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Advancing Halal Integrity: Policy and Strategic Insights for Indonesia's Digital Cold Chain Transformation

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Abstract With a population of over 230 million Muslims, Indonesia is a pivotal driver of the global halal market. As demand for halal-compliant logistics grows, the Indonesian halal sector requires rapid modernization to maintain a competitive advantage. This study examines the application of halal cold chain theory within the Indonesian logistics landscape to enhance operational efficiency, transparency, and strict regulatory compliance. Utilizing a comprehensive case study methodology and a **systematic literature review (2015–2025)**, the research investigates the synergy between organizational capabilities and the implementation of digital technologies. Findings reveal that integrating the Internet of Things (IoT), Blockchain, and Big Data is essential for maintaining halal integrity and temperature stability for sensitive commodities. Despite persistent challenges such as high operational costs and infrastructure deficits, digital transformation offers a critical pathway to mitigate risks through automation and real-time monitoring. The results provide strategic insights for policymakers (BPJPH and MUI) to develop standardized protocols and fiscal incentives. Furthermore, this research offers a framework for logistics operators to leverage digital tools, fostering consumer trust and securing a resilient position in an evolving global market.

Keywords: Cold Chain; Halal Logistics; Digital Transformation; Indonesia; IoT

INTRODUCTION

In the global landscape of 2026, the Halal economy has matured into a dominant market force, with Indonesia serving as its primary driver due to a Muslim population exceeding 230 million whose consumer behaviors are deeply rooted in Sharia compliance. This demographic shift necessitates a logistical infrastructure that guarantees both operational efficiency and religious integrity; however, as the demand for perishable halal goods such as pharmaceuticals, dairy, and fresh proteins surges, the cold chain has emerged as the most critical yet vulnerable link in the supply chain. Despite its vast potential, the Indonesian cold chain industry faces a significant "integrity gap" characterized by a dearth of standardization, high operational costs, and geographical complexities that lead to temperature fluctuations and cross-contamination risks (Zailani et al., 2017). In the specific context of Halal logistics, even a momentary lapse in temperature control or unmonitored contact with non-halal substances renders an entire shipment non-compliant, a risk that current manual monitoring systems can no longer mitigate to meet the transparency requirements of 2026 consumers and regulatory bodies like BPJPH and MUI. Consequently, this study argues that digital transformation, specifically the synergy of the Internet of Things (IoT), Blockchain, and Big Data, is the only viable pathway to securing halal integrity (Syahputri & Sucipto, 2021). While existing literature has explored general digital logistics, there remains a significant dearth of empirical evidence specifically linking organizational readiness with integrated digital frameworks in the Indonesian context. Utilizing a systematic literature review spanning 2015–2025 and a comprehensive case study, this research fills that critical gap by providing a strategic

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roadmap for both industry players and policymakers to foster a resilient, digitally-driven halal ecosystem.

METHOD

This study employs a dual-methodological approach to investigate the integration of digital technologies within the Indonesian halal cold chain. The research is structured into two distinct phases: a Systematic Literature Review (SLR) to establish a theoretical foundation, followed by a qualitative case study to capture real-world operational insights.

A. Phase I: Theoretical Foundation and Literature Review

The first phase of this study involved an extensive review of existing literature to establish a robust theoretical baseline for the Indonesian halal cold chain. Rather than a broad overview, the search was purposefully focused on the evolution of digital logistics within the last decade (**2015–2025**). This timeframe was selected to capture the industry's progression from basic tracking technologies to the sophisticated integration of AI and Blockchain currently observed in the mid-2020s.

- **Source Selection:** Key academic databases, including Scopus and Google Scholar, were utilized to identify high-impact research. The search was centered on themes such as "Halal Cold Chain," "Digital Logistics in Indonesia," and "Technological Traceability."
- **Focus Areas:** The review prioritized peer-reviewed articles and industry reports that specifically discuss the intersection of technological capabilities and Sharia compliance requirements.
- **Objective:** The insights gained from this literature phase served as the conceptual foundation, identifying the "integrity gaps" and digitalization hurdles that were subsequently analyzed through the practical case study phase.

B. Phase II: Qualitative Case Study

The second phase utilized a comprehensive case study methodology to examine the practical challenges and strategies of Indonesian logistics operators. This qualitative approach was selected to provide an in-depth understanding of "how" and "why" certain digital tools are adopted within the local context.

- **Data Collection:** Information was gathered through semi-structured interviews with key stakeholders in the Indonesian logistics sector and a review of internal organizational policies regarding halal management.
- **Case Selection:** The study focused on logistics providers currently navigating the transition toward "Halal Digital Transformation" to ensure the findings reflect contemporary industry hurdles and best practices.

C. Data Analysis

A thematic analysis was applied to the collected data. The SLR findings were coded to identify recurring technological themes, while the case study data was analyzed to identify "Organizational Readiness" and "Policy Compliance" patterns. The synergy between these two data sources allowed for the development of a strategic roadmap that addresses both technical requirements and the regulatory expectations of BPJPH and MUI.

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RESULTS AND DISCUSSION

A. Analysis of the Technological Landscape and Implementation Barriers

The analysis of the Indonesian logistics sector reveals a pronounced imbalance between the rapid expansion of the halal market and the relatively slow pace of cold chain modernization. As illustrated in **Figure 1. (The Smart Halal Gateway)**, halal integrity depends on the convergence of two critical input streams: *temperature stability* and *halal segregation assurance*. However, empirical findings from the case study indicate that this convergence is frequently disrupted by persistent structural bottlenecks. First, **infrastructural gaps** remain a dominant constraint. Indonesia's geographical fragmentation complicates the maintenance of uninterrupted cold chain conditions, particularly during high-risk last-mile delivery stages. These disruptions directly undermine the left-side input of the Smart Halal Gateway *IoT-enabled temperature monitoring* where even short-term deviations may compromise both food safety and *toyyiban* status (Ali et al., 2021; Zailani et al., 2017).

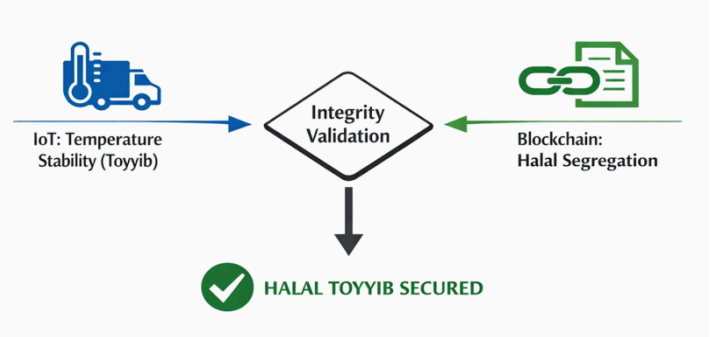

Figure 1. The Smart Halal Gateway

This finding aligns with prior studies highlighting the vulnerability of cold chains in archipelagic logistics systems. Second, **economic barriers**, notably high capital expenditure (CAPEX) associated with IoT sensors and blockchain-enabled platforms, limit digital adoption among small and medium enterprises (SMEs). As a result, many logistics operators remain unable to implement the dual-input validation mechanism depicted in Figure 1., leaving halal compliance reliant on fragmented or manual documentation systems (Mubin et al., 2021). Third, **standardization deficits** continue to generate information silos across the halal logistics ecosystem(Nurhayati N, 2025). The absence of unified digital protocols between private logistics providers and regulatory authorities such as BPJPH and MUI hinders the seamless integration of temperature data and halal segregation records. Consequently, the "integrity validation gate" illustrated in Figure 1. often lacks synchronized, verifiable inputs, weakening end-to-end halal assurance.

B. Technological Synergy and the "Self-Auditing" Halal Ecosystem

Despite these barriers, the findings demonstrate that the **integrated application of IoT, Blockchain, and Big Data enables** a transformative "self-auditing" halal ecosystem, as conceptualized in **Figure 1**. Within this framework, IoT sensors continuously generate real-time temperature data, fulfilling the *toyyiban* requirement by ensuring product safety and cold chain stability throughout logistics operations (Syahputri & Sucipto, 2021). In parallel, blockchain technology operationalizes the right-side input of the Smart Halal Gateway by recording immutable halal segregation data at every logistics node. This

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decentralized ledger provides transparent and tamper-resistant documentation, significantly reducing the risk of halal–haram cross-contamination and enhancing trust among regulators and consumers (Thakur et al., 2020). The convergence of these two verified inputs temperature stability and halal segregation activates the **Integrity Validation Gate** shown in Figure 1. Once validated, the system produces a "Halal Toyyib Secured" outcome, transforming halal assurance from a reactive, inspection-based model into a proactive and continuously verifiable process. Furthermore, the incorporation of **Big Data analytics** strengthens this ecosystem by enabling predictive insights, allowing firms to anticipate cold chain disruptions caused by traffic congestion, infrastructure delays, or weather volatility before compliance breaches occur (Jin et al., 2020; Li et al., 2023).

C. Strategic Discussion and Policy Roadmap

Synthesizing the empirical findings with the literature reviewed from 2015–2025, it is evident that technological effectiveness is fundamentally contingent upon **organizational readiness**. Firms equipped with dedicated **Halal Management Teams (HMTs)** demonstrate a significantly higher capacity to operationalize the Smart Halal Gateway framework presented in Figure 1. This observation is consistent with behavioral and organizational studies indicating that internal commitment and governance structures strongly influence digital adoption in halal logistics systems (Syahputri & Sucipto, 2021).

According to Ali & Suleiman (2018) and Azwar et al., (2022) From a policy perspective, the findings suggest that **BPJPH and MUI** must evolve beyond traditional certification roles toward becoming active enablers of digital halal ecosystems. The Smart Halal Gateway framework (Figure 1.) highlights the urgency of establishing a **National Halal Digital Standard** that integrates IoT-generated temperature data, blockchain-based segregation records, and regulatory oversight into a unified digital system. To accelerate adoption particularly among SMEs policy instruments such as tax incentives, digital infrastructure subsidies, and standardized technical guidelines are essential, echoing recommendations in prior digital logistics and traceability studies (Abd Rahman et al., 2023; Karia, 2022)

Strategic alignment between organizational capabilities and regulatory frameworks will not only strengthen domestic consumer trust by 2026 but also position Indonesia as a global reference model for digitally enabled halal cold chain governance(Nurhayati, 2023).

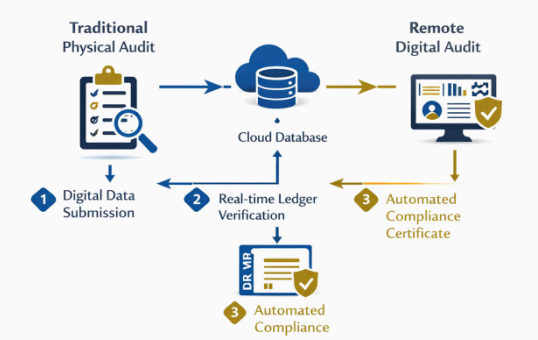

Figure 2. Blueprint for National Halal Digital Standard

Figure 2. illustrates a proposed policy roadmap for transitioning Indonesia's halal certification system from traditional, on-site physical audits to a remote, digitally enabled compliance model. The framework highlights the integration of regulatory authorities

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(BPJPH and MUI) with a centralized cloud-based database, enabling sequential stages of (1) digital data submission, (2) real-time ledger verification, and (3) automated issuance of halal compliance certificates. This digital-first approach enhances transparency, reduces audit latency, and supports scalable halal governance within Indonesia's evolving cold chain and logistics ecosystem.

CONCLUSION

This study has examined the critical intersection of digital transformation and halal integrity within the Indonesian cold chain landscape. By synthesizing a decade of literature (2015–2025) with contemporary case study insights, the research demonstrates that the transition from traditional to digital logistics is no longer an elective upgrade but a fundamental requirement for market resilience in 2026.

A. Key Findings

The research confirms that while the Indonesian halal sector possesses immense growth potential, it remains hindered by a persistent "integrity gap" caused by geographical fragmentation and high technological entry barriers. However, the synergy of **IoT, Blockchain, and Big Data** provides a robust solution, creating an immutable "self-auditing" ecosystem that ensures Sharia compliance through real-time transparency.

B. Managerial and Policy Contributions

For logistics practitioners, this study highlights that **"Organizational Readiness"** specifically the establishment of dedicated Halal Management Teams is the primary predictor of successful digital adoption. Strategically, firms must shift their view of digital tools from a cost center to a value-generating asset that builds non-negotiable consumer trust.

From a policy perspective, the findings advocate for **BPJPH and MUI** to transition toward a digital-first certification model. The recommendation for a "National Halal Digital Standard," supported by fiscal incentives such as tax rebates for IoT infrastructure, provides a roadmap for the Indonesian government to lower the CAPEX burden on SMEs.

C. Limitations and Future Research

While this study focuses on the Indonesian context, the findings offer a scalable framework for other OIC (Organization of Islamic Cooperation) nations. Future research should explore the role of Artificial Intelligence in automating halal risk prediction and the potential for cross-border digital halal protocols to facilitate international trade.

Ultimately, the digital transformation of the cold chain will be the defining factor in whether Indonesia achieves its goal of becoming the global epicenter of the halal economy.

REFERENCES

Abd Rahman, A., Abd Mubin, N., Yusof, R. N. R., & Kamarulzaman, N. H. (2023). Building supply chain performance through halal logistics, organisational capabilities and knowledge management. *International Journal of Logistics Research and Applications*, *26*(4), 498–520. https://doi.org/10.1080/13675567.2021.1969347

Ali, M. H., & Suleiman, N. (2018). Eleven shades of food integrity: A halal supply chain perspective. *Trends in Food Science and Technology*, *71*(November 2017), 216–224. https://doi.org/10.1016/j.tifs.2017.11.016

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DOI: 10.47841/icorad.v5i1.415

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*(May), 120870. https://doi.org/10.1016/j.techfore.2021.120870

Azwar, A., Usman, A. H., & Abdullah, M. F. R. (2022). The Opportunities and Challenges of the Halal Food Industry in Indonesia: Some Notes From Quranic and Economic Perspectives. *Al-Irsyad Journal of Islamic and Contemporary Issues*. https://doi.org/10.53840/alirsyad.v7i1.270

Jin, C., Bouzembrak, Y., Zhou, J., Liang, Q., & ... (2020). Big Data in food safety-A review. In *Current Opinion in Food …*. Elsevier. https://www.sciencedirect.com/science/article/pii/S2214799320301260

Karia, N. (2022). Halal logistics: practices, integration and performance of logistics service providers. *Journal of Islamic Marketing*, *13*(1), 100–118. https://doi.org/10.1108/JIMA-08-2018-0132

Li, L., Gong, Y., Wang, Z., & Liu, S. (2023). Big data and big disaster: a mechanism of supply chain risk management in global logistics industry. *International Journal of Operations and Production Management*, *43*(2), 274–307. https://doi.org/10.1108/IJOPM-04-2022-0266

Mubin, N. A., Rahman, A. A., Kamarulzaman, N. H., & Yusof, R. N. R. (2021). Readiness and Stakeholders Influence for Halal Logistics Practices Implementation towards Supply Chain Performance. *International Journal of Asian Social Science*, *12*(1), 26–42. https://doi.org/10.18488/5007.v12i1.4394

Nurhayati N, C. A. M. Y. FC. 2025. U. halal potential: exploring the dynamics of halal logistics in T. C. Indonesia. (2025). UNLEASHING HALAL POTENTIAL: EXPLORING THE DYNAMICS OF HALAL LOGISTICS IN TANGERANG CITY, INDONESIA. *Agrociencia*, (2025: Early Access (59-3)), 1–13. https://doi.org/https://doi.org/10.47163/agrociencia.v59i3.3272

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

Syahputri, B. E., & Sucipto, S. (2021). Monitoring of beef cold chain to ensure quality, safety, and halal using RFID: A review. *IOP Conference Series: Earth and Environmental Science*, *924*(1). https://doi.org/10.1088/1755-1315/924/1/012001

Thakur, M., Møen Tveit, G., Vevle, G., & Yurt, T. (2020). A framework for traceability of hides for improved supply chain coordination. *Computers and Electronics in Agriculture*, *174*(October 2019), 105478. https://doi.org/10.1016/j.compag.2020.105478

Zailani, S., Iranmanesh, M., Aziz, A., & Kanapathy, K. (2017). Halal Logistics Opportunities and Challenges. *Journal of Islamic Marketing*. https://doi.org/10.1108/jima-04-2015-0028