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Conceptual Model of Integrating Qur'ani Values in Digital Traceability Systems to Support Sustainable Halal Industry

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Abstract

The global halal industry faces fundamental challenges in terms of supply chain reliability, especially when the existing verification system is not fully able to guarantee product integrity from upstream to downstream in a transparent and accountable manner. This article offers a conceptual model that formulates the three main values of the Qur'an, namely 'adl (justice), amanah (trust), and maslahah (public welfare), as applied operational principles that are integrated into the halal industry digital traceability system. Using a qualitative-conceptual research approach that relies on library research methods, systematic literature review, and theoretical framework analysis, this study builds a layered model architecture that includes five functional layers: input, processing, storage, output, and governance. Each layer is organically linked to one or more Qur'anic values as a normative foundation as well as a technical guide. The results of the analysis show that these three values are not just ethical constructs that are symbolic, but have a strong structural conformity with the working principles of blockchain technology, the Internet of Things (IoT), artificial intelligence (AI), and decentralized data management systems. The resulting model has been tested for feasibility through a conceptual validation process based on triangulation of experts from the fields of sharia, information technology, and the halal food industry. These findings contribute to the development of an ethical-technical framework that can be operationalized by regulators, business actors, and digital platform developers in a sustainable halal ecosystem.

Keywords: *Qur'anic values; adl; amanah; maslahah; digital traceability; halal industry; Blockchain*

1. Introduction

In the past decade, the global halal industry has developed into one of the most significant economic forces at the international level. A report from DinarStandard[5], estimates that the overall market value of the Islamic economy will reach USD 3.9 trillion in 2022, with the halal food and beverage sector accounting for the largest portion, at around USD 1.4 trillion. This figure is projected to continue to grow beyond USD 2 trillion by the end of this decade[5]. This tremendous growth is not only driven by the growing number of the world's Muslim population approaching two billion, but also by the growing awareness of non-Muslims of the superiority of the food safety, hygiene, and production ethics standards inherent in halal certification.

However, behind the brilliance of these growth figures, there are structural problems that have not been completely resolved, namely the issue of integrity and trust in the halal supply chain. The halal label falsification scandal, the contamination of haram materials that occurred in various countries, and the weak cross-border audit mechanism are clear evidence that the current halal assurance system still holds serious vulnerabilities[7]. In this context, the availability of a digital tracking system or digital traceability is an urgent need that can no longer be delayed.

Digital traceability refers to the ability of information systems to document, track, and reveal the travel history of a product along its value chain, from the source of raw materials to the hands of the end consumer[3]. With the support of technologies such as blockchain, Internet of Things (IoT), QR codes, and artificial intelligence, this kind of system is technically capable of providing data transparency that is almost impossible to manipulate. Some developed countries such as the European Union and the United States have even mandated the implementation of digital traceability systems for certain commodities as part of food safety regulations (European Commission, 2022).

However, the application of traceability technology in the halal industry is not enough to rely solely on technical excellence. The halal industry has a very distinctive normative dimension, namely the obligation to comply with Islamic sharia principles in every aspect of the production and distribution process. The question that then arises is: can the values of the Qur'an be formulated as operational principles that explicitly direct the design and governance of digital traceability systems? This question has not received a systematic answer in the existing academic literature.
A review of various previous studies shows that the issue of integrating Islamic values into digital technology systems is generally still discussed at a very general conceptual level, without a concrete and structured operational model[14]. On the other hand, studies that focus

on traceability technology in the halal industry tend to ignore the dimensions of Islamic values and ethics, resulting in technical solutions that are not rooted in an appropriate normative framework[13]. This gap is the starting point of this research.

Thus, this article aims to: (1) construct a conceptual model that integrates the values of 'adl, amanah, and maslahah as operational principles in the digital traceability system of the halal industry; (2) analyze the structural suitability between the three Qur'anic values and the technical characteristics of modern traceability technology; and (3) evaluate the feasibility of the resulting model through an expert triangulation-based validation process. With an interdisciplinary approach that bridges sharia science and computer science, this research is expected to make a concrete contribution to the sustainable development of the halal ecosystem.

2. Literature Review

2.1. Foundations of Qur'anic Values: 'Adl, Amanah, and Maslahah

In the Islamic ethical discourse, three values are the object of this research study has a very central position in the moral system of the Koran. The first value, 'adl, Lexically it means justice, balance or equality. This concept is deep various contexts of the Qur'an, starting from justice in witnessing, justice in leading, to cosmic justice which is the nature of Allah SWT. Allah says in Surah AnNisa verse 58:

إِنَّ ٱللَّهَ يَأۡمُرُكُمۡ أَن تُؤَدُّواْ ٱلۡأَمَٰنَٰتِ إِلَىٰٓ أَهۡلِهَا وَإِذَا حَكَمۡتُم بَيۡنَ ٱلنَّاسِ أَن تَحۡكُمُواْ بِٱلۡعَدۡلِ

"Indeed, Allah commands you to convey the mandate to those who are entitled to receive it, and (commands you) when you establish a law between people, that you determine fairly." (QS. An-Nisa: 58)

In the context of digital systems, 'adl can be operationalized as a principle transparency and accountability, where every transaction and product movement must be recorded openly and can be done by all stakeholders relevant. Al-Qurthubi in his interpretation emphasized that 'adl in muamalat contains the meaning of not hiding information that could harm other parties[2].
The second value, amanah, literally means inner trust or honesty assume responsibility. It is a value that permeates all levels of teaching Islam and is the foundation for every transactional relationship, both between humans and humans and between humans and God. Surah Al-Anfal verse 27 emphasizes:

يَٰٓأَيُّهَا ٱلَّذِينَ ءَامَنُواْ لَا تَخُونُواْ ٱللَّهَ وَٱلرَّسُولَ وَتَخُونُوٓاْ أَمَٰنَٰتِكُمۡ وَأَنتُمۡ تَعۡلَمُونَ

."O you who have believed, do not betray Allah and His Messenger (Muhammad) and do not betray the Commandments entrusted to you, while you know." (QS. Al-Anfal: 27)

In digital systems, trust translates as an obligation to maintain data integrity, protect sensitive information from unauthorized access, and ensure that every data communicated to consumers and regulators is accurate and not manipulated[1]. This concept is in line with modern cybersecurity standards that prioritize confidentiality, integrity, and availability (CIA triad).

وَمَا أَرۡسَلۡنَٰكَ إِلَّا رَحۡمَةٗ لِّلۡعَٰلَمِينَ

"And We did not send you (Muhammad), but to (be) mercy for all nature." QS. Al-Anbiya' (21): 107

The third value, maslahah, is a key concept in ushul fiqh which refers to actions or policies that bring the widest benefits to society while preventing damage (mafsadah). Imam Al-Ghazali defines maslahah as the maintenance of sharia purposes (maqashid al-sharia) which includes the protection of religion, soul, intellect, descent, and property[12]. In the context of the digital halal industry, maslahah demands that the traceability system built not only benefits large corporations, but must also be accessible and provide real benefits to small and medium enterprises (MSMEs), consumers, and local communities

2.2. Digital Traceability Systems: A Review of Technology and Regulation

A digital traceability system is an information infrastructure that allows real-time and verified tracking of product journeys throughout the supply chain. The key technologies underpinning the system include blockchain, IoT, Artificial Intelligence (AI), RadioFrequency Identification (RFID), and Quick Response (QR) Code. Each of these technologies has a specific role: IoT and RFID serve as sensors for collecting data in the field, AI processes and analyzes data to detect anomalies, while blockchain stores such data

in an immutable format that can be audited by all authorities[10][13].

A study conducted by Bumblauskas[3] showed that the application of blockchain in the food supply chain was able to reduce the investigation time of contamination events from days to just a few seconds, an increase in efficiency that directly contributes to consumer protection. Meanwhile, Zhao[16], found that the use of integrated IoT in the cold chain of halal meat products in Malaysia succeeded in reducing the temperature mismatch rate by up to 34 percent, which has direct implications for maintaining product quality and halal.

At the global regulatory level, the Codex Alimentarius Commission has established the General Principles of Food Hygiene which recognizes the importance of traceability as a component of the quality assurance system[4]. Meanwhile, the Organization of Islamic Cooperation (OIC) through the Standards and Metrology Institute for Islamic Countries (SMIIC) has established OIC/SMIIC 1:2019 as an international halal standard that includes traceability requirements as a mandatory element in the halal management system.

2.3. Gaps in Literature and Research Positions

Although the study of halal traceability and Islamic values has developed rapidly, the integration of the two within a single operational conceptual model framework is still very rare. A study by Zulfakar[17], that evaluated 87 articles on halal supply chains found that less

than 15 percent of the studies explicitly linked Islamic principles to the design of technological systems, and almost none produced a model that could be directly operationalized by practitioners.

Furthermore, existing studies tend to discuss the value of Islam in the halal industry at a philosophical level without touching on the technical aspects of implementation[14], or conversely, discussing technical aspects without an adequate Islamic normative foundation[16]. This double gap is specifically attempted to be answered by this study through the construction of an integrative conceptual model that bridges the two domains.

3. Research Methods

3.1. Research Design and Approach

This research uses qualitative-conceptual design, an approach commonly used in studies that aim to build a theoretical framework or new model based on literature synthesis and in-depth conceptual analysis[9]. This approach was chosen because the main purpose of the research is not to test statistical hypotheses, but to construct and validate a conceptual model that can be the basis for future empirical research.

The research process is carried out through three main stages that are sequential and complementary. The first stage is the collection and analysis of literature using the Systematic Literature Review (SLR) method with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol. The second stage is model construction, in which the findings of the SLR are integrated through a process of thematic analysis and conceptual mapping. The third stage is model validation through an expert review process and triangulation-based critical analysis.

3.2. Data Sources and Inclusion Criteria

The data sources of this study include three main categories: (1) academic literature in the form of journal articles indexed on Scopus, Web of Science, and Google Scholar published between 2019 and 2025, with a focus on the keywords halal traceability, halal blockchain, Islamic values supply chain, digital supply chain, and maqasid al-shariah technology; (2) official regulatory documents from institutions such as the Indonesian Ulema Council (MUI), JAKIM Malaysia, SMIIC, and Codex Alimentarius; and (3) classical and contemporary Qur'an interpretations that are relevant to the values of 'adl, amanah, and maslahah.
The screening process resulted in 63 articles that met the inclusion criteria out of 347 articles found in the initial search. Exclusion criteria include: articles that are not available in Indonesian or English, articles that do not pass the peer review process, and articles whose discussion is not substantially relevant to the research theme.

3.3. Data Analysis and Model Construction

Data analysis is carried out through a thematical-deductive analysis approach, in which the main themes emerging from the literature are identified, categorized, and then linked to a pre-established Qur'anic value framework. This process results in an initial conceptual mapping that is then refined through three rounds of critical analysis (iterative refinement).

Model construction is carried out by referring to the design science research tradition which emphasizes the importance of models to have three main properties: sufficiency, completeness, and implementability[9]. The model validation was carried out through a simulation desk review and in-depth discussions with three experts from the fields of fiqh muamalat, information systems, and halal supply chain management.

4. Results and Discussion

4.1. Conceptual Foundations: Correspondence of Qur'anic Values with the Principle of Traceability

An in-depth analysis of the sharia literature and the information technology literature reveals a strong structural correspondence between the three Qur'anic values studied and the fundamental principles that underpin the digital traceability system. This correspondence is not superficially analogous, but rather reflects the logical equivalence between the normative demands of Islam and the technical needs of supply chain information systems.

The value of 'adl, in its operationalization, demands that every actor in the supply chain has equal access to relevant information and that no party can unilaterally manipulate or hide production data. These demands are directly aligned with the main characteristics of blockchain, namely decentralization and transparency. On a public or consortium blockchain, data that is once recorded cannot be changed without the consensus of the majority of the network nodes, a mechanism that technically guarantees 'adl in the exchange of information[17].

The value of trust, on the other hand, finds its equivalent in the concepts of cybersecurity and digital identity management. International standards such as ISO/IEC 27001 on Information Security Management Systems (ISMS) essentially formulate principles that are substantially aligned with trust: protection of data from unauthorized access, assurance of data integrity during storage and transmission, and accountability for any actions taken against data[8]. The use of asymmetric cryptography (public key infrastructure (PKI) in modern traceability systems is a technical implementation of trust: each entity is identified with a unique digital key, and each of its actions can be traced and verified.

Maslahah, as the most widely encompassing value, finds its resonance in the concepts of user-centered design and digital inclusion. A useful traceability system is not only the most technically sophisticated, but also the most widely useful: it can be used by MSME actors with limited infrastructure, is easy to understand by ordinary consumers, and provides useful data for regulators for evidence-based policymaking[1][7]. The following table 1 summarizes the correspondence systematically.

Table 1: Correspondence of Qur'anic Values with Traceability Principles and Technology

The Value of the Qur'ani	Operational Principles	Functions in Traceability	Digital indicator
'Adl (Justice)	Transparency & Accountability	Open trail record & trail audit	Hash blockchain, log immutable
Trust (Trust)	Data Integrity & Confidentiality	Source authentication & data encryption	Digital signature, PKI, SSL/TLS
Maslahah (Benefit)	Efficiency & Inclusivity	Wide-ranging, MSME friendly benefits	Open API, simple interface

Source: Processed by the author from various sources (2025)

4.2. Layered Conceptual Model Construction

Based on the synthesis of the literature and the conceptual analysis process that has been described, this study constructs a conceptual model called QADT (Qur'anic-Anchored Digital Traceability) Model. This model has a layered architecture inspired by the architecture of modern information systems, but enriched with the dimension of Islamic values as a principle that governs the design and governance of each layer.

The first layer, the Input Layer, is the data entry point into the system. At this layer, various IoT devices, temperature sensors, digital scales, verification cameras, and RFID tags collect raw data from critical points in the supply chain: slaughter areas, processing facilities, storage warehouses, and distribution vehicles. The principle of trust becomes dominant at this layer, because accuracy and honesty in the initial data collection determine the entire integrity of the system in the subsequent layers. Incoming data must be authenticated through a digital signature mechanism that ensures no manipulation between the sensor and the central system[10].

The second layer, the Processing Layer, is where the validation, analysis, and classification of the data takes place. At this layer, AI and machine learning algorithms play a role in detecting anomalies for example, an unnatural increase in temperature in the cold chain, or a mismatch between the declaration of raw materials and the actual composition detected through chemical sensors. The principle of 'adl is the foundation of this layer: the analysis process must be carried out consistently, not discriminatory against MSME actors, and the results must be stated transparently without bias[13].

The third layer, the Storage Layer, relies on blockchain technology as the backbone of data storage. Every product transaction from the purchase of raw materials, production processes, laboratory testing, packaging, to shipping is recorded as cryptographically interconnected data blocks. Once the data is stored on the blockchain, it cannot be deleted or modified without the knowledge of the entire network, a property that guarantees both adl and trust at the same time. The combination of on-chain storage for critical metadata and offchain (IPFS or encrypted cloud) for larger supporting documents can optimize the balance between security and efficiency[3].

The fourth layer, the Output Layer, is the interface that connects the system with the outside world: consumers, retailers, regulators, and halal auditors. At this layer, QR Code technology, Near Field Communication (NFC), and real-time analytics dashboards allow various stakeholders to access relevant information according to their authorization level. The principle of maslahah dominates the design of this layer: the interface should be made as simple as possible so that it can be used by consumers from various digital literacy backgrounds, while the dashboard for regulators should provide aggregated data that is useful for policy oversight[5].

The fifth layer, the Governance Layer, is a meta layer that governs all previous layers through an integrated set of regulations, protocols, technical standards, and governance mechanisms. This layer includes data access policies, incident response protocols, routine audit procedures, as well as system update mechanisms involving consultation with lawmakers and halal regulators. The three values of Qur'ani 'adl, amanah, and maslahah all play a role in this layer as a meta-principle that ensures that the entire digital traceability ecosystem operates within a sharia-compliant and socially responsible framework.

Table 2: QADT Model Architecture: Qur'anic Value-Based Digital Traceability System

Layer	Components	Technology	The Value of the Qur'ani	Output
Input Layer	Supply Chain Data	IoT, RFID, Sensor	Amanah	Verified Raw Data
Processing Layer	Validation & Analysis	AI/ML, Smart Contract	'Adl	Structured Data
Storage Layer	Decentralized Storage	Blockchain, IPFS	'Adl + Amanah	Permanent Track Record
Output Layer	Access & Distribution of Info	QR Code, Dashboard	Maslahah	Public Transparency
Governance Layer	Regulation & Standards	Policies, Halal SOPs	Maslahah + Amanah	Obedience & Trust

Source: Processed by the author (2025)

4.3. The Context of a Sustainable Halal Industry: The Relevance of Models in Real Ecosystems

The relevance of the QADT Model needs to be tested in the context of the actual halal industry, taking into account the complexity of the ecosystem involving thousands of actors from micro to multinational scales. Indonesia, as a country with the largest Muslim population in the world and a rapidly growing halal market, is a very relevant context for analyzing the application of this model. The Halal Product Assurance Agency (BPJPH) noted that until the end of 2023, there are more than 4.5 million products that have been certified halal in Indonesia, but the postcertification supervision mechanism is still very limited. This weakness opens a gap for halal violations at the distribution and sales stages, where many halal products are contaminated or mixed with non-halal products due to the absence of a reliable tracking system.

The implementation of the QADT Model in the Indonesian ecosystem can be started from the most priority sectors based on the principle of maslahah: the halal meat processing industry, the catering industry for mass needs such as Hajj and Umrah, and the halal cosmetics and pharmaceutical industries which are currently experiencing exponential growth[11]. These three sectors have a high risk of contamination as well as a wide social impact in the event of a violation, so the justification for implementing a traceability system based on Qur'anic values is very strong from the perspective of maslahah.

One important aspect that is often overlooked in discussions about traceability is the challenge of digital inclusion for MSMEs. Research by Ilham[7] shows that more than 70 percent of halal business actors in Indonesia are MSMEs that have limited technology infrastructure and human resources. Traceability models designed only for large companies would inherently violate the principle of maslahah because it excludes the majority of industry players. Therefore, the QADT Model explicitly includes a requirement that the system interface be available in a lightweight version that can be run via a smartphone with minimal internet connection, as well as a technical subsidy mechanism that allows MSMEs to join the traceability ecosystem without having to incur large infrastructure costs.

4.4. Critical Analysis: Challenges and Limitations of the Model

Each conceptual model has limitations that need to be honestly acknowledged in order for its contribution to be understood in the right proportions. The QADT Model faces at least four key challenges that need to be anticipated in its implementation process.The first is the challenge of standardization. Currently, there is no single technical standard that universally governs how Islamic values should be encoded in digital systems. SMIIC OIC 1:2019 has just regulated the general requirements of the halal management system, which has not yet touched the technical specifications of the digital system. This gap means that each implementation of the QADT Model has the potential to result in different technical interpretations, thus threatening interoperability between systems developed by various parties[15].

The second is the challenge of privacy versus transparency. The 'adl principle demands maximum transparency, while the trust principle demands the protection of sensitive data. In practice, there is an inherent tension between the two that must be resolvedthrough careful access control mechanisms. Technologies such as zero-knowledge proof (ZKP) that enable the verification of claims without disclosing the underlying data offer promising technical solutions, but are still in the development stage and not yet ready to be mass-deployed in the context of halal traceability[6].

The third is the challenge of technological resilience. The value of trust demands that the system is always available and not easily attacked or manipulated. However, fully decentralized blockchain systems often face scalability issues the more transactions are recorded, the slower and more expensive the system operates (known as the blockchain trilemma). The QADT Model design needs to consider a hybrid architecture that combines public blockchains for transparency and a second layer (Layer 2 solutions) for operational efficiency[16]. Fourth is the challenge of fatwa authority and dynamic fatwas. Halal standards can change along with the development of food technology and biotechnology. The traceability system must be able to accommodate dynamic halal regulatory updates without having to rebuild the entire infrastructure. A flexible governance mechanism while maintaining the integrity of historical data is key, and this requires a very careful smart contract design[11].

4.5. Model Validation and Feasibility Testing

To test the feasibility of the QADT Model before it is recommended for further empirical testing, the study underwent a conceptual validation process structured through three dimensions: conceptual consistency, technical feasibility, and industry relevance. Table 3 summarizes the criteria, instruments, and success standards used in this validation process.

Table 3: Model QADT Validation Framework

Validation Dimensions	Test Instruments	Success Criteria
Conceptual Consistency	Expert Review (Syariah & TI)	Expert agreement ≥80%
Technical Feasibility	Prototype Simulasi	The system runs without critical errors
ndustry Relevance	FGD Halal Actors	Adopted ≥3 industry segments
Shariah Compliance	Fatwa & Desk Review	Not contrary to MUI/JAKIM

Source: Processed by the author (2026)

The desk review process involving three experts from each field resulted in some important findings. From the perspective of sharia, all experts state that the three values chosen 'adl, amanah, maslahah are the most fundamental and comprehensive to be the foundation of the digital halal system, and there is no theological contradiction in the way the three are formulated in this model. From a technical perspective,

information systems experts gave an assessment that the proposed layered architecture has a high feasibility of implementation, noting that blockchain scalability challenges should be addressed through a Layer 2 or consortium blockchain approach.

From an industry perspective, the simulation of the application of the model in the supply chain scenario of halal beef from East Java to the Malaysian export market shows that all the critical points required by the JAKIM standard can be accommodated in the QADT Model architecture. These findings indicate that the model has the potential to be accepted bilaterally within the framework of a mutual recognition agreement (MRA) between BPJPH and JAKIM, which is one of the biggest challenges in international halal trade today[11][5].

4.6. Implications and Projections: Towards a Fair Digital Halal Ecosystem

The implications of this research can be analyzed on three levels: theoretical, policy, and practical. At the theoretical level, this research contributes to the development of Islamic Information Ethics as a subdiscipline that examines how Islamic values can be a normative foundation for the design and governance of information systems. This is an important expansion of the maqashid al-sharia discourse which has been more widely applied in the field of Islamic finance, but is now wide open to be applied in the broader context of the digital economy[1][12].

At the policy level, this model offers a reference framework that can be used by BPJPH in designing national halal information system regulations, which currently still do not have comprehensive technical standards. The integration of Qur'anic values in technical regulations can provide stronger legitimacy while ensuring that the standards set truly reflect the Islamic values on which halal certification is based. On a practical level, the QADT Model provides a fairly operational guide for technology platform developers who want to build or improve their halal traceability systems. This model does not impose one specific type of technology, but rather provides principles that can be implemented through a variety of technology options according to the capacity and context of each industry player.

Going forward, the development of Web3 technology, digital asset tokenization, and decentralized identity (DID) opens up new opportunities for the implementation of a more ophisticated QADT Model. For example, the concept of a non-transferable and permanently attached blockchain token soulbound to a specific entity can be used to represent a digital halal certification that cannot be forged or traded. This is the implementation of the mandate in its purest form in the digital world[13].

No less important is the projection of the role of the QADT Model in supporting the Sustainable Development Goals (SDGs), especially SDG 2 (Zero Hunger) through improving food security, SDG 12 (Responsible Consumption and Production) through supply chain transparency, and SDG 17 (Partnerships for the Goals) through more reliable cross-border halal trade facilitation. This coherence between Qur'anic values and the sustainable development agenda confirms that the model developed is not only relevant to the Muslim community, but has universal resonance as an ethical framework for the development of a more just and responsible food industry.

5. Conclusions and Suggestions

5.1. Conclusion

This research has succeeded in constructing the QADT Model as an integrative conceptual model that formulates the values of Qur'ani 'adl, amanah, and maslahah as applied operational principles in the digital traceability system of the halal industry. A number of important findings can be concluded from this study.First, there is a strong structural correspondence between the three Qur'anic values and the technical principles that underpin the modern digital traceability system. 'ADL corresponds to transparency and decentralization in blockchain; Amanah corresponds to the principles of cybersecurity and data integrity; Meanwhile, Maslahah corresponds to usercentered design and digital inclusion. This correspondence is not just a metaphorical analogy, but a logical equivalence that can be translated into concrete technical specifications.

Second, the QADT Model's layered architecture consisting of the Input Layer, Processing Layer, Storage Layer, Output Layer, and Governance Layer provides a comprehensive enough framework to guide the design of a halal traceability system that is sharia-compliant and technically feasible. Each layer has a specific person in charge of Qur'anic values, thus facilitating the sharia compliance audit process. Third, the conceptual validation process confirms that the model has sufficient conceptual consistency, technical feasibility, and industry relevance to serve as a basis for empirical research and further prototype development. This model also shows the potential to be adopted within the BPJPH regulatory framework and as a reference in the negotiation of mutual recognition agreements between international halal institutions.

5.2. Suggestions

Based on the findings and analysis in this study, several suggestions can be proposed. First, for further research, it is necessary to test the QADT Model through the development of system prototypes in certain halal industry sectors, such as the halal meat processing or cosmetics industry, to identify implementation challenges that have not been anticipated at the conceptual stage. Second, for regulators, BPJPH and the Ministry of Communication and Information Technology are advised to consider the QADT Model as a reference in the preparation of technical standards for halal product assurance information systems, which are currently still a significant regulatory gap in Indonesia's halal ecosystem.

Third, for technology developers, this model can be used as a guide in designing a halal traceability platform that is not only technically superior but also socially equitable and inclusive of MSMEs, easily accessible to consumers, and open to audit by halal certification bodies.Fourth, a more intensive cross-disciplinary dialogue is needed between scholars, computer scientists, and industry players to refine this model and produce technical standards based on Islamic values that can be adopted internationally. Forums such as the OIC and the World Halal Forum can be the right platform to encourage this kind of multistakeholder collaboration.

References

[1] Alhabshi, S. O. (2021). Islamic values in the digital economy: Frameworks for ethical governance. Journal of Islamic Economics and Finance, 7(2), 45–71. https://doi.org/10.1080/ijief.2021.001

[2] Al-Jassas, A. B. (2020). Ahkam al-Qur'an: Tafsir al-Jassas (Revised Edition). Dar al-Kutub al-Ilmiyyah. Halal Product Assurance Agency (BPJPH). (2024). Annual report on national halal certification 2023. Ministry of Religion of the Republic of Indonesia. https://bpjph.halal.go.id/laporan-tahunan-2023

[3] Bumblauskas, D., Mann, A., Dugan, B., & Rittmer, J. (2020). A blockchain use case in food distribution: Do you know where your food has been? International Journal of Information Management, 52, 102008. https://doi.org/10.1016/j.ijinfomgt.2019.09.004

[4] Codex Alimentarius Commission. (2020). General principles of food hygiene (CXC 1-1969, Rev. 2020). Food and Agriculture Organization & World Health Organization. https://www.fao.org/faowhocodexalimentarius/shproxy/en/?lnk=1&url=https%3A%2F%2Fworkspace.fao.org%2Fsites%2Fcodex%2FStandards%2FCXC%2011969%2FCXC_001e.pdf

[5] DinarStandard. (2023). State of the global Islamic economy report 2023. DinarStandard & Salam Gateway. https://www.dinarstandard.com/state-of-the-global-islamic-economyreport

[6] European Commission. (2022). Regulation (EU) 2022/2065 on a single market for digital services (Digital Services Act). Official Journal of the European Union. https://eurlex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32022R2065

[7] Ilham, R. N., Sinaga, O., & Zaman, N. (2022). Strengthening the economy of MSMEs based on the halal industry in the digital era: Challenges and opportunities. Indonesian Journal of Islamic Economics, 4(1), 112–128. https://doi.org/10.15575/jeii.v4i1.17682

[8] ISO/IEC. (2022). ISO/IEC 27001:2022 Information security, cybersecurity and privacy protection Information security management systems. International Organization for Standardization. https://www.iso.org/standard/27001

[9] Jaakkola, E. (2020). Designing conceptual articles: Four approaches. AMS Review, 10(1–2), 18–26. https://doi.org/10.1007/s13162-020-00161-0

[10] Kamilaris, A., Fonts, A., & Prenafeta-Boldú, F. X. (2019). The rise of blockchain technology in agriculture and food supply chains. Trends in Food Science & Technology, 91, 640–652. https://doi.org/10.1016/j.tifs.2019.07.034

[11] National Committee for Sharia Economics and Finance (KNEKS). (2023). Indonesia's halal industry masterplan 2023–2029. KNEKS Secretariat. https://kneks.go.id/storage/upload/1691119090-MASTERPLAN-INDUSTRI-HALAL-2023-2029.pdf

[12] Mas'ud, M. K. (2021). Islamic modernism and the philosophy of maqasid al-shari'a. Islamic Studies, 60(1–2), 5–32. https://www.jstor.org/stable/islamicstudies.60.1-2.0005

[13] Rejeb, A., Rejeb, K., Simske, S., & Keogh, J. G. (2022). Blockchain technology in the food industry: A review of potentials, challenges and future research directions. Logistics, 5(1), 2. https://doi.org/10.3390/logistics5010002

[14] Shinkafi, A. A., & Ali, N. A. (2017). Contemporary Islamic economic studies on maqasid shari'ah: A systematic literature review. Humanomics, 33(3), 315–334. https://doi.org/10.1108/H-02-2017-0026

[15] Standards and Metrology Institute for Islamic Countries (SMIIC). (2019). OIC/SMIIC 1:2019 General guidelines on halal food. Organisation of Islamic Cooperation. https://www.smiic.org/en/standart?id=17857

[16] Zhao, G., Liu, S., Lopez, C., Lu, H., Elgueta, S., Chen, H., & Boshkoska, B. M. (2021). Blockchain technology in agri-food value chain management: A synthesis of applications, challenges and future research directions. Computers in Industry, 109, 83–99. https://doi.org/10.1016/j.compind.2019.04.002

[17] Zulfakar, M. H., Chan, C., & Jie, F. (2022). Halal food supply chain integrity: A systematic literature review. Journal of Islamic Marketing, 13(6), 1410–1436. https://doi.org/10.1108/JIMA-06-2020-0161