real-time so that any discrepancies or problems can be addressed immediately and avoid the risk of fraud or misrepresentation. Blockchain uses a consistent data format across the supply chain. Such standardization is valuable for accurately representing halal product attributes. As well as the blockchain model used that includes halal certification bodies as active participants in the network, this integration can ensure that each certification process is not only transparent but also accountable because the halal organization body can directly monitor and supervise compliance and intervene if needed (Alamsyah et al., 2022).

CONCLUSION

The integration of blockchain technology in the halal supply chain offers concrete solutions to address long-standing challenges in halal assurance. By enabling transparent and immutable recording of transactions, blockchain strengthens traceability and security, thereby reducing risks of fraud and ensuring compliance with halal standards. Specifically, this technology provides advantages in

P-ISSN: 2715-6214
E-ISSN: 2964-4909

improving supply chain efficiency, enhancing data integrity, and supporting halal sustainability. Nevertheless, several obstacles remain, including high implementation costs for small and medium enterprises, technical complexity in integrating blockchain with existing systems, the absence of harmonized global regulations for halal certification, and resistance from industries accustomed to conventional methods. To fully realize the potential of blockchain, collaboration among stakeholders such as certification bodies, regulators, industry players, and technology providers is essential. With continuous technological development and coordinated adoption strategies, blockchain has the potential to serve as a cornerstone for ensuring the integrity, reliability, and global competitiveness of halal food supply chains.

REFERENCES

Abidin, N. Z., & Perdana, F. F. P. (2020). A proposed conceptual framework for blockchain technology in halal food product verification. *Journal of Halal Industry & Services*, *3*(Special). https://doi.org/10.36877/jhis.a0000079

Agung, A. A. G., Nugroho, H., & Hendriyanto, R. (2022). A blockchain-based halal certificate recording and verification prototype. *JOIV: International Journal on Informatics Visualization*, *6*(2), 364. https://doi.org/10.30630/joiv.6.2.995

Akbar, A., Rakhmawati, N. A., & Vanany, I. (2022). Halal blockchain application for a chicken slaughtering factory. *International Journal on Food System Dynamics*, *13*(3), 321–334. https://doi.org/10.18461/ijfsd.v13i3.C6

Alamsyah, A., Hakim, N., & Hendayani, R. (2022). Blockchain-based traceability system to support the Indonesian halal supply chain ecosystem. *Economies*, *10*(6), 134. https://doi.org/10.3390/economies10060134

Ali, M. H., Chung, L., Kumar, A., Zailani, S., & Tan, K. H. (2021). A sustainable blockchain framework for the halal food supply chain: Lessons from Malaysia. *Technological Forecasting and Social Change*, *170*, 120870. https://doi.org/10.1016/j.techfore.2021.120870

Aziz, M., Rofiq, A., & Ghofur, A. (2019). Regulasi penyelenggaraan jaminan produk halal di Indonesia perspektif statute approach. *ISLAMICA: Jurnal Studi Keislaman*, *14*(1), 151–170. https://doi.org/10.15642/islamica.2019.14.1.150-170

Bawafie, A. A. A., Tompson, M. D., & Muin, R. (2024). Industri halal: Paradigma tauhid mewujudkan rantai nilai halal di Indonesia. *Kinerja*, *7*(01), 205–212. https://doi.org/10.34005/kinerja.v7i01.3972

Bux, C., Varese, E., Amicarelli, V., & Lombardi, M. (2022). Halal food sustainability between certification and blockchain: A review. *Sustainability*, *14*(4), 2152. https://doi.org/10.3390/su14042152

Casino, F., Kanakaris, V., Dasaklis, T. K., Moschuris, S., Stachtiaris, S., Pagoni, M., & Rachaniotis, N. P. (2021). Blockchain-based food supply chain traceability: A case study in the dairy sector. *International Journal of Production Research*, *59*(19), 5758–5770. https://doi.org/10.1080/00207543.2020.1789238

Chandra, G. R., Liaqat, I. A., & Sharma, B. (2019). Blockchain redefining: The halal food sector. *2019 Amity International Conference on Artificial Intelligence (AICAI)*, 349–354. https://doi.org/10.1109/AICAI.2019.8701321

Dewi, A. P., & Hakiki, M. I. (2023). Transformasi digital dalam industri halal di Indonesia (Studi implementasi teknologi blockchain dalam proses sertifikasi halal). *Indo-Fintech Intellectuals: Journal of Economics and Business*, *3*(2), 360–370. https://doi.org/10.54373/ifijeb.v3i2.240

Effendi, K. A., Mukhlis, T. I., Padmanegara, O. H., & Widajatun, V. W. (2023). Analisis transformasi halal awerness dan teknologi blockchain terhadap penguatan halal value chain di Indonesia. *Jurnal Ilmiah Ekonomi Islam*, *9*(3), 3275. https://doi.org/10.29040/jiei.v9i3.10383

Ghali-Zinoubi, Z. (2022). Examining drivers of environmentally conscious consumer behavior: Theory of planned behavior extended with cultural factors. *Sustainability*, *14*(13), 8072. https://doi.org/10.3390/su14138072

Handayani, D., Vanany, I., & Ciptomulyono, U. (2023). Proposed model for halal blockchain barrier: Literature review and interview. *Proceedings of the 4th International Conference on Advanced Engineering and Technology*, 47–54. https://doi.org/10.5220/0012105200003680

Hassam, S. F., Talip, A., Mustapha, Y. A. A., & Shaharudin, M. R. (2025). Blockchain technology in the halal supply chain: Comparative insights from Malaysian micro, small, and medium enterprises.

P-ISSN: 2715-6214
E-ISSN: 2964-4909

Environment-Behaviour Proceedings Journal, *10*(SI28), 19–24. https://doi.org/10.21834/e-bpj.v10iSI28.6971

Hendayani, R., & Fernando, Y. (2023). Adoption of blockchain technology to improve halal supply chain performance and competitiveness. *Journal of Islamic Marketing*, *14*(9), 2343–2360. https://doi.org/10.1108/JIMA-02-2022-0050

Joshi, R., Kulkarni, Y. A., & Wairkar, S. (2018). Pharmacokinetic, pharmacodynamic and formulations aspects of Naringenin: An update. In *Life Sciences* (Vol. 215). https://doi.org/10.1016/j.lfs.2018.10.066

Kafeel, H., Kumar, V., & Duong, L. (2023). Blockchain in supply chain management: A synthesis of barriers and enablers for managers. *International Journal of Mathematical, Engineering and Management Sciences*, *8*(1), 15–42. https://doi.org/10.33889/IJMEMS.2023.8.1.002

Li, K., Gharehgozli, A., Ahuja, M. V., & Lee, J.-Y. (2020). Blockchain in maritime supply chain: A synthesis analysis of benefits, challenges and limitations. *Journal of Supply Chain and Operations Management*, *18*(2), 257–273.

Liu, N., Bouzembrak, Y., van den Bulk, L. M., Gavai, A., van den Heuvel, L. J., & Marvin, H. J. P. (2022). Automated food safety early warning system in the dairy supply chain using machine learning. *Food Control*, *136*, 108872. https://doi.org/10.1016/j.foodcont.2022.108872

Mahsun, M., Putra, Y. H. S., Asnawi, N., Djalaluddin, A., & Hasib, N. (2023). Blockchain as a reinforcement for traceability of Indonesian halal food information through the value chain analysis framework. *AL-Muqayyad*, *6*(1), 49–66. https://doi.org/10.46963/jam.v6i1.1031

Masudin, I., Rahmatullah, B. B., Agung, M. A., Dewanti, I. A., & Restuputri, D. P. (2022). Traceability system in halal procurement: A bibliometric review. *Logistics*, *6*(4), 67. https://doi.org/10.3390/logistics6040067

Mohaiyadin, N. M. Hj., Zahari, H. M., & Mardzuki, K. (2024). Addressing challenges in halal certification using blockchain technology. In *Emerging Technology and Crisis Management in The Halal Industry* (pp. 49–66). Springer Nature Singapore. https://doi.org/10.1007/978-981-97-1375-2_4

Munawar, M., & Mugiono, A. (2024). Framework for smart contract blockchain in halal traceability, integrity, and transparency. *International Journal of Electrical and Computer Engineering (IJECE)*, *14*(3), 2875. https://doi.org/10.11591/ijece.v14i3.pp2875-2884

Novianti, D., Arkeman, Y., Almunawar, M. N., Haditjaroko, L., & Ismayana, A. (2020). Designing a transparent distributed systems for halal supply chains using blockchain technology. *Journal of Business and Economic Analysis*, *03*(02), 151–170. https://doi.org/10.36924/sbe.2020.3204

Nurhayati, N. (2023). Digital innovation in halal logistics: An Indonesian case study. *Agripreneur: Jurnal Pertanian Agribisnis*, *12*(2), 23–37. https://doi.org/10.35335/agripreneur.v12i2.4672

Qanita, A., Maghfuroh, N. L., & Muhammad, Z. (2024). Integration of HAS with blockchain as halal sustainability in maqashid sharia perspective. *Journal of Halal Product and Research*, *7*(1), 40–51. https://doi.org/10.20473/jhpr.vol.7-issue.1.40-51

Rahim, N. F. (2023). Rapid scoping review of blockchain adoption in halal industry supply chain. *11th International Conference on Applied Science and Technology 2022 (11th ICAST 2022)*, 030043. https://doi.org/10.1063/5.0166546

Rejeb, A., Keogh, J. G., Zailani, S., Treiblmaier, H., & Rejeb, K. (2020). Blockchain technology in the food industry: A review of potentials, challenges and future research directions. *Logistics*, *4*(4), 27. https://doi.org/10.3390/logistics4040027

Rohmah, D., Maharani, S., Kholis, M., Taqwa, S., & Setyaningrum, H. (2019). Traceability and tracking systems of halal food using blockchain technology to improve food industry competitiveness. *Proceedings of the Proceedings of the 1st International Conference on Business, Law And Pedagogy, ICBLP 2019, 13-15 February 2019, Sidoarjo, Indonesia*. https://doi.org/10.4108/eai.13-2-2019.2286199

Rosli, W. N. W., Sikin, A. M., & Ramli, M. H. (2024). Blockchain challenges in halal food industry using technology-organization-environment (TOE) And FMEA framework. *International Journal of Business and Technology Management*, *6*(1), 357–368. https://doi.org/10.55057/ijbtm.2024.6.1.30

Sahai, A., & Pandey, R. (2020). Smart contract definition for land registry in blockchain. *2020 IEEE 9th International Conference on Communication Systems and Network Technologies (CSNT)*, 230–235. https://doi.org/10.1109/CSNT48778.2020.9115752

P-ISSN: 2715-6214
E-ISSN: 2964-4909

Sarah, A. A., & Bergmans, B. (2021). Blockchain technology as a solution of integration issue in halal food supply chain. *Diponegoro Journal of Accounting*, *10*(4), 1–15.

Sidarto, L. P., & Hamka, A. (2021). Improving halal traceability process in the poultry industry utilizing blockchain technology: Use case in Indonesia. *Frontiers in Blockchain*, *4*. https://doi.org/10.3389/fbloc.2021.612898

Singh, V., & Sharma, S. K. (2023). Application of blockchain technology in shaping the future of food industry based on transparency and consumer trust. *Journal of Food Science and Technology*, *60*(4), 1237–1254. https://doi.org/10.1007/s13197-022-05360-0

Sookhak, M., Jabbarpour, M. R., Safa, N. S., & Yu, F. R. (2021). Blockchain and smart contract for access control in healthcare: A survey, issues and challenges, and open issues. *Journal of Network and Computer Applications*, *178*, 102950. https://doi.org/10.1016/j.jnca.2020.102950

Sumarliah, E., Li, T., Wang, B., Khan, S. U., & Khan, S. Z. (2023). Blockchain technology adoption in Halal traceability scheme of the food supply chain: evidence from Indonesian firms. *International Journal of Emerging Markets*. https://doi.org/10.1108/IJOEM-05-2021-0678

Sup, D. F. A., Fahmi, A. S. R., Hilal, F. N., & Firdaus, M. I. (2020). Dinamika regulasi sertifikasi halal di Indonesia. *Jurnal Ekonomi Syariah Indonesia*, *10*(1), 36–44.

Tan, A., Gligor, D., & Ngah, A. (2022). Applying blockchain for halal food traceability. *International Journal of Logistics Research and Applications*, *25*(6), 947–964. https://doi.org/10.1080/13675567.2020.1825653

Vanany, I., Pramesti, N. S., Rakhmawati, N. A., & Soon, J. M. (2021). Blockchain adoption for halal food integrity in Indonesian food industry. *2nd Asia Pacific International Conference on Industrial Engineering and Operations Management*, 728–736.

Villanuev, N. E. (2021). Blockchain technology application: Challenges, limitations and issues. *Journal of Computational Innovations and Engineering Applications*, *5*(2), 8–14.

Wu, C., Xiong, J., Xiong, H., Zhao, Y., & Yi, W. (2022). A review on recent progress of smart contract in blockchain. *IEEE Access*, *10*, 50839–50863. https://doi.org/10.1109/ACCESS.2022.3174052

Younus, A. M., & Younus, K. M. (2021). Supply chain using smart contract blockchain technology in organizational business. *European Journal of Research Development and Sustainability (EJRDS)*, *2*(7), 99–104.

Yudhianto, K. A., Siregar, J., & Hajar, B. S. (2024). Innovation in education fund management. *Jurnal Kajian Pendidikan Dan Psikologi*, *1*(3), 170–178. https://doi.org/10.61397/jkpp.v1i3.120