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A Systematic Review of Traceability and Monitoring in Port Transportation Processes for Halal Compliance and Certification

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Abstract

This systematic review provides a comprehensive analysis of halal transportation practices at ports, with a focus on the critical aspects of traceability and monitoring mechanisms. As the global halal market continues to expand rapidly, ensuring the integrity of halal products across the entire supply chain, particularly during port clearance and transportation—has become increasingly vital. This article synthesizes current research on the challenges faced in transportation, technological advancements, and the regulatory frameworks governing halal logistics at ports. It evaluates existing methods for tracking and verifying the halal status of goods from their origin to the destination, emphasizing the pivotal role of traceability and monitoring in upholding halal integrity. The review identifies significant gaps in the literature, particularly concerning the standardization of halal transport protocols and the integration of advanced tracking technologies. Additionally, it examines the policies and regulatory bodies responsible for overseeing the halal transport process. The findings underscore the urgent need to develop comprehensive, globally recognized guidelines that can adapt to the rapidly evolving technological landscape and address the diverse needs of the halal market. This study is instrumental in fostering more efficient, transparent, and reliable halal shipping practices at ports, ultimately bolstering consumer confidence and supporting the continued growth of the global halal market.

Keywords: Halal Port, Halal Transportation, Halal Logistics, Traceability, Monitoring.

I. INTRODUCTION

The global Halal market has experienced unprecedented growth in recent years, expanding beyond food to include pharmaceuticals, cosmetics, and logistics services. Among these, Halal transportation plays a crucial role in maintaining the integrity and compliance of Halal products from the point of origin to consumers. This is particularly critical at ports, where goods are transferred from one mode of transport to another, increasing the risk of cross-contamination with non-Halal items. Ports are considered a driving force in the global supply chain due to their critical role in transportation and

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logistics, serving as essential hubs of economic growth both nationally and internationally. They contribute significantly to a country's gross domestic product (GDP) through the facilitation of trade and the movement of goods across borders (Reyna et al., 2018; Tieman et al., 2019; Vikaliana et al., 2020). Despite the significant growth and evolution of the Halal market, a notable gap remains in the standardization of Halal transport protocols and the implementation of advanced traceability technologies such as blockchain and IoT, which are vital for maintaining the integrity of Halal products during transportation. This gap poses challenges to maintaining the integrity of Halal products, especially during complex logistical operations at ports. The lack of unified guidelines and the underutilization of emerging technologies like blockchain and IoT in Halal logistics represent critical areas that require further exploration.

Thus, the importance of traceability and monitoring in Halal transportation cannot be overstated, as they ensure that products remain pure, safe, and compliant with Islamic law throughout their journey. This article reviews the Halal transportation process at ports, focusing on the traceability and monitoring mechanisms employed to uphold Halal integrity. The review identifies key gaps in the literature, specifically in the areas of standardization and technology adoption, and aims to address these gaps by analyzing various publications on Halal transportation implemented at ports. By examining existing literature, case studies, industry publications, and newspaper articles, this review offers insights into the current state of Halal transportation, highlighting the significance of robust traceability and monitoring systems in meeting consumer demands and religious obligations. As the Halal market continues to evolve, understanding the dynamics of Halal transportation at ports becomes essential for stakeholders across the supply chain. This article contributes to the body of knowledge by providing a detailed overview of current practices and future directions in Halal transportation logistics, offering valuable perspectives for academics, industry professionals, and policymakers involved in the Halal ecosystem.

Additionally, the systematic review examines critical aspects of traceability and monitoring in port transport processes, focusing on their importance in ensuring compliance with Halal standards and certification requirements. Halal products that comply with Islamic dietary laws require strict monitoring throughout the transport chain to maintain their integrity. This study aims to analyze the existing literature and identify key factors and challenges related to the traceability and tracking of Halal products in port operations. Through a comprehensive examination of these processes, the review aims to provide insights to improve Halal compliance and certification of port transportation systems. This review systematically examines publications on Halal transportation or logistics at ports published up to 2023. The literature search for this study was comprehensive, encompassing publications in both the English and Malay languages. This bilingual approach was necessary due to the scarce availability of scholarly work addressing Halal ports. Once the relevant articles were identified, they were systematically categorized according to their year of publication, revealing trends and fluctuations in academic interest over time. The review identifies critical factors and challenges in ensuring Halal integrity throughout the transportation chain, providing insights into enhancing traceability and monitoring mechanisms to uphold Halal standards in port operations.

II. LITERATURE REVIEW

The growth of the global Halal market has driven significant interest in ensuring that Halal products maintain their integrity throughout the supply chain. This is especially critical in logistics, where the risk of cross-contamination is high, particularly during port transportation. This literature review examines the key areas of Halal logistics, focusing on traceability and monitoring mechanisms, the adoption of advanced technologies like blockchain and IoT, and the regulatory frameworks that govern Halal logistics.

2.1. Halal Logistics and Port Operations

Ports play a pivotal role in global trade and are essential for countries' economic growth, acting as critical nodes in the supply chain (Reyna et al., 2018; Tieman et al., 2019). Despite their importance, the standardization of Halal logistics practices at ports remains underdeveloped. Studies by Tieman et al. (2019) highlight the challenges ports face in maintaining Halal integrity, mainly due to the lack of consistent standards across different regions. The complexity of port operations, coupled with the high risk of cross-contamination during the transfer of goods, necessitates stringent monitoring and traceability mechanisms. These logistics centres play a fundamental role in ensuring the efficiency and reliability of supply chains, particularly within the Halal industry, where the integrity of products is paramount. However, the standardization of Halal logistics practices at ports remains underdeveloped, posing significant challenges to maintaining the purity and compliance of Halal goods.

2.2. Traceability and Monitoring Mechanisms

Traceability is a foundational pillar in Halal logistics, ensuring that products adhere to Islamic dietary laws from origin to the final consumer. It is essential for maintaining the integrity of Halal products throughout the supply chain, particularly in complex logistics operations where the risk of cross-contamination is high. As the demand for Halal products grows globally, the need for more sophisticated traceability mechanisms has become increasingly apparent. Recent technological advancements have introduced innovative methods to enhance the traceability and monitoring of Halal products. Among these, blockchain technology is an up-and-coming tool for improving transparency and reliability within Halal logistics (Reyna et al., 2018; Vikaliana et al., 2020). Blockchain operates as a decentralized ledger that records transactions across a network of computers in a way that ensures the data is both secure and immutable. This technology is particularly well-suited to Halal logistics because it creates a tamper-proof record of each transaction, from sourcing raw materials to the final product sale.

Utilizing blockchain allows each step in the supply chain to be logged and verified, providing a clear and unalterable history of the product's journey. This is crucial in Halal logistics, where maintaining the purity and compliance of products with Islamic laws is paramount. For instance, blockchain can record the certification status of suppliers, the conditions under which products are stored and transported, and the compliance checks conducted at various points in the supply chain. This level of transparency helps verify the Halal status of products and builds consumer trust, as customers can access and review the history of the product they purchase. In addition to blockchain, other technologies such as IoT (Internet of Things) also enhance traceability in Halal logistics. IoT devices can monitor real-time data on various aspects of product handling, such as temperature, humidity, and location, ensuring that products are stored and transported under conditions that comply with Halal standards (Reyna et al., 2018). Integrating IoT with blockchain further strengthens the traceability system by providing real-time updates

securely recorded on the blockchain, creating a comprehensive and reliable system for monitoring Halal products.

2.3. IoT (Internet of Things)

The Internet of Things (IoT) is increasingly playing a pivotal role in enhancing the monitoring capabilities within Halal logistics. IoT devices, which are interconnected sensors and systems, enable real-time data collection and analysis regarding the conditions of goods during transportation. This capability is crucial for maintaining the Halal status of perishable items, where specific conditions such as temperature, humidity, and handling practices must be rigorously controlled to ensure compliance with Islamic dietary laws (Reyna et al., 2018). By continuously monitoring these critical environmental factors, IoT technology helps to mitigate risks associated with the complex and often fragmented nature of global supply chains. For instance, IoT sensors can be embedded within vehicles or storage units to track the temperature and humidity levels that perishable Halal products are exposed to throughout their journey. Any deviations from the required standards can be immediately detected and addressed, thereby preventing potential contamination or spoilage that could compromise the Halal integrity of the products (Reyna et al., 2018; Vikaliana et al., 2020). Furthermore, the integration of IoT with other technologies, such as blockchain, enhances the overall traceability and transparency of the Halal supply chain. IoT devices can feed real-time data directly into blockchain systems, creating a secure and immutable record of the conditions under which Halal goods are transported and stored. This combination not only ensures strict adherence to Halal standards but also provides verifiable evidence of compliance that can be accessed by all stakeholders, including consumers, regulators, and certification bodies (Reyna et al., 2018; Tieman et al., 2019).

2.4. Challenges in Standardization and Technology Adoption

While the potential of blockchain and IoT in Halal logistics is clear, their adoption faces several barriers. One of the significant challenges is the lack of a unified framework for Halal logistics across different countries. The global nature of Halal trade means that products often pass through multiple jurisdictions, each with its standards and regulations. This lack of standardization can lead to inconsistencies in monitoring and enforcing Halal compliance (Tieman et al., 2019; Vikaliana et al., 2020). Moreover, integrating advanced technologies into existing logistics systems requires significant investment and technical expertise, which can be a barrier for smaller companies. Additionally, there is a need for greater collaboration between governments, industry stakeholders, and technology providers to develop and implement effective solutions that can be widely adopted across the Halal logistics sector (Reyna et al., 2018). Regulatory bodies play a crucial role in overseeing Halal logistics and ensuring that standards are upheld throughout the supply chain. However, the effectiveness of these regulations varies widely across different regions. In some countries, the regulatory frameworks are well-established and provide clear guidelines for Halal logistics. In others, the regulations are less stringent, leading to potential gaps in Halal compliance (Vikaliana et al., 2020). Industry practices also vary, with some companies leading the way in adopting new technologies and setting high standards for Halal logistics. The practice disparity highlights the need for more consistent regulations and greater industry collaboration to ensure Halal products maintain their integrity throughout the supply chain (Reyna et al., 2018). Henceforth, the literature on Halal logistics underscores the critical importance of traceability and monitoring in maintaining Halal integrity during transportation. While advancements in technology, such as blockchain and IoT, offer promising solutions, their widespread adoption is hindered by challenges in standardization and the need for greater

regulatory oversight. As the Halal market continues to grow, stakeholders must work together to develop and implement unified standards and technologies to ensure Halal products' integrity throughout the global supply chain.

III. RESEARCH METHODOLOGY

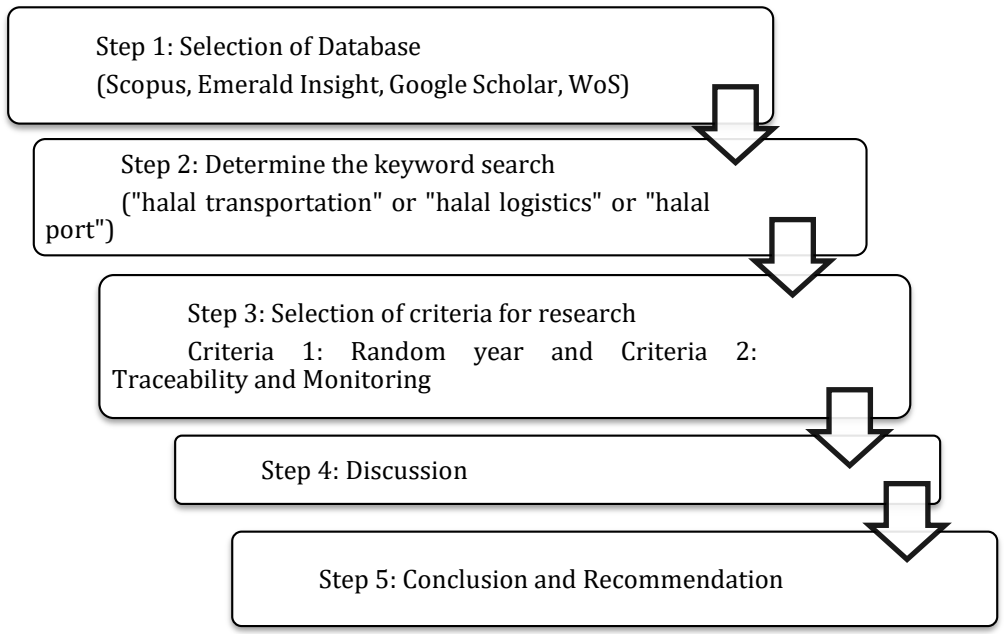
This study employed a systematic review approach to analyze and synthesize the literature on Halal logistics and port operations. The systematic review method was chosen because it allows for a comprehensive and structured examination of a broad range of studies, enabling the identification of patterns, trends, and gaps in the current body of knowledge. By rigorously following this method, the research ensured that the findings were reliable and relevant to stakeholders in the Halal logistics industry. This research methodology is essential because it can ensure comprehensive, focused, and rigorous data collection and analysis, which is critical for producing meaningful and actionable findings in Halal logistics and port operations. Figure 2 provides a detailed overview of the research methodology employed in this study, designed to review and analyze the literature on Halal port operations systematically. The methodology commenced with selecting relevant databases, including Scopus, Emerald Insight, and Google Scholar, which are known for their comprehensive coverage of academic publications and industry reports. These platforms were chosen for their ability to provide access to a wide range of sources, including peer-reviewed journal articles, conference proceedings, and industry white papers, which are crucial for thoroughly exploring the subject matter.

The literature search strategically focused on sourcing articles related to Halal port operations, utilizing various mediums such as newspapers, press releases, conference papers, and search engines to ensure a diverse and inclusive data collection. The search strategy involved the careful identification of articles using specific and targeted keywords like "Halal port," "Halal transportation," and "Halal logistics." These keywords were selected to capture the full scope of research pertinent to the logistics and operational aspects of Halal ports, reflecting the study's comprehensive approach to understanding current practices, challenges, and advancements in the field. The selection process was governed by two primary criteria designed to ensure the relevance and quality of the included literature. Criteria 1 adopted a non-restrictive approach to the publication year, including historical and recent studies to provide a holistic view of the evolution of Halal port logistics. This inclusive criterion ensured that the review could trace the development of practices and identify long-standing challenges and emerging trends. Criteria 2 focused on the articles' traceability and systematic monitoring aspects, prioritizing those that provided in-depth analysis or case studies on how Halal integrity is maintained through various monitoring mechanisms.

Following identifying and selecting relevant articles, the study proceeded to Step 4, which involved a thorough analysis and synthesis of the findings. This step included categorizing the literature based on technological advancements, regulatory frameworks, and operational challenges. The synthesis process was critical for distilling the insights gained from the diverse sources and identifying common threads as well as divergent viewpoints within the existing body of knowledge. Finally, Step 5 involved presenting the conclusions and recommendations derived from the synthesized insights. This stage was crucial for translating the literature review into actionable insights, offering recommendations for future research and practical implementations in Halal logistics. The methodology ensured that the study was comprehensive, systematic, and capable of providing meaningful contributions to Halal port operations. This enhanced

methodology reflects a robust approach to reviewing and synthesizing literature, ensuring the findings are well-supported and relevant to academic and industry stakeholders interested in Halal logistics and port operations.

Figure 1.
Research Methodology Process



IV. RESULTS AND DISCUSSIONS

This research's significant contribution lies in its comprehensive analysis of the existing literature on Halal port operations, focusing mainly on traceability and monitoring within Halal logistics. The research provides a systematic review that identifies critical patterns and trends in adopting technologies, the challenges in maintaining Halal integrity, and the gaps in standardization across different regions.

4.1. Identification of Key Patterns and Trends

The research highlights several vital patterns and trends within the field of Halal logistics at ports that prioritize on technological adoption. The study identifies a growing trend toward adopting advanced technologies such as blockchain and IoT. These technologies are increasingly recognized for their potential to enhance traceability and monitoring in Halal logistics, offering solutions to some of the most pressing challenges in the field. The research also uncovers a persistent pattern of inconsistencies in the standardization of Halal logistics practices across different regions. This finding underscores the need for more harmonized global standards to ensure the integrity of Halal products throughout the supply chain.

4.2. Framework Development

Although the research does not propose a new operational framework, it contributes to the conceptual framework of Halal logistics by synthesizing existing knowledge and identifying the critical components necessary for effective traceability and monitoring. This conceptual framework serves as a basis for future studies that might develop more specific operational frameworks or guidelines for Halal logistics at ports.

4.3. Discussion

The systematic review conducted in this study yielded several key findings related to Halal logistics and port operations, particularly in traceability, monitoring, and the implementation of advanced technologies. These findings underscore the critical role that ports play in maintaining the integrity of Halal products and highlight the challenges and opportunities present in this sector.

4.3.1. Inconsistencies in Standardization

One of the review's most significant findings is inconsistent standards across different regions regarding Halal logistics practices at ports. The absence of uniform regulations creates vulnerabilities in the Halal supply chain, where the risk of cross-contamination and non-compliance with Halal standards is heightened. This inconsistency hampers the effectiveness of Halal logistics, as different ports may apply varying levels of rigour in maintaining Halal integrity, leading to potential gaps in the supply chain (Reyna et al., 2018; Tieman et al., 2019). The halal industry necessitates an integrated logistics and transportation framework to guarantee that halal products are moved in adherence to halal procedures. This demands a cooperative effort between the halal industry and the maritime transportation field to formulate and apply halal transportation regulations and criteria, ensuring that ports and shipping firms are prepared to manage halal goods efficiently (Ja'afar et al.; A.M., 2023). Several studies have proposed conceptual frameworks for halal transportation and logistics. The frameworks emphasise the need for integrity, transparency, and Shariah compliance throughout the transportation process, with the critical components including halal certification requirements, training for personnel involved in halal transportation, and the use of technology to ensure traceability and compliance.

4.3.2. Challenges in Traceability and Monitoring

The study found that while traceability and monitoring are recognized as crucial for ensuring the Halal status of products, their implementation remains challenging. The complexity of port operations and the high turnover of goods make it difficult to maintain continuous monitoring throughout the supply chain. Although technologies like blockchain and IoT offer potential solutions, their adoption is still limited due to the high costs and technical expertise required for implementation (Reyna et al., 2018; Vikaliana et al., 2020). The monitoring referred to in this paper is the guideline and regulation set by the government or Halal authority. Nurul Ain et al. (2020) identified challenges in implementing Halal Hubs due to the need for specific procedures. The key issues include low industry demand for Halal Hubs in ports, stringent regulations, and limited categories of halal goods. Thus, Aziz, A.A., and Zailani, S. (2016) agreed on the crucial role of ports in halal logistics, serving as critical points for delivering halal products to consumers. Effective halal logistics at ports involve transfer, delivery/receipt, shipping, and storage processes, with a strict inspection to maintain halal integrity, thereby improving the supply chain.

4.3.3. Technological Advancements and Opportunities

Despite the challenges, the review highlights significant opportunities presented by technological advancements in Halal logistics. Blockchain technology, in particular, is identified as a promising tool for enhancing transparency and reliability in the Halal supply chain. Blockchain's ability to create secure, immutable records of transactions can be crucial for verifying the Halal status of products at every stage of the supply chain. IoT devices provide real-time data on the conditions of goods during transportation, such as temperature and humidity, which are critical for maintaining the Halal status of perishable items (Reyna et al., 2018; Vikaliana et al., 2020). Recent studies have explored technology's role in enhancing halal transportation's integrity and efficiency. Blockchain,

the Internet of Things (IoT), and smart contracts are promising technologies for ensuring compliance, traceability, and transparency in the halal supply chain. Ensuring the physical separation of halal from non-halal items, designated storage areas, and clear labelling is essential (Aziz et al.; S., 2016). Furthermore, labelling is the practice to segregate the different products and easy handling of goods. However, exporters often do not classify items like cosmetics and pharmaceuticals as halal. In addition, Northport also lacks mandatory halal storage procedures, and its staff cannot inspect containers to uphold customer privacy. The shift of auditing responsibilities from HDC to JAKIM has also introduced confusion and complexity (Ain et al., 2020). Thus, it shows the importance of traceability in Halal transportation to ensure it is documented and quickly declared by the exporters.

4.3.4. Need for Regulatory Reform and Collaboration

The findings also suggest a pressing need for regulatory reform and greater collaboration among stakeholders in the Halal logistics sector. The study emphasizes the importance of developing globally recognized guidelines that can be consistently applied across different regions. This requires not only regulatory changes but also collaboration between governments, industry players, and technology providers to ensure that Halal logistics practices are both effective and scalable (Reyna et al., 2018; Tieman et al., 2019). The halal industry necessitates an integrated logistics and transportation framework to guarantee that halal products are moved in adherence to halal procedures. This demands a cooperative effort between the halal industry and the maritime transportation field to formulate and apply halal transportation regulations and criteria, ensuring that ports and shipping firms are prepared to manage halal goods efficiently (Ja'afar et al.; A.M., 2023). Several studies have proposed conceptual frameworks for halal transportation and logistics. The frameworks emphasise the need for integrity, transparency, and Shariah compliance throughout the transportation process, with the critical components including halal certification requirements, training for personnel involved in halal transportation, and the use of technology to ensure traceability and compliance.

4.3.5. Consumer Confidence and Market Growth

Finally, the review indicates that improving traceability and monitoring mechanisms in Halal logistics can significantly enhance consumer confidence in Halal products. As the global demand for Halal-certified products grows, robust, transparent, and reliable Halal logistics practices are becoming increasingly necessary. Addressing the challenges identified in this study will be critical for supporting the continued expansion of the global Halal market (Vikaliana et al., 2020). As the demand for Halal-certified products continues to expand globally, implementing stringent traceability and monitoring systems is becoming increasingly necessary. These systems ensure that products remain compliant with Halal standards throughout the supply chain, from production to consumption. The Halal industry can significantly improve its logistics operations by addressing the challenges identified in this study, such as the need for standardized practices, the adoption of advanced technologies like blockchain and IoT, and greater regulatory oversight. This, in turn, will support the continued expansion of the global Halal market by reinforcing consumer confidence and meeting the growing demand for Halal-certified products (Reyna et al., 2018; Tieman et al., 2019; Vikaliana et al., 2020).

V. CONCLUSION

This review has illuminated the vital role that traceability and monitoring play in safeguarding Halal integrity during port transportation, a critical juncture in the global supply chain. As Halal products become increasingly prevalent in international markets, ensuring that these products adhere to strict religious standards throughout their journey is not just a matter of compliance but a cornerstone of consumer trust. The findings of this research have revealed both the progress made and the significant challenges that still need to be addressed to uphold these standards effectively. One of the key insights from this study is the inconsistency in Halal logistics practices across different regions. These inconsistencies pose a significant risk, as varying standards can lead to discrepancies in how Halal compliance is monitored and enforced. This variation is not just a technical issue but one that strikes at the heart of consumer confidence. For consumers who rely on Halal certification as a guarantee of religious compliance, any doubt about the integrity of that certification can lead to a loss of trust—not only in specific products but in the broader Halal certification system.

The research also shines a light on the potential of modern technology to bridge some of these gaps. Blockchain and the Internet of Things (IoT) offer powerful tools to enhance transparency and accountability in Halal logistics. These technologies can create a reliable, tamper-proof record of how products are handled at every stage of their journey, from farm to table. However, the study found that these technologies are not yet widely adopted despite their promise. The barriers to their implementation—such as high costs and the need for specialized knowledge—are significant, particularly in regions with less developed infrastructure. This is a critical area where more work is needed to harness these innovations' full potential. Moreover, the study highlights the need for robust monitoring systems to identify and rectify deviations from Halal standards quickly. The complexity of port operations—where goods are frequently transferred between different modes of transport and stored in various conditions—makes these monitoring systems essential. Without them, the risk of cross-contamination or non-compliance increases, which could have severe implications for the integrity of individual products and the reputation of the entire Halal industry.

In response to these findings, it is clear that there is an urgent need for globally recognized standards that can be applied consistently across all regions involved in Halal logistics. Such standards would help mitigate the risks associated with regional discrepancies and ensure that Halal products meet the highest levels of compliance, no matter where they are produced or consumed. This standardization is not just about regulation, it is about building a system that consumers can trust, knowing that every Halal-certified product they purchase has been handled with the utmost care and respect for their religious beliefs. The research also points to the importance of collaboration. Governments, industry leaders, and technology providers must work together to make the necessary tools and standards accessible to all players in the Halal market, regardless of their size or location. This collaboration will be vital in overcoming the challenges of technology adoption, ensuring that even small or less technologically advanced regions can participate fully in the global Halal supply chain.

Thus, more research is needed to explore how technologies like blockchain and IoT can be integrated into Halal logistics practically and cost-effectively. Future studies should focus on developing scalable solutions that can be implemented in diverse environments, from major international ports to smaller regional hubs. Additionally, there is a need to investigate these technologies' economic and operational impacts

further to ensure that they enhance, rather than hinder, the efficiency of Halal logistics. In conclusion, the findings of this study underline the pressing need for more robust, transparent, and reliable Halal logistics practices at ports. By addressing the challenges identified in this review, we can build a more robust, trustworthy Halal supply chain that meets the evolving needs of a global market. This is not just about logistics; it is about honouring consumers' trust in Halal certification and ensuring that the products they buy genuinely meet the standards they expect. As the demand for Halal-certified products continues to grow, so must our efforts to uphold the integrity of the Halal supply chain, ensuring that it remains a pillar of trust and reliability for consumers worldwide.

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