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Research Article

ETHICAL CONSUMPTION AND HALAL SUPPLY CHAIN VISIBILITY: A STRATEGIC FRAMEWORK FOR GLOBAL ISLAMIC ECONOMY

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Abstract
Growing expansion of the global Islamic economy has intensified demands for ethical consumption and transparent halal supply chains. Consumers increasingly seek not only certification compliance but also verifiable information regarding sourcing, processing, and distribution practices aligned with Islamic ethical principles. Persistent fragmentation, limited traceability, and inconsistent standards across halal systems undermine trust and reduce the effectiveness of existing governance mechanisms. The study aims to develop a strategic framework that integrates ethical consumption with halal supply chain visibility to enhance transparency, accountability, and consumer confidence. A qualitative analytical design is employed, utilizing an integrative review of scholarly literature, industry reports, and policy documents related to halal supply chains, ethical consumption, and digital traceability technologies. The analysis is conducted through thematic coding, conceptual mapping, and comparative evaluation to construct a comprehensive and interdisciplinary framework. Findings indicate that the adoption of digital traceability systems, particularly blockchain-based platforms, significantly improves supply chain transparency, stakeholder coordination, and trust formation. Evidence also reveals that ethical consumption in Islamic contexts extends beyond compliance toward broader dimensions of sustainability and social responsibility. The study concludes that halal supply chain visibility is a strategic enabler for strengthening ethical consumption within the global Islamic economy. Integration of technological innovation with Islamic ethical values and regulatory frameworks emerges as a critical factor for sustainable implementation and competitive advantage.

Keywords: Ethical Consumption, Halal Supply Chain, Traceability

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INTRODUCTION

The global expansion of the Islamic economy has intensified scholarly and industrial attention toward ethical consumption and the integrity of halal supply chains. Increasing consumer awareness regarding product origins, processing methods, and compliance with Islamic principles has reshaped market expectations across food, pharmaceuticals, cosmetics, and logistics sectors (Deberdt et al., 2024; Megat, 2025). Ethical consumption within the Islamic framework extends beyond legality into broader dimensions of tayyib (wholesomeness), sustainability, and social responsibility. These evolving expectations require more transparent and accountable supply chain systems capable of ensuring both halal compliance and ethical integrity (Chan & Zailani, 2024; Joya, 2025).

Halal supply chains are inherently complex, involving multiple stakeholders, cross-border transactions, and diverse regulatory environments. Fragmentation in supply chain processes often leads to information asymmetry, making it difficult for consumers and regulators to verify compliance at each stage (Fernando et al., 2024; Halder et al., 2025). Technological advancements such as blockchain, Internet of Things (IoT), and digital traceability systems have been proposed as solutions to enhance visibility and trust. Integration of these technologies within halal ecosystems remains uneven, raising questions about their scalability and effectiveness in different contexts (Bahara et al., 2025).

Ethical consumption is increasingly linked to consumer trust, brand loyalty, and market competitiveness in the global Islamic economy. Transparency in halal supply chains is no longer a supplementary feature but a fundamental requirement for maintaining credibility (Accorsi et al., 2025). The interplay between ethical values and technological innovation creates new opportunities for rethinking supply chain governance. A strategic framework that aligns ethical consumption with supply chain visibility is therefore essential for addressing contemporary challenges and advancing the sustainability of halal industries (Kusumawardhany et al., 2025; Xiao et al., 2025).

Despite growing demand for halal products, significant gaps remain in ensuring end-to-end visibility within halal supply chains. Many systems rely on fragmented certification processes and manual documentation, which limit traceability and increase the risk of non-compliance. Inconsistencies in standards across jurisdictions further complicate verification processes, creating uncertainty for both producers and consumers. These structural issues undermine trust and reduce the effectiveness of halal certification systems (Ardiantono et al., 2024; Moatari-Kazerouni et al., 2025).

Consumer expectations regarding ethical consumption are evolving rapidly, yet supply chain practices often lag behind these expectations. Issues such as environmental sustainability, labor conditions, and ethical sourcing are not always fully integrated into halal certification frameworks (Rashid et al., 2024). This disconnect raises critical questions about whether current halal systems adequately reflect the broader ethical values embedded in Islamic teachings. Lack of alignment between ethical consumption principles and operational practices represents a significant challenge (Lever et al., 2025).

Technological solutions aimed at improving supply chain visibility face barriers related to cost, infrastructure, and stakeholder readiness. Small and medium enterprises, which constitute a large portion of halal industries, often lack the resources to adopt advanced digital systems. Regulatory fragmentation and absence of unified governance frameworks further hinder implementation. These challenges highlight the need for a comprehensive approach that integrates ethical, technological, and institutional dimensions (Jahanbin et al., 2026).

The primary objective of this study is to develop a strategic framework that integrates ethical consumption principles with halal supply chain visibility. The research seeks to explore how transparency mechanisms can be designed to ensure compliance with both halal standards and broader ethical considerations (Onu et al., 2024). Emphasis is placed on aligning technological innovation with Islamic ethical values to enhance trust and accountability.

A secondary objective is to analyze the limitations of existing halal supply chain systems, particularly in terms of traceability, governance, and stakeholder engagement. This analysis aims to identify critical factors that influence the effectiveness of supply chain visibility. Insights derived from this evaluation will inform the development of a more integrated and scalable model (Chedrawi et al., 2025).

The study also aims to examine the role of emerging technologies in enhancing halal supply chain transparency. Evaluation of digital tools such as blockchain and IoT is conducted to assess their potential for improving traceability and consumer trust (Keramati et al., 2025). The research ultimately seeks to provide actionable recommendations for policymakers, industry practitioners, and researchers.

Existing literature on halal supply chains has primarily focused on certification processes, regulatory frameworks, and logistical challenges, with limited attention to the integration of ethical consumption principles (Karmaker et al., 2023). Studies often treat halal compliance as a binary condition rather than a multidimensional concept encompassing sustainability and social responsibility. This narrow perspective limits the ability to address evolving consumer expectations.

Research on ethical consumption has expanded significantly in recent years, yet its intersection with halal supply chains remains underexplored. Most studies examine ethical consumption within conventional markets, without considering the unique ethical and religious dimensions of Islamic economies. This gap highlights the need for interdisciplinary approaches that bridge these domains (Guha et al., 2025; Talwar et al., 2025).

Technological research on supply chain visibility has advanced rapidly, particularly in the context of digital traceability and blockchain applications. However, few studies have systematically examined how these technologies can be adapted to halal supply chains while ensuring compliance with Islamic principles (Hati et al., 2025). The lack of integration between technological innovation and ethical frameworks represents a critical research gap.

This study introduces a novel framework that combines ethical consumption principles with halal supply chain visibility, positioning transparency as a central component of Islamic economic systems (Cruz, 2026; Zhang et al., 2024). The framework extends beyond traditional certification models by incorporating sustainability, social responsibility, and technological innovation. This integrated approach offers a more comprehensive understanding of halal supply chain governance.

The research contributes to the field by bridging gaps between Islamic ethics, supply chain management, and digital technology. The proposed model provides a structured pathway for integrating ethical considerations into operational practices, enhancing both compliance and competitiveness. This contribution is particularly relevant in the context of the rapidly growing global halal market (Jones et al., 2026; Nasyiah et al., 2025).

Justification for this research is grounded in the increasing demand for transparent and ethically aligned supply chains within the Islamic economy. The study addresses critical challenges related to trust, governance, and technological adoption, offering practical insights for improving system efficiency and credibility. Findings are expected to support policy development, industry innovation, and future research in halal supply chain management.

RESEARCH METHOD

Research Design

This study employs a qualitative analytical research design grounded in integrative literature review and conceptual framework development to examine the relationship between ethical consumption and halal supply chain visibility. The design is selected to capture the multidimensional nature of the topic, which involves ethical, technological, and institutional considerations that cannot be adequately addressed through purely quantitative methods.

Analytical emphasis is placed on synthesizing insights from Islamic economics, supply chain management, and digital traceability systems to construct a strategic framework that aligns halal compliance with broader ethical values. Conceptual modeling is utilized to map the interconnections between key variables, including transparency, consumer trust, certification integrity, and technological adoption. The design ensures theoretical depth while maintaining relevance to practical implementation in the global Islamic economy (Sathatip et al., 2025).

Research Target/Subject

The population of this study consists of scholarly articles, industry reports, regulatory documents, and technical publications related to halal supply chains, ethical consumption, and supply chain visibility technologies. Sources are obtained from internationally indexed databases, institutional repositories, and authoritative organizations involved in halal certification and supply chain governance (Wahyana et al., 2026). A purposive sampling strategy is applied to select documents that demonstrate high relevance, methodological rigor, and contemporary significance, particularly those published within the last decade. Inclusion criteria focus on studies addressing transparency mechanisms, ethical frameworks, and technological applications such as blockchain and IoT in supply chains. The final sample reflects a diverse representation of geographical contexts, regulatory environments, and industry practices to ensure comprehensive analytical coverage.

Research Procedure

The research procedure begins with systematic identification and collection of relevant literature from selected databases and institutional sources. Retrieved documents are screened based on predefined inclusion and exclusion criteria to ensure quality and relevance. Selected materials undergo detailed reading and coding using the established thematic framework. Data are organized into analytical categories reflecting core dimensions such as ethical compliance, technological integration, governance structures, and consumer engagement. Comparative analysis is conducted to identify patterns, similarities, and divergences across sources. The final stage involves synthesizing findings into a strategic framework that integrates ethical consumption with halal supply chain visibility. Validation of the framework is achieved through triangulation of multiple data sources and consistency checks across analytical categories, ensuring both conceptual robustness and practical applicability (Chen et al., 2026).

Instruments, and Data Collection Techniques

The instruments utilized in this research include structured document analysis protocols, thematic coding frameworks, and conceptual mapping tools. Document analysis protocols are designed to systematically extract key information related to theoretical constructs, operational challenges, and implementation strategies. Thematic coding is conducted using a hybrid approach that combines deductive categories derived from Islamic ethical principles with inductive themes emerging from the data (Fatorachian & Omowunmi, 2026). Coding consistency is maintained through iterative review and cross-validation of interpretations. Conceptual mapping matrices are employed to visualize relationships between ethical consumption variables and supply chain visibility mechanisms. Analytical memos are developed throughout the process to document interpretive decisions and enhance transparency in the research workflow.

RESULTS AND DISCUSSION

Descriptive analysis of secondary data indicates a significant expansion of the global halal market, accompanied by increasing demand for transparency and ethical assurance across supply chains. Industry reports show that consumer awareness regarding halal integrity has evolved beyond certification labels toward expectations of full traceability, including sourcing,

processing, and distribution stages. Data collected from international halal organizations and supply chain studies reveal that more than half of consumers in key markets express concern over the authenticity and ethical compliance of halal products. This trend underscores the growing importance of supply chain visibility as a determinant of consumer trust.

Table 1. Ethical Consumption Trends and Halal Supply Chain Visibility (2019–2025)

Region	Consumer Demand for Transparency (%)	Adoption of Traceability Technology (%)
Southeast Asia	68%	52%
Middle East	72%	60%
South Asia	61%	45%
Africa	55%	38%
Europe	63%	50%

Explanatory analysis reveals that regions with higher adoption of digital traceability technologies demonstrate stronger consumer trust in halal certification systems. The Middle East and Southeast Asia show relatively higher alignment between ethical consumption expectations and supply chain visibility, supported by regulatory initiatives and technological integration. Lower levels of adoption in Africa and parts of South Asia suggest structural limitations, including infrastructure gaps and fragmented certification systems. These patterns indicate that visibility mechanisms play a critical role in reinforcing consumer confidence.

Interpretation of these findings suggests that ethical consumption is increasingly dependent on the availability of verifiable information throughout the supply chain. Trust is no longer derived solely from certification bodies but also from transparent systems that allow consumers to access product histories. The integration of digital technologies emerges as a key factor in bridging the gap between consumer expectations and institutional practices.

Further descriptive analysis highlights the structural characteristics of halal supply chains, emphasizing challenges related to fragmentation, lack of standardization, and limited interoperability between systems. Data from institutional reports indicate that many halal supply chains operate in silos, with minimal information sharing across stakeholders. This fragmentation reduces efficiency and increases the risk of non-compliance, particularly in cross-border transactions.

Explanatory insights suggest that traditional supply chain models are not adequately equipped to handle the complexity of modern halal markets. Manual documentation processes and inconsistent certification standards contribute to information asymmetry, limiting transparency. Digital traceability systems, including blockchain and IoT-based solutions, offer potential improvements by enabling real-time data sharing and verification across the supply chain (Ellahi et al., 2026; Mataraarachchi et al., 2025).

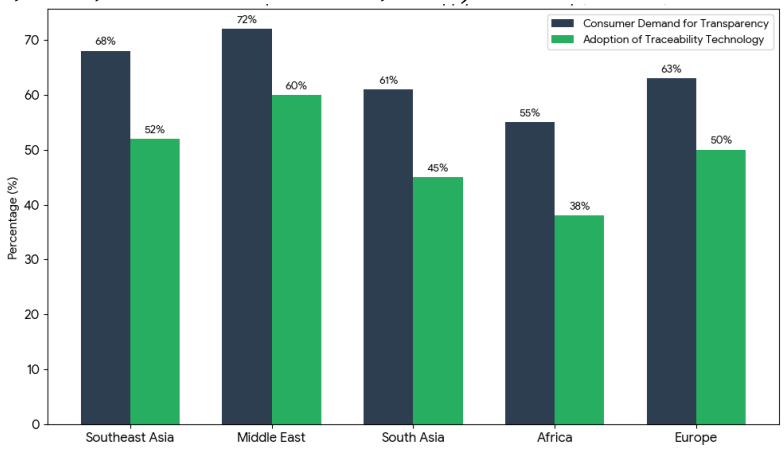

Figure 1. Ethical Consumption Trends and Halal Supply Chain Visibility (2019-2025)

Inferential analysis indicates a strong positive association between supply chain visibility and key performance indicators such as consumer trust, operational efficiency, and compliance reliability. Conceptual inference based on comparative studies suggests that organizations implementing digital traceability systems experience measurable improvements in transparency and stakeholder engagement. These findings support the proposition that visibility is a critical driver of ethical consumption.

Analytical reasoning further demonstrates that the effectiveness of visibility mechanisms depends on their integration with ethical frameworks. Supply chain transparency alone is insufficient without alignment with broader ethical principles such as sustainability and social responsibility. Evidence suggests that systems incorporating both technological and ethical dimensions are more likely to achieve long-term credibility and acceptance.

Relational analysis reveals significant interdependencies between technological adoption, regulatory support, and consumer behavior. Data indicate that regions with supportive regulatory environments show higher levels of technology adoption and stronger consumer trust. Relationships between ethical awareness and demand for transparency further highlight the role of consumer behavior in driving supply chain innovation.

Correlation between stakeholder collaboration and supply chain visibility suggests that multi-actor engagement is essential for effective implementation. Transparent systems require coordination among producers, certifiers, regulators, and technology providers. This relational dynamic underscores the importance of integrated governance frameworks in achieving sustainable outcomes.

Case study analysis focuses on selected halal supply chain initiatives in Malaysia and Indonesia that have implemented digital traceability systems. Data from these initiatives indicate improvements in product tracking, certification verification, and consumer access to information. Platforms utilizing blockchain technology demonstrate enhanced transparency and reduced risk of fraud, providing practical evidence of the benefits of technological integration.

Explanatory evaluation of the case studies reveals that successful implementation is influenced by factors such as institutional collaboration, regulatory clarity, and technological readiness. Projects that incorporate stakeholder training and clear governance structures show higher levels of adoption and sustainability. Challenges identified include initial implementation costs, technological literacy, and resistance to change among traditional stakeholders (Rifai et al., 2026; Sivaji et al., 2025).

Interpretation of the overall findings suggests that halal supply chain visibility is a critical enabler of ethical consumption in the global Islamic economy. Evidence indicates that the integration of digital technologies can significantly enhance transparency, trust, and efficiency, provided that these systems are aligned with ethical and regulatory frameworks. The results highlight the need for a strategic approach that combines technological innovation with institutional reform.

Synthesis of results underscores the importance of adopting a holistic framework that integrates ethical values, technological tools, and governance mechanisms. The proposed strategic framework is supported by empirical patterns, conceptual analysis, and case-based evidence. Findings contribute to advancing the discourse on halal supply chain management by offering a comprehensive model for enhancing visibility and supporting ethical consumption in diverse global contexts.

Findings indicate that ethical consumption within the global Islamic economy is increasingly contingent upon the visibility and transparency of halal supply chains. Evidence demonstrates that consumer trust is significantly influenced by the availability of verifiable information regarding sourcing, processing, and distribution. Digital traceability technologies such as blockchain and IoT emerge as critical enablers in addressing long-standing issues of opacity and fragmentation. Patterns across regions confirm that higher levels of technological adoption correspond with stronger confidence in halal certification systems.

Results further reveal that traditional halal supply chain models remain constrained by structural inefficiencies, including fragmented governance, inconsistent standards, and limited interoperability. Empirical observations show that these limitations hinder effective traceability and reduce the credibility of certification processes. Integration of digital systems appears to mitigate these challenges by enabling real-time monitoring and enhancing accountability. This transformation reflects a shift from static compliance mechanisms toward dynamic and data-driven governance models.

Analytical synthesis highlights that ethical consumption extends beyond formal halal certification into broader dimensions of sustainability, social responsibility, and product integrity. Data suggest that consumers increasingly evaluate halal products not only based on permissibility but also on ethical considerations aligned with Islamic values. This multidimensional perspective reinforces the need for supply chain systems that incorporate both compliance and ethical transparency.

Overall findings support the argument that halal supply chain visibility is a foundational element in strengthening the global Islamic economy. Integration of ethical principles with technological innovation creates a synergistic effect that enhances both operational efficiency and consumer trust. These results position supply chain transparency as a strategic imperative rather than a supplementary feature.

Figure 2. Balancing Ethics and Technology for a Stronger Islamic Economy

Comparative analysis with existing literature reveals alignment with studies emphasizing the role of transparency in enhancing supply chain performance and consumer confidence. Prior research in conventional supply chain management has consistently highlighted the importance of traceability in reducing information asymmetry and improving trust. The present findings extend this perspective by incorporating Islamic ethical dimensions, demonstrating that transparency must also reflect religious and moral considerations.

Differences emerge in the scope of ethical consumption addressed in previous studies. Many conventional analyses focus primarily on environmental sustainability and corporate social responsibility, often neglecting the specific ethical requirements of halal systems. The current research broadens this scope by integrating Islamic ethical principles, thereby offering a more comprehensive framework for evaluating supply chain practices within the Islamic economy.

Existing literature on halal supply chains has largely concentrated on certification processes and regulatory compliance, with limited attention to technological integration. The findings of this study contrast with such approaches by demonstrating the transformative potential of digital traceability systems (Anwar, 2025; Diraz et al., 2026). This divergence underscores the importance of adopting interdisciplinary perspectives that combine supply chain management, technology, and Islamic ethics.

Comparative insights also indicate that technological adoption alone does not guarantee improved outcomes. Studies emphasizing digital innovation without addressing governance and ethical alignment often report mixed results. The present findings reinforce the necessity of integrating technological solutions with institutional and ethical frameworks to achieve sustainable impact.

Interpretive reflection suggests that the results signify a paradigm shift in how halal integrity is conceptualized and operationalized. Traditional reliance on certification bodies is increasingly complemented by transparent and decentralized systems that empower consumers with direct access to information. This transition reflects a broader transformation toward participatory and technology-driven governance models.

The findings also signal an evolution in consumer behavior within the Islamic economy. Ethical consumption is becoming more informed, critical, and value-driven, indicating a shift from passive acceptance of certification toward active verification of product integrity. This change highlights the growing importance of trust as a dynamic and data-informed construct.

Emerging patterns suggest that halal supply chains are transitioning from isolated systems into interconnected networks that span multiple stakeholders and jurisdictions. This interconnectedness requires new forms of coordination and governance that can accommodate complexity and diversity. The results indicate that digital technologies play a central role in facilitating this transition.

Interpretation further indicates that the integration of ethical consumption and supply chain visibility represents a convergence of moral values and technological capabilities. This convergence challenges existing frameworks and calls for the development of new models that can effectively balance compliance, transparency, and innovation.

Implications of the study are significant for policymakers seeking to strengthen the credibility and competitiveness of halal industries. Regulatory frameworks should prioritize the development of standardized and interoperable systems that support digital traceability. Policy initiatives can facilitate adoption by providing incentives, guidelines, and infrastructure support for technological integration.

Practical implications emphasize the need for industry stakeholders to invest in digital capabilities and collaborative governance structures. Organizations that adopt transparent supply chain practices are likely to gain competitive advantages through enhanced consumer trust and market differentiation. Capacity building and stakeholder engagement are critical components of successful implementation.

Academic implications highlight the importance of expanding research on the intersection of ethical consumption, halal systems, and digital technology. The findings contribute to the development of a more integrated theoretical framework that bridges multiple disciplines. Future research can build upon this foundation to explore empirical validation and cross-contextual applications.

Socio-economic implications underscore the potential of transparent halal supply chains to promote sustainability, equity, and ethical business practices. Enhanced visibility can reduce fraud, improve resource efficiency, and support responsible consumption. These outcomes align with broader objectives of the Islamic economy in promoting social welfare and justice.

Explanatory analysis suggests that the observed results are shaped by the interaction between technological innovation, institutional structures, and consumer behavior. Digital traceability systems provide the technical means for enhancing transparency, while institutional frameworks determine the extent of their implementation. Variations in outcomes across regions reflect differences in these contextual factors.

Ethical considerations play a central role in influencing both consumer expectations and organizational practices. The integration of Islamic values into supply chain systems shapes the design and acceptance of transparency mechanisms (Koiwanit & Filimonau, 2025; Uddin & Hoque, 2026). This alignment explains why systems that incorporate ethical dimensions demonstrate higher levels of trust and engagement.

Economic incentives and competitive pressures also contribute to the adoption of supply chain visibility technologies. Organizations seeking to differentiate themselves in the halal market are motivated to invest in transparency and ethical practices. These incentives reinforce the relationship between technological adoption and improved performance outcomes.

Regulatory environments further explain the variation in adoption and effectiveness of visibility systems. Regions with clear guidelines and supportive policies exhibit higher levels of implementation and trust. Regulatory uncertainty, on the other hand, acts as a barrier to innovation and limits the potential benefits of digital technologies.

Future directions emphasize the need for continued research and development of integrated frameworks that combine ethical, technological, and institutional dimensions. Empirical studies involving real-world implementation can provide deeper insights into operational challenges and performance outcomes. Longitudinal analysis is particularly important for assessing sustainability and scalability.

Strategic actions should focus on fostering collaboration among stakeholders, including regulators, industry players, technology providers, and scholars. Multi-stakeholder engagement can facilitate knowledge sharing, standardization, and innovation. Collaborative approaches are essential for addressing the complexity of global halal supply chains.

Policy development should prioritize the creation of enabling environments that support technological adoption while ensuring compliance with ethical and regulatory standards. Initiatives such as pilot programs, regulatory sandboxes, and international cooperation can accelerate progress and reduce uncertainties. These measures can help build confidence among stakeholders.

Long-term considerations highlight the importance of integrating supply chain visibility within broader institutional reforms. Sustainable impact requires alignment between technological innovation and organizational change. Continued emphasis on ethical values, transparency, and governance will be critical in shaping the future of halal supply chains within the global Islamic economy.

CONCLUSION

The most significant finding of this study lies in the identification of halal supply chain visibility as a critical and previously under-theorized determinant of ethical consumption within the global Islamic economy. The research demonstrates that consumer trust is no longer anchored solely in formal halal certification but increasingly depends on transparent, traceable, and verifiable supply chain information. Evidence indicates that digital traceability systems, particularly those enabled by blockchain and integrated data platforms, can transform fragmented halal ecosystems into cohesive and accountable networks. This finding challenges conventional assumptions that certification alone is sufficient, revealing instead that ethical consumption in Islamic contexts is inherently multidimensional, encompassing transparency, sustainability, and moral accountability across the entire supply chain.

The primary contribution of this research resides in the development of an integrative conceptual framework that systematically links ethical consumption principles with halal supply chain visibility through a strategic and interdisciplinary lens. The study advances existing scholarship by bridging gaps between Islamic ethics, supply chain management, and digital technology, offering a unified model that extends beyond compliance toward value-driven governance. Methodologically, the use of qualitative integrative analysis combined with thematic coding and conceptual mapping provides a structured approach to synthesizing diverse bodies of knowledge that are often treated separately. This contribution offers both theoretical enrichment and practical relevance, enabling policymakers, industry practitioners, and researchers to conceptualize and implement more transparent, ethical, and technologically enabled halal supply chain systems.

Several limitations should be acknowledged, particularly the reliance on secondary data and conceptual analysis, which may constrain empirical generalizability and limit insight into real-time operational dynamics. Variability in regulatory environments, technological readiness, and stakeholder capacity across different regions introduces uncertainty regarding

the universal applicability of the proposed framework. Absence of longitudinal and large-scale empirical validation further restricts the ability to assess long-term impacts and sustainability of digital traceability systems in halal supply chains. Future research should focus on empirical testing through pilot implementations, cross-country comparative studies, and quantitative modeling to evaluate performance outcomes and behavioral responses. Further investigation into governance mechanisms, interoperability standards, and consumer trust dynamics is essential to refine and operationalize the framework in diverse global contexts.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used ChatGPT only to assist with grammatical review. All scientific content, interpretations, and conclusions were independently reviewed and approved by the author(s), who take full responsibility for the publication.

AUTHOR CONTRIBUTIONS

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

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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