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Enhancing Halal Supply Chain Resilience through Digital Traceability: A Multi-Stakeholder Perspective

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Abstract. *The increasing complexity of global halal supply chains has created significant challenges in maintaining integrity, transparency, and resilience across interconnected stakeholders. Disruptions caused by technological limitations, information asymmetry, regulatory differences, and trust issues can threaten halal compliance and consumer confidence. This study aims to examine how digital traceability mechanisms contribute to enhancing halal supply chain resilience from a multi-stakeholder perspective. Using a qualitative conceptual approach based on an integrative literature review, this study synthesizes insights from halal supply chain management, digital transformation, organizational resilience, and industrial psychology. The findings indicate that digital traceability improves supply chain resilience through three key mechanisms: strengthening information transparency, increasing stakeholder trust, and facilitating collaborative decision-making. However, technological adoption alone is insufficient; successful implementation requires psychological readiness, organizational commitment, digital competency, and trust-based relationships among stakeholders. From an industrial psychology perspective, employee acceptance, perceived usefulness, organizational support, and cross-functional collaboration represent critical determinants influencing digital traceability effectiveness. This study contributes to the halal supply chain literature by integrating technological and behavioral perspectives, emphasizing that resilient halal ecosystems require alignment between digital infrastructure and human-centered organizational practices. The findings provide practical implications for halal industry managers, policymakers, and certification authorities in designing sustainable and adaptive halal supply chain systems.*

Keywords: *Digital Traceability; Halal Supply Chain; Organizational Psychology; Stakeholder Collaboration; Supply Chain Resilience.*

1. INTRODUCTION

The proliferation of the global halal sector has rendered halal supply chains increasingly intricate ecosystems, encompassing diverse stakeholders such as primary material providers, manufacturing entities, logistics operators, certifying agencies, regulatory authorities, distributors, and end consumers. In contrast to traditional supply chains, halal supply chains necessitate not merely operational efficiency and economic optimization but also the maintenance of religious adherence, product authenticity, and ethical openness across the entire value chain (Mulyana, et.al., 2024). However, traditional certification systems frequently suffer from fragmented documentation and operational inefficiencies, leaving the network vulnerable to risks such as contamination, fraudulent labeling, and certification gaps (Julian et al., 2025).

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The notion of halal integrity underscores the imperative of preserving halal status throughout the entire sequence of activities spanning raw material procurement, manufacturing, transit, warehousing, and ultimate consumption. Any interruption or informational discontinuity within these procedures may engender risks of cross-contamination, fraudulent representation, and erosion of consumer confidence. Consequently, supply chain resilience has emerged as a critical capability for halal-oriented enterprises to preempt, address, and recover from unforeseen adversities. Digital traceability, facilitated by technologies such as blockchain and artificial intelligence, offers a robust mechanism for mitigating these risks by ensuring end-to-end transparency and verifiable provenance (Sunmola et al., 2025).

Contemporary global perturbations, encompassing health pandemics, geopolitical tensions, logistical disruptions, and escalating consumer expectations regarding transparency, have expedited the imperative for digital transformation within supply chain operations. Digital traceability innovations including distributed ledger technologies, the Internet of Things, cloud-enabled infrastructures, and integrated data ecosystems offer avenues for augmenting visibility and accountability throughout supply chains. By integrating real-time monitoring through IoT sensors and immutable records via blockchain, these systems facilitate rapid incident response and satisfy the growing demand for authentic, Shariah-compliant product verification (Aufi, et.al, 2024).

Nevertheless, technological capacity in isolation does not ensure efficacious deployment. From an industrial-organizational psychology standpoint, digital transformation constitutes a sociotechnical phenomenon wherein workforce dispositions, organizational ethos, leadership endorsement, interpersonal trust, and stakeholder cooperation substantively shape adoption trajectories. Furthermore, the successful integration of these systems necessitates a comprehensive alignment between technical infrastructure and regulatory frameworks to address barriers, such as resistance from logistics providers and the need for standardized guidelines (Azizov, et.al., 2025).

Organizational members must regard digital traceability platforms as utilitarian, feasible, and congruent with institutional objectives. Resistance to technological innovation, inadequate digital literacy, and deficient trust among stakeholders may diminish the efficacy of traceability endeavors. Moreover, the lack of systemic interoperability and standardized data protocols across diverse geographical nodes complicates the establishment of a cohesive, transparent ledger for verifying the provenance of halal-certified goods (Awaludin, et.al., 2025). To bridge

these operational divides, stakeholders must harmonize digital integration with robust governance models to ensure data integrity and system scalability.

Accordingly, the present study posits that bolstering halal supply chain resilience necessitates an integrative perspective that synthesizes technological advancement with human behavioral determinants. This inquiry investigates the contribution of digital traceability to halal supply chain resilience through a multi-stakeholder analytical lens. By conceptualizing the "Single Digital Halal Passport," this research evaluates how blockchain-enabled frameworks and IoT-driven monitoring can harmonize global halal standards while reducing informational silos.

The objectives of this research are as follows: to analyze the contribution of digital traceability to reinforcing halal supply chain resilience; to delineate the behavioral and organizational determinants that affect the adoption of digital traceability; and to construct a multi-stakeholder framework that reconciles technological and psychological perspectives within halal supply chain governance.

2. LITERATURE REVIEW

Halal Supply Chain Management and the Challenge of Maintaining Halal Integrity

The notion of halal supply chain management has transcended conventional halal certification paradigms by foregrounding the continuous safeguarding of halal integrity across the entirety of the supply chain. Diverging from conventional supply chains that predominantly prioritize cost minimization, velocity, and operational efficiency, halal supply chains demand supplementary assurances concerning the permissibility, safety, and ethical stewardship of commodities from upstream suppliers through to end consumers. Halal integrity must be sustained across these pivotal operations, encompassing the procurement of raw inputs, manufacturing protocols, transit, warehousing, and distribution networks (Nur Ihsan Purwanto, et.al., 2024).

The accelerating internationalization of halal markets has engendered increasingly elaborate supply chain architectures involving a multiplicity of stakeholders with heterogeneous operating practices, regulatory environments, and technological proficiencies. Such intricacy amplifies the probability of halal-related vulnerabilities, including contamination, erroneous documentation, opacity, and informational disjunctions among supply chain participants. Accordingly, the preservation of halal integrity necessitates not merely compliance systems but also robust coordination, information dissemination, and surveillance mechanisms among stakeholders. Current certification systems frequently

struggle with these complexities, as traditional manual auditing processes are susceptible to fraud, mislabeling, and persistent inefficiencies (Osmanov, et.al., 2025)

Moreover, achieving comprehensive integrity requires moving beyond static certification toward dynamic control mechanisms that engage actors at every stage of the supply chain. Despite these requirements, research indicates that achieving seamless traceability remains a complex, unresolved challenge within the halal ecosystem (Nugroho et al., 2024), as traditional systems often suffer from significant bottlenecks, fraud, and informational opacity. These limitations are further compounded by the reliance on manual record-keeping, which hinders the real-time monitoring of critical control points and complicates swift corrective actions when contamination is suspected (Tumiwa et al., 2023).

Prior scholarship underscores that trust and transparency constitute foundational pillars of halal supply chains, given that consumers frequently lack direct access to information pertaining to production and distribution protocols. The inability to authenticate halal-related data may engender ambiguity and attenuate consumer confidence. Consequently, halal supply chains necessitate more robust visibility mechanisms that empower stakeholders to corroborate product status and ensure adherence throughout the supply chain. The persistence of fragmented certification standards and the lack of a globally accepted framework further exacerbate these vulnerabilities, leading to inconsistencies that undermine the legitimacy of global halal value chains (Munawar & Mugiono, 2024).

From an organizational vantage point, halal supply chain management constitutes a socio-technical arrangement wherein technological capabilities and human conduct are inextricably intertwined. The efficacy of halal assurance frameworks depends not only upon formalized protocols but also upon employee cognizance, organizational dedication, and collaborative conduct among supply chain participants. Hence, comprehending halal supply chain resilience mandates the consideration of both operational mechanisms and human determinants that shape supply chain efficacy. This dual-faceted approach is essential for mitigating the rising incidence of food fraud, in which the misuse of certification logos exposes critical weaknesses in current compliance validation.

Supply Chain Resilience in the Halal Industry

Supply chain resilience denotes the capacity of organizations and supply networks to anticipate, withstand, adapt to, and recuperate from unforeseen adversities while sustaining uninterrupted operations. Within halal industries, resilience assumes an augmented significance, as disruptions may compromise not only product availability but also halal conformity and consumer confidence. Consequently, the integration of robust risk management

strategies is essential to prioritize hazards and address the interdependencies inherent in complex agro-industrial networks.

The halal supply chain milieu confronts a spectrum of challenges, encompassing global supply interruptions, geopolitical volatility, interjurisdictional regulatory divergences, logistical constraints, and escalating consumer demands for transparency. These exigencies underscore the imperative for halal enterprises to cultivate adaptive capabilities that preserve both operational efficiency and religious adherence. Empirical literature suggests that fostering such resilience requires a systemic integration of risk management and adaptive mechanisms, ensuring that the system can recover from disruptions without forfeiting the fundamental halal status of products.

Resilience in supply chains is conventionally linked to a set of competencies, including visibility, agility, collaboration, risk mitigation, and knowledge dissemination. Among these, supply chain visibility emerges as a pivotal determinant, since the effective management of risks is predicated upon the availability of precise and contemporaneous information. Inadequate visibility may impede timely risk identification and attenuate organizational capacity to implement corrective actions. Furthermore, unlike conventional supply chain resilience, which primarily focuses on maintaining functional continuity, halal-specific resilience mandates the unwavering preservation of religious integrity across all nodes, regardless of the magnitude of operational disturbances (Harwati et al., 2025).

Within halal supply chains, visibility assumes heightened salience, as any ambiguity regarding raw materials, handling protocols, or certification status may jeopardize halal integrity. Consequently, resilient halal supply chains necessitate mechanisms facilitating continuous surveillance and authentication of supply chain operations. Digital traceability serves as a transformative tool in this context, enabling real-time monitoring and verification of products from farm to table (Azizli, et.al., 2025). By leveraging technologies such as blockchain, the Internet of Things, and artificial intelligence, firms can construct secure, decentralized systems that effectively mitigate the risks of information asymmetry and logistical contamination (Almunawar et al., 2025).

Moreover, resilience is predicated not exclusively upon organizational resources but also upon relational dynamics among supply chain participants, where collaboration, trust, and information exchange between suppliers, manufacturers, certification bodies, regulators, and consumers are instrumental in fostering resilient halal ecosystems. These interpersonal dynamics facilitate the coordination of control and assurance activities, which are vital for improving resilience efficacy among network partners.

Digital Traceability as an Enabler of Halal Supply Chain Resilience

Digital traceability has assumed a salient position as a technological instrument for augmenting transparency, accountability, and resilience within contemporary supply chains. It denotes the capacity to monitor and authenticate data pertaining to products, processes, and transactions across the entire supply chain infrastructure, leveraging digital technologies such as blockchain, the Internet of Things, cloud computing, and integrated information management systems. Blockchain technology, by creating a secure, immutable ledger, ensures the permanent integrity of halal certification data, effectively preventing tampering and unauthorized alterations.

Within halal supply chains, digital traceability confers considerable advantages by affording stakeholders the ability to ascertain halal-related data across the entire value continuum, extending from primary material origins through to final consumption. Through digital record-keeping mechanisms, organizations can enhance documentation precision, mitigate informational asymmetries, and fortify verification protocols. Furthermore, the integration of Internet of Things sensors facilitates real-time monitoring of critical control points, ensuring that environmental conditions maintain halal compliance throughout transit (Shabanov, et.al., 2025).

A principal contribution of digital traceability lies in the augmentation of supply chain visibility. The provision of real-time information access enables organizations to identify potential vulnerabilities more expediently and to institute prophylactic interventions before disruptions escalate. This capacity bolsters the resilience of halal supply chains by enhancing both preparedness and responsiveness. Additionally, the deployment of smart contracts automates compliance verification processes, effectively streamlining regulatory oversight and reducing the latency typically associated with manual certification audits.

Furthermore, digital traceability facilitates the cultivation of trust among stakeholders by providing transparent and verifiable data, thereby attenuating uncertainty among producers, regulatory authorities, and consumers alike. When consumers are afforded access to reliable information regarding the halal status of products, their confidence in such commodities is correspondingly reinforced. These technological integrations drastically curtail the risks associated with food fraud and cross-contamination, which are critical vulnerabilities in globalized distribution networks.

Notwithstanding these merits, the adoption of digital traceability entails considerable challenges. Technological implementation necessitates substantial capital investment, digital competencies, robust data governance frameworks, and organizational preparedness. In the absence of adequate preparatory measures, digital systems may fail to realize their anticipated utility. Consequently, technological innovation must be undergirded by accompanying organizational and behavioral adaptation. The shift toward digital integration requires addressing existing gaps in local capacity and regulatory harmonization to ensure that technical infrastructures align with industry-specific halal standards.

Organizational Readiness and Human Factors in Digital Transformation

Digital transformation within supply chains constitutes not only a technological transition but also an encompassing organizational change process. From an industrial psychology perspective, the effective implementation of digital traceability is contingent upon employee perceptions, attitudes, and behavioral responses to technological innovation. Organizational readiness, therefore, relies heavily on comprehensive training programs that equip personnel with the necessary competencies to interpret real-time data and respond effectively to systemic alerts.

Technology acceptance theory posits that individuals exhibit a heightened propensity to adopt novel technologies when they perceive them as useful and user-friendly. Within halal supply chain contexts, employees and stakeholders must therefore develop an appreciation of how digital traceability systems augment operational efficacy and underpin halal compliance objectives. Furthermore, the successful integration of these systems necessitates overcoming critical barriers such as high implementation costs and a significant shortage of skilled labor, which often hinder SMEs from transitioning away from traditional management methods.

Organizational readiness constitutes another pivotal determinant of digital transformation success. Firms characterized by resolute leadership commitment, comprehensive training programs, an enabling organizational culture, and sound change management practices demonstrate a greater capability to adopt digital technologies. Moreover, fostering cross-functional collaboration and a culture of continuous learning is essential for cultivating the technical proficiency required to manage emerging innovations such as AI and blockchain. Crucially, this readiness must be supported by strategic investments in digital infrastructure and vendor partnerships to ensure that technical solutions align with the specific operational demands of halal logistics.

Leadership exerts a formative influence on employee dispositions toward digital transformation. Leaders who articulate clear directives, mobilize sufficient resources, and extend psychological support can attenuate resistance and cultivate employee engagement. Conversely, insufficient organizational backing may engender uncertainty and oppositional behaviors among personnel. Furthermore, research indicates that digital lean transformations often falter due to a lack of leadership support, staff resistance, and unclear goals rather than technical shortcomings. Moreover, addressing internal organizational factors such as digital readiness and the compatibility of new systems with existing cultural frameworks remains paramount for mitigating risks associated with system incompatibility.

Equally important, employee digital competence represents an indispensable capability underpinning the effective utilization of digital traceability systems. Organizations are thus impelled to invest in continuous learning and competency development to ensure that personnel possess the requisite knowledge and skills to operate digital platforms effectively. Beyond individual skill sets, organizations must cultivate a proactive culture of adaptability and growth, as transformational leadership is vital for inspiring employees to embrace these disruptive technological shifts.

Stakeholder Trust and Collaboration in Halal Supply Chain Ecosystems

Halal supply chains are characterized by a constellation of diverse stakeholders encompassing suppliers, manufacturers, logistics operators, certification bodies, regulatory agencies, retailers, and end consumers each assuming distinct yet interdependent roles. Given the inherent complexity of these multi-tier relationships, the establishment of robust collaboration frameworks anchored in mutual trust and collective accountability is imperative. Fostering open communication and data exchange among these actors is essential for mitigating information asymmetry and ensuring transparency throughout the halal ecosystem (Ismail, et.al., 2024).

Trust among stakeholders emerges as a particularly salient prerequisite for the operationalization of digital traceability, which necessitates the cross-organizational exchange of sensitive operational data. The absence of such trust may engender reluctance among stakeholders to disclose pertinent information, driven by apprehensions related to confidentiality, competitive sensitivities, and the potential misuse of shared data. To bridge these gaps, stakeholders must establish transparent, Shariah-compliant governance protocols that delineate data usage rights, privacy safeguards, and accountability mechanisms, fostering the trust necessary for digital traceability.

Digital traceability systems require a combination of technological advancements and stakeholder collaboration to effectively rebuild trust and integrity (Dashti et al., 2024). Furthermore, the realization of a resilient halal supply chain requires a concerted, cooperative effort in which all participants actively contribute to data sharing and process digitization to meet stringent consumer requirements (Surjandari et al., 2021). Integrating Maqasid Syariah principles ensures that digital governance not only enhances operational efficiency but also upholds the ethical integrity required to maintain consumer confidence (Zulkifli & Yusuf, 2023).

Stakeholder collaboration thus functions as a pivotal conduit linking digital traceability capabilities with the resilience of halal supply chains. Effective collaboration empowers stakeholders to mount coordinated responses to disruptions while safeguarding halal integrity throughout the supply chain. By establishing standardized guidelines and formalizing communication channels, these collaborative networks reduce operational bottlenecks and significantly strengthen the transparency required for regulatory alignment.

3. RESEARCH METHOD

This study employs a qualitative methodology anchored in an integrative literature review to construct a holistic understanding of the mechanisms through which digital traceability reinforces resilience within halal supply chains, viewed through a multi-stakeholder lens. The integrative review was deemed appropriate given its capacity to synthesize heterogeneous theoretical orientations and empirical evidence drawn from interdisciplinary domains, encompassing halal supply chain management, digital transformation, supply chain resilience, organizational behavior, and industrial psychology. Such an approach enables the discernment of recurring patterns, interrelationships, and conceptual linkages among the technological, organizational, and psychosocial determinants that shape the efficacy of digital traceability deployment.

The literature retrieval process leveraged established academic repositories, including Scopus, Web of Science, ScienceDirect, SpringerLink, Emerald Insight, Taylor & Francis Online, and Google Scholar. Source prioritization emphasized peer-reviewed journal publications, predominantly issued between 2020 and 2025, using keywords such as halal supply chain, digital traceability, blockchain technology, supply chain resilience, stakeholder collaboration, technology acceptance, and organizational readiness. This rigorous selection process ensures that the synthesized evidence reflects current advancements in traceability

frameworks, such as the deployment of permissioned blockchain networks and integrated compliance systems (Surjandari et al., 2021).

The assembled literature underwent a thematic analysis aimed at distilling salient constructs and formulating an integrated conceptual framework. The analytical process unfolded across three iterative phases: data identification, thematic categorization, and conceptual synthesis. In the initial phase, pertinent studies were selected based on their theoretical contributions and practical relevance to halal supply chain resilience and the adoption of digital traceability. During the second phase, extracted insights were systematically organized into three overarching dimensions: digital capability, organizational capability, and psychological-social capability.

In the third phase, the interrelations among these dimensions were integrated to construct the Digital Traceability-Based Halal Supply Chain Resilience Model. The inclusion of an industrial psychology perspective augments this analytical framework by foregrounding the significance of human-centric factors—namely technology acceptance, stakeholder trust, psychological safety, and collaborative behavior—as pivotal mechanisms governing the outcomes of digital transformation. Through this methodological design, the study yields a theoretically substantiated framework explicating how technological innovation, when coupled with human-centered organizational practices, collectively fosters resilient halal supply chain ecosystems (Maulidizen, et.al., 2026).

4. RESULTS AND DISCUSSION

RQ1: How Does Digital Traceability Contribute to Enhancing Halal Supply Chain Resilience?

The findings indicate that digital traceability constitutes a pivotal capability for reinforcing halal supply chain resilience by augmenting transparency, visibility, and responsiveness throughout supply chain networks. In contrast to traditional supply chain systems, which frequently depend on fragmented documentation and manual verification procedures, digital traceability facilitates continuous monitoring of halal-related information across the entire supply chain, from raw material procurement to final consumer distribution. By integrating technologies such as blockchain and the Internet of Things, stakeholders can achieve decentralized transparency that enables rapid identification and mitigation of halal non-compliance risks during exogenous disruptions.

Research suggests that digital traceability improves halal supply chain resilience by enhancing risk mitigation capacities. *First*, digital traceability mitigates information asymmetry among supply chain actors. Within halal supply chains, the preservation of product integrity necessitates accurate information concerning the provenance, handling protocols, transportation conditions, and certification status of products. Digital platforms afford stakeholders access to reliable and real-time information, thereby diminishing uncertainty pertaining to halal compliance. Furthermore, this real-time visibility acts as a foundational element for building trust among stakeholders, which is a critical precursor to the broader adoption of distributed ledger systems within complex networks (Dashti et al., 2024).

From a supply chain resilience standpoint, heightened visibility enables organizations to discern potential disruptions more expeditiously and to institute preventive measures. For instance, prospective risks associated with dubious raw materials, inappropriate handling, or certification discrepancies can be detected prior to their propagation across broader supply chain operations. Moreover, this proactive identification of vulnerabilities facilitates rapid, coordinated recovery efforts, as stakeholders can leverage shared digital records to isolate affected batches and maintain operational continuity (Alvarenga et al., 2023).

Second, digital traceability refines organizational responsiveness (Razak et al., 2021). Resilient supply chains demand the capacity to absorb disruptions and to recover rapidly. Through integrated digital systems, organizations are able to monitor product movements, pinpoint disruption loci, and orchestrate remedial actions among stakeholders. This capability is particularly significant within halal supply chains, wherein any lapse in preserving halal integrity may substantially impair consumer trust and organizational reputation. Furthermore, these systems facilitate supply chain agility by allowing for the seamless integration of new partners and resources, which effectively mitigates risks in highly volatile and disruptive environments.

Third, digital traceability enables knowledge exchange among supply chain participants. Effective resilience hinges not solely upon technological infrastructure but also upon the organizational capacity to disseminate knowledge and to coordinate responses. Accordingly, digital traceability operates as an organizational mechanism for knowledge dissemination that underpins collective problem-solving endeavors. By facilitating instantaneous data exchange, these platforms empower organizations to anticipate environmental perturbations and refine risk mitigation strategies, such as diversified procurement and redundant inventory management.

These findings substantiate the contention that digital traceability ought to be conceptualized not merely as a compliance instrument but as a strategic capability that bolsters adaptive capacity, operational continuity, and enduring competitiveness within halal supply chain ecosystems. Furthermore, the implementation of these traceability procedures serves as a robust communication tool, effectively minimizing long-term cross-contamination risks and associated operational expenses. Moreover, by proactively detecting potential forbidden components within the workflow, this method empowers firms to maintain stringent control over their production and logistics management systems, thereby meeting overall food safety requirements.

Consequently, such digital oversight fosters an environment where proactive corrective actions can be executed immediately to prevent the cross-contamination of haram goods, thereby upholding the sanctity of the halal certification process. Furthermore, the adoption of these technologies facilitates the use of buffer-oriented strategies, such as maintaining multiple sources and redundant inventory, to neutralize agency uncertainties and supply risks. Moreover, the integration of these digital architectures strengthens collaborative supply chain networks, allowing firms to synchronize operational workflows instantly and enhance overall flexibility in highly volatile market environments (Cui et al., 2022).

RQ2: What Organizational and Psychological Factors Influence the Successful Adoption of Digital Traceability in Halal Supply Chains?

Although digital traceability provides significant technological benefits, the findings demonstrate that successful implementation strongly depends on organizational and psychological factors. Technology adoption within halal supply chains represents a socio-technical transformation process in which human behavior determines the effectiveness of technological systems. Specifically, the literature highlights that stakeholder readiness and consumer trust act as primary determinants of technological deployment, necessitating a cultural transition toward greater data transparency and shared responsibility.

The first critical factor is technology acceptance among employees and stakeholders. Based on the Technology Acceptance perspective, individuals are more likely to adopt digital traceability systems when they perceive the technology as useful, accessible, and supportive of their work objectives. Conversely, complex systems, insufficient training, and uncertainty regarding technological changes may create resistance. Moreover, leadership support and the cultivation of a digital-first organizational culture are essential to mitigate these psychological barriers, as management commitment directly influences the perceived legitimacy and prioritization of traceability initiatives.

From an industrial psychology perspective, resistance to digital transformation is often associated with technology anxiety and perceived loss of autonomy. Therefore, organizations need to ensure that digital transformation initiatives involve employees as active participants rather than merely technology users. Additionally, fostering an environment of trust and long-term commitment among supply chain partners is vital to overcoming systemic barriers, as these psychological underpinnings drive the collaborative integration necessary for successful system transparency.

The second factor is organizational support and leadership commitment. The findings indicate that managerial support plays an essential role in shaping employee readiness toward digital traceability adoption. Leaders who provide adequate resources, training opportunities, and psychological support can reduce employee uncertainty and encourage positive attitudes toward technological change. Conversely, a lack of intraorganizational support and misaligned departmental objectives often create significant friction, hindering the seamless flow of data necessary for effective traceability.

Moreover, addressing the sociocultural challenges and organizational silos is paramount, as resistance from actors particularly small-scale suppliers often stems from a lack of resources and concerns regarding data privacy and power imbalances. To bridge these gaps, organizations must invest in human capital development, ensuring staff possess the technical capabilities to manage complex, high-volume inputs while overcoming inherent resistance to changing established manual communication workflows. Indeed, the successful navigation of this transition hinges on replacing entrenched, hierarchical command-and-control structures with agile leadership models that prioritize autonomy and collaborative innovation.

Organizational support also strengthens employees' perceived value of digital transformation. When employees believe that the organization is committed to supporting their adaptation process, they are more likely to engage in knowledge-sharing behaviors and collaborative practices. Furthermore, sustained leadership commitment is indispensable, as executives must actively champion the digital vision to prevent initiatives from stalling due to organizational inertia. Additionally, managers must lead by example to ensure that traceability systems are not merely adopted as administrative burdens, but are utilized as strategic assets for quality assurance and continuous operational improvement.

The third factor is trust and psychological safety. Halal supply chains involve multiple independent stakeholders with different interests and responsibilities. Trust determines whether organizations are willing to share critical information through digital platforms. Without sufficient trust, stakeholders may hesitate to disclose operational data due to concerns regarding

confidentiality, competition, or misuse of information. This reluctance is frequently exacerbated by the pervasive silo mentality within the food industry, where fragmented organizational structures inhibit the transparency required for effective digital integration.

Cooperation and willingness among stakeholders are essential for maximizing the benefits of digital traceability. Furthermore, the implementation of these platforms necessitates a collective stakeholder-wide effort, as the foundational integrity of halal data relies on the willingness of every participant to engage in transparent, standardized information sharing. Integrating these digital frameworks requires aligning organizational objectives with Islamic principles such as accountability and honesty, which serve as foundational pillars for a robust innovation culture.

Overall, these findings emphasize that digital traceability adoption requires balancing technological innovation with human-centered approaches. Organizations must address employee readiness, behavioral responses, and stakeholder relationships to ensure sustainable implementation. Future research should further investigate how blockchain infrastructures and AI-driven systems specifically mitigate integrity breaches caused by information asymmetry among diverse halal supply chain partners.

RQ3: How Can a Multi-Stakeholder Perspective Strengthen the Integration of Digital Traceability and Halal Supply Chain Resilience?

The findings demonstrate that halal supply chain resilience cannot be achieved by individual organizations alone. Instead, resilience emerges from collaborative relationships among multiple stakeholders, including suppliers, manufacturers, logistics providers, certification institutions, regulators, retailers, and consumers. This collaborative network facilitates an integrated ecosystem where real-time data sharing mitigates information asymmetry, thereby enhancing the overall reliability of halal certification. By leveraging blockchain-based verification and IoT-enabled real-time monitoring, these stakeholders can collectively ensure end-to-end transparency, which is critical for maintaining consumer trust and certifying product authenticity.

A multi-stakeholder perspective highlights the importance of shared responsibility in maintaining halal integrity. Digital traceability provides the infrastructure for collaboration by creating a common information environment where stakeholders can verify, exchange, and utilize supply chain data. This collaborative approach to governance ensures that every participant remains accountable for upholding halal standards, effectively transforming individual verification tasks into a collective, value-generating process. Furthermore, this

collaborative framework fosters cross-sector innovation, allowing diverse actors to reconcile differing operational priorities and standardize their approaches to halal compliance.

The first contribution of stakeholder collaboration is the development of collective transparency. When all actors participate in digital traceability systems, information flows become more consistent and reliable, reducing conflicts regarding halal verification and increasing accountability throughout the supply chain. Moreover, this collaborative governance model mitigates the complexity often associated with multiple food supply chain actors by fostering an environment of value co-creation and operational efficiency. By leveraging collaborative governance, stakeholders can enhance halal assurance and strengthen supply chain resilience.

The second contribution is improved institutional coordination. Halal certification bodies and government authorities can utilize digital traceability data to strengthen monitoring mechanisms and improve regulatory effectiveness, while businesses benefit from clearer compliance requirements and faster verification processes (Wei et al., 2025). By synchronizing these institutional processes, the supply chain enhances its organizational performance and integrity, facilitating better management of risks related to halal breaches (Bachtiar et al., 2024). Ultimately, the integration of these technological and institutional perspectives creates a resilient framework capable of mitigating logistical risks and potential contamination while ensuring long-term sustainability across the global halal ecosystem (Maghfirah, et.al., 2026).

The third contribution is enhanced consumer confidence. Modern halal consumers increasingly demand not only halal certification but also evidence of ethical sourcing, safety, and transparency, and digital traceability allows them to access trustworthy product information, strengthening their confidence in halal products (Rochim, et.al., 2024). This heightened level of transparency serves to strengthen consumer confidence and support industry growth. By bridging the information gap between producers and end-users, these systems align supply chain performance with evolving consumer preferences for safety and accountability.

However, the findings also reveal several challenges in developing multi-stakeholder digital ecosystems. These include differences in technological capability, unequal access to digital infrastructure, data governance concerns, and varying levels of digital literacy among stakeholders. Addressing these disparities requires tailored capacity-building initiatives and inclusive policy frameworks that provide smaller enterprises with the necessary digital tools and technical support. Furthermore, the shift toward a unified digital infrastructure necessitates

robust regulatory oversight to harmonize disparate standards, thereby ensuring that blockchain-enabled traceability remains equitable across various geographical and economic contexts.

Therefore, successful implementation requires collaborative governance mechanisms that include technological standardization, stakeholder education, data-sharing agreements, and continuous capability development. Specifically, the establishment of decentralized consortia comprising certifiers, SMEs, and technology providers can bridge these implementation gaps by creating shared protocols that uphold religious compliance alongside operational transparency.

5. CONCLUSION

This study highlights that digital traceability plays a strategic role in enhancing halal supply chain resilience by improving transparency, strengthening trust, and facilitating stakeholder collaboration. However, technological implementation alone cannot guarantee supply chain resilience. The effectiveness of digital traceability depends heavily on human and organizational factors, including employee readiness, organizational support, trust, and collaborative behavior. From an industrial psychology perspective, halal supply chain resilience should be understood as a socio-technical capability where technology and human behavior interact continuously. Organizations that successfully integrate digital systems with supportive organizational cultures will be better positioned to maintain halal integrity, respond to disruptions, and achieve sustainable competitiveness. The multi-stakeholder perspective proposed in this study provides a broader understanding of halal supply chain resilience by connecting technological innovation with behavioral and psychological mechanisms.

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