IMPLEMENTATION OF THE GLOBAL HALAL STANDARD BASED ON BLOCKCHAIN TECHNOLOGY

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ABSTRAK

Penelitian ini bertujuan untuk mengeksplorasi implementasi standar halal global berbasis blockchain dan dampaknya terhadap peningkatan transparansi, keterlacakan, dan kepercayaan konsumen. Menggunakan metode deskriptif dengan pendekatan kualitatif, penelitian ini memanfaatkan teknik pengumpulan data berupa tinjauan literatur dan analisis data sekunder dari berbagai laporan industri halal global. Data dianalisis menggunakan teknik analisis konten untuk memahami sejauh mana teknologi blockchain diadopsi dalam proses sertifikasi halal dan hambatan yang dihadapi dalam implementasinya. Hasil penelitian menunjukkan bahwa meskipun adopsi teknologi blockchain dapat meningkatkan transparansi dan integritas rantai pasokan halal, kesiapan institusi seperti Lembaga Pengkajian Halal (LPH) di Indonesia masih terbatas. Hambatan utama meliputi biaya implementasi yang tinggi dan kompleksitas integrasi dengan sistem yang sudah ada. Penelitian ini berkontribusi secara orisinal dengan mengidentifikasi kesenjangan antara standar global dan praktik aktual di lapangan, serta menawarkan rekomendasi untuk meningkatkan kesiapan infrastruktur regulasi global yang mendukung adopsi teknologi ini. Novelty penelitian ini terletak pada analisis kritis terhadap kesiapan teknologi dan infrastruktur regulasi, serta implikasinya terhadap pertumbuhan pasar halal global dan kepercayaan konsumen.

Kata kunci: *Standar Halal Global, Blockchain, Sertifikasi Halal, Transparansi, Regulasi*

ABSTRACT

This research project aims to investigate the implementation of blockchain-based global halal standards and their potential impact on enhancing transparency, traceability and consumer trust. This research employs a descriptive method with a qualitative approach, utilising data collection techniques in the form of a literature review and secondary data analysis of various global halal industry reports. The data were subjected to content analysis to ascertain the extent to which blockchain technology is being adopted in the halal certification process and the barriers faced in its implementation. The findings indicate that while the implementation of blockchain technology has the potential to enhance the transparency and integrity of the halal supply chain, the preparedness of institutions such as the Halal Assessment Institute (LPH) in Indonesia remains constrained. The most significant obstacles include the high costs of implementation and the complexity of integrating with existing systems. This research makes an original contribution by identifying discrepancies between global standards and actual practices in the field and provides recommendations to increase the readiness of the global regulatory infrastructure to support the adoption of this technology. The novelty of this research lies in the critical analysis of the readiness of the technology and regulatory infrastructure and its implications for the growth of the global halal market and consumer confidence.

Keywords*: Global Halal Standard, Blockchain, Halal Certification, Transparency, Regulation*

INTRODUCTION

Global Sharia governance standards and halal certification hold crucial urgency in the global economy, especially given the important findings of this study. The data show that halal brand awareness is positively related to consumer purchasing decisions. This is reflected in the positive effect of religiosity as a moderating variable on the relationship between brand awareness and halal product purchase decisions. Religiosity also strengthens the relationship between consumption habits and purchasing decisions for halal products. The existence of global Sharia governance standards and halal certification not only provides halal assurance to Muslim consumers but also increases the level of trust in and awareness of halal products, which is crucial in an increasingly integrated and culturally diverse global context. As such, the implementation and enforcement of these standards support the development of the global halal market, creating economic added value and strengthening the relationship between producers and consumers on the basis of religious values (Abbasian, Onn, & Nordberg, 2023; Caccialanza, Cerrato, & Galli, 2023; Karyani, Geraldina, Haque, & Zahir, 2024; Rafiki, Hidayat, & Nasution, 2023; Yasmeen, 2023).

The 2022 State of the Global Islamic Economy Report indicates that the global demand for halal products reached approximately USD 2.2 trillion in 2019 and is projected to reach USD 2.4 trillion by 2024. This reflects a substantial market potential for sustained economic growth within the sector (ISEF, 2024).

The implementation of global halal governance has included the establishment of a set of standards and practices that are designed to guarantee integrity and consumer confidence in halal products. In general, the global halal standards that have been implemented include halal certification by institutions such as the Malaysian Islamic Development Department (JAKIM) and the Indonesian National Board for Religious Harmony (BPJPH). This certification process entails the recognition of products as being in accordance with Islamic

law, with the certification procedure itself comprising a series of stages. Furthermore, the utilisation of blockchain technology in halal certification has commenced, with the objective of enhancing transparency and consumer confidence. In this context, the BPJPH has demonstrated support for the integration of this technology in Indonesia. In the context of agrofood supply chains, blockchain technology is also being employed to increase product traceability, operational transparency, and food quality and safety. These factors are also associated with sustainability and the realisation of sustainable development goals (SDGs) (Noordin, Md Noor, Hashim, & Samicho, 2009; Sarim, Khan, Akhtar, & Tabash, 2019).

Normatively, the global halal industry has reached a consensus on the criteria to be met for halal certification, including the requirements of traceability, transparency, and compliance with Islamic law. Regulatory frameworks that have been implemented on a global scale include certification standards set forth by government agencies and the utilisation of blockchain technology. International collaboration within the global halal industry entails the harmonisation of standards and regulations, as evidenced by the State of the Global Islamic Economy report and the Global Islamic Economy Report 2022. These sources emphasise the importance of regulating and harmonising halal standards on a global scale, with the aim of supporting the integrity and growth of the halal market. The global demand for halal products, which reached USD 2.2 trillion in 2019 and is projected to reach USD 2.4 trillion by 2024, underscores the need for consistent and globally accepted standards, as well as the importance of international collaboration in the implementation and practical application of these standards (González-Mendes, Alonso-Muñoz, García-Muiña, & González-Sánchez, 2024; Khademi, Essers, & Van Nieuwkerk, 2023; Sarim et al., 2019).

One area where there is a discrepancy between the intended and actual implementation of global halal governance standards is the readiness and adoption of blockchain technology in the halal certification process. Normatively, the adoption of blockchain technology is anticipated to enhance transparency, traceability, and consumer confidence in halal products. Nevertheless, in practice (das sein), institutions such as LPH in Indonesia are not yet fully prepared to adopt this technology, despite the strong support expressed by BPJPH. This illustrates the discrepancy between the anticipated optimal standard and the prevailing practice in this domain, where the lack of technological and resource preparedness represents a significant obstacle to the implementation of blockchain technology for halal certification, particularly within the context of the global halal regulatory infrastructure. Blockchain technology offers substantial benefits in terms of providing consumers with information regarding the provenance of halal food products. (Hidayati, Vamelia, Hammami, & Endri, 2023; Kusnadi, Arkeman, Syamsu, & Wijaya, 2023; Susanty, Puspitasari, Rosyada, Pratama, & Kurniawan, 2024).

In general, blockchain technology enhances transparency and integrity in the halal supply chain by enabling the immutable recording and verification of halal certificates, thus addressing issues such as data leakage, manipulation, and cross-contamination. The deployment of this technology ensures that consumers can rely on the halal status of products, which is crucial for maintaining consumer confidence and compliance with Sharia law (Arkeman, Hidayah, Suharso, Adhzima, & Kusuma, 2023; Vanany, Soon-Sinclair, & Rahkmawati, 2024).

Furthermore, blockchain has the potential to increase the efficiency and competitiveness of supply chains by streamlining the monitoring of product data from the farm to the consumer. This is exemplified by the implementation of blockchain in chicken-

based food supply chains. Nevertheless, the adoption of blockchain technology is not without its challenges. The high costs of implementation, which are particularly onerous for MSMEs, represent a significant barrier. Furthermore, the preparedness of regulatory bodies and the intricacy of integrating blockchain with existing systems present additional challenges. The absence of automated validation techniques and integration with geomapping and product imaging further constrains the efficiency and ease of use of the system (Ali et al., 2023; Hendayani & Fernando, 2023; E Sumarliah, Li, Wang, Khan, & Khan, 2023).

The objective of this article is to examine the discrepancy between the preparedness and capability of regulatory frameworks and the actual deployment of blockchain technology on a global scale. Inadequate infrastructure results in increased costs associated with the implementation of advanced technologies, such as blockchain. The establishment of a coherent and cohesive global regulatory infrastructure would serve to reduce the technological complexity of the situation by providing clear standards and guidance. For regulators to adopt and oversee new technologies effectively, it is necessary for them to have access to a supportive infrastructure design. It would be optimal for the infrastructure to facilitate the scalability of the technology, thereby enabling its adoption across a range of industry scales and allowing new technologies to function in a harmonious manner with existing systems on a global scale.

LITERATURE REVIEW

A systematic review of the literature on the global regulation of blockchain technology has identified several key elements of the normative infrastructure of the global halal regulatory framework. It is evident that governments and international authorities, such as global halal certification bodies and multilateral organisations, play pivotal roles in the creation and regulatory oversight of blockchain technology and personal data protection. In the context of the globalisation of technology, electronic systems and blockchain services, it is evident that a common set of regulations related to data collection, retention and processing is required at the international level. This is because each country applies varying regulatory frameworks, which creates a need for a unified approach. Furthermore, it is essential to consider the role of consumers who utilise blockchain technology to verify halal certification and the general public engaged in the digital economy, as they are also key subjects of these norms. The norms pertain to three key areas: blockchain technology itself, personal data, and the digital infrastructure that supports the application of blockchain technology and the protection of personal data (Arkeman et al., 2023; Hendayani & Fernando, 2023; Kusnadi et al., 2023; E Sumarliah et al., 2023).

The successful implementation of this technology is contingent upon the availability of equitable and affordable digital infrastructure, as well as compliance with regulations set by various countries and global authorities. Furthermore, a sufficient level of digital literacy among the general public and businesses is necessary to facilitate the effective adoption and utilisation of blockchain technology on a global scale (Hakim, 2014).

From the perspective of the global regulatory framework, Lex Crypto and Lex Informatica, as norm operators, provide the requisite framework for law enforcement and the utilisation of blockchain technology in digital data management. Lex Digitalis plays a significant role in the orderly utilisation of internet technologies, providing the legal basis

for virtual jurisdictions around the world. The implementation of blockchain technology can be carried out effectively and efficiently in various sectors, including personal data protection and halal certification, through the improvement of supportive digital infrastructure, strengthening of digital literacy, and compliance with international regulations. Furthermore, previous research has highlighted the necessity for international collaboration and the implementation of global digital governance to guarantee the security, fairness and trustworthiness of digital technology, with the aim of enhancing transparency and accountability in the global halal certification process (Ali et al., 2023; Mugiono, 2024; Susanty et al., 2024; Vanany et al., 2024).

The findings of previous research include the discovery of several key areas of interest, namely, smart contracts, supply chains, data privacy, distributed ledgers and cryptography. The use of smart contracts is becoming increasingly prevalent across a range of sectors, including finance and supply chain management. These contracts have the potential to automate and streamline transactions, thereby enhancing overall efficiency (E Sumarliah et al., 2023). The implementation of blockchain technology within the supply chain facilitates enhanced transparency and traceability, enables the circumvention of regulatory constraints, and enhances operational efficiency (Chen, Hu, Wang, & Wu, 2023; E Sumarliah et al., 2023; M. Wang, Yang, Shan, & Guo, 2024). The necessity for robust encryption techniques to safeguard personal data within blockchain systems is of paramount importance (S. Wang et al., 2024). The provision of a transparent and reliable distributed ledger network for various industrial applications is described in the article 'A bipolar neutrosophic combined compromise solution-based hybrid model for identifying blockchain application barriers and benchmarking consensus algorithms' (Aytekin et al., 2024). The utilisation of cryptographic methodologies, including ring signatures, stealth addresses, and threshold proxy re-encryption, serves to guarantee the security and anonymity of transactions within the blockchain system. Consequently, this technique may be regarded as a principal reference framework for global halal standardisation regulations, which may be adopted by each country (Cai et al., 2023; Crompton & Jensen, 2018; Salem, Hassan, Moustafa, & Hassan, 2023; Yan & Zheng, 2023).

Lex Informatica provides a flexible and adaptable framework within the context of global halal regulatory standardisation, facilitating the implementation of policy through the utilisation of technical standards and the engagement of multistakeholder participation. The roles of technical standards, legal support, technical infrastructure, public oversight, international cooperation, and privacy and data security considerations are common provisions and constraints. This approach allows for the consistent and efficient application of halal standards around the world, thereby increasing consumer confidence and ensuring compliance with halal principles (Calderón Marenco, del Socorro Rodríguez Palacios, Garzón Solano, & Ravelo Franco, 2024).

The fundamental principles of blockchain-based global halal regulatory design, when integrated with Lex Informatica, can facilitate the creation of a coherent and adaptive framework. Blockchain technology, as a decentralised system and distributed database, provides a transparent and secure platform for tracking halal products throughout their production, distribution and consumption. In this context, blockchain technology functions as a digital ledger, recording all transactions related to halal products in a permanent and irreversible manner (McMenemy, 2023).

Lex Informatica offers a framework for the development of the technical standards necessary for the regulation of halal products on a global scale. Such standards may be implemented in a blockchain system, thereby ensuring that all stages of the halal supply chain comply with the stipulated criteria. Blockchain technology facilitates the accurate recording and verification of every stage in the production and distribution process, thereby ensuring compliance with halal standards (Amelin, Channov, & Lipatov, 2022).

The standards developed through Lex Informatica are modular, thereby enabling specific elements to be adopted or customised according to local regulatory needs without necessitating a comprehensive alteration to the system as a whole. Blockchain technology facilitates this modularity by enabling the implementation of smart contracts that can be tailored to align with the specific halal regulations prevailing in different countries or communities. This guarantees the preservation of the fundamental tenets of halal while allowing for the incorporation of local nuances (McMenemy, 2023).

The inclusive standardisation process employed by Lex Informatica involves the participation of a diverse range of stakeholders, including government representatives, industry professionals, consumer groups, and halal certification organisations. Blockchain technology facilitates transparency and participation by providing an open, accessible record that can be accessed by all relevant parties. The tracking and verification of each transaction or alteration to the standard is possible for all stakeholders, thereby ensuring accountability and trust in the system.

The technology implemented through Lex Informatica can be integrated with existing local infrastructure. Blockchain facilitates interoperability with existing logistics and distribution systems, thereby ensuring the widespread and effective implementation of technical solutions. Blockchain-based tracking systems are designed to be adaptable, allowing them to be integrated with a range of platforms and devices used across the globe (Marsden, 2021).

Blockchain technology facilitates the real-time aggregation and analysis of data, which can be employed to tailor standards and practices to the particular requirements of a given region. The utilisation of data pertaining to consumer preferences, local regulations and market conditions can facilitate the optimisation of the production and distribution process of halal products. This technology guarantees that halal standards are perpetually current and pertinent to alterations in regulations or market requirements (Khan, Loukil, Ghedira-Guegan, Benkhelifa, & Bani-Hani, 2021).

Lex Informatica can be employed by governments to establish a legal framework that facilitates the implementation of blockchain-based technical standards. The law can provide general guidance and allow the technical details to be determined by mutually agreed upon standards, thereby affording flexibility for local adaptation. The implementation of enforcement mechanisms, such as immunity for companies that comply with standards and liability for those that do not comply, could facilitate the adoption of customised standards on a wider scale (Khan et al., 2021).

Lex Informatica and blockchain can be employed in conjunction to facilitate innovation and the development of new technologies that are tailored to local requirements. Governments may establish incentive structures to encourage developers to

design technologies with the requisite flexibility of information flows. Incentives may take the form of funding support, accreditation, or tax incentives (Ada et al., 2021).

METHOD

This research is normative legal research. Normative legal research analyses theoretical legal materials and relevant legal documents to understand, interpret and develop existing legal concepts. The research approach used is a conceptual approach and a comparative approach. The conceptual approach is used to understand basic concepts related to regulatory infrastructure and blockchain technology. The comparative approach will be used to compare different regulatory frameworks in different countries to identify best practices and barriers (Mubarak & Mahfudz, 2023).

The study uses secondary data, including first, scholarly articles, books, journals, and research reports on the implementation of blockchain technology and regulation, as well as official reports from government agencies, international organisations, and regulatory bodies on the readiness and capacity of the regulatory infrastructure. Data were collected through desk research to gather legal materials, academic articles and research reports. Searches of legal and academic databases such as Scopus, Emerald, Google Scholar and ProQuest were performed to identify relevant literature. Collection of official reports from the websites of government agencies, international organisations and regulatory bodies. Data triangulation was carried out to ensure data validity through source triangulation, which compares information from different sources to ensure data consistency and validity. Triangulation methods involve the use of different data collection methods, such as literature reviews, database searches and the collection of official reports (Amalia & Musa, 2023; Isman & Ahmad Zainul Muttaqin, 2024; Mubarak & Mahfudz, 2023).

The procedure for analysing the data includes the coding of the data, through which the main themes and subthemes are identified. Content analysis is conducted to gain an in-depth understanding of the themes and subthemes that have been identified. This enables the relationship between regulatory concepts and principles to be elucidated. Comparative analysis is employed to compare regulatory frameworks from various countries. This allows gaps, challenges and best practices to be identified. Conclusions are drawn through the deductive method. This confirms or modifies existing theories on the basis of the research results. The synthesis technique combines findings from various sources and methods. This enables comprehensive and applicable recommendations to be produced (Hambali & Ali, 2023; Suadi & Affandi, 2023).

RESULTS AND DISCUSSION

The discussion on the implementation of global halal standards needs to be systematic. First, the discussion will focus on identifying the challenges that arise, including gaps in the application of consistent regulations in different countries, as well as differences in the interpretation of Sharia principles in business practices.

Second, the impact of the implementation of the global halal standard can be seen not only in the form of increased transparency and consumer confidence in halal products but also in the complexity of monitoring and accountability. The global implications for halal business include an increased need for regulatory harmonisation to ensure alignment

between different international markets and the integration of technologies such as smart contracts, supply chain management, data protection, distributed ledgers and cryptography (Carlet, 2020).

Third, recommendations for terms of reference for global halal regulatory design should include the subject of the standard, the object of the standard, the conditions of the standard and the operators of the standard with approaches that use the latest technology to improve efficiency and security in the process of certification and monitoring halal products (Alfansyur & Mariyani, 2020; Rahardjo, 2010; Salem et al., 2023; Taekema, 2021; Weisbrod, Handler, & Komesar, 2023).

CHALLENGES IN IMPLEMENTING GLOBAL HALAL STANDARDS

According to the findings of Tariqullah (2019) and Ismael et al. (2021), the obstacle to the implementation of global halal regulations is the variability in the level of ethical commitment, which creates difficulties in harmonising halal standards across different contexts and countries. This includes differences in the interpretation and application of halal standards, which can hinder efforts to create a consistent and unified framework across the world. This means that incorporating responsibility and ethical issues into the regulatory design of global halal standards must not only ensure that the regulations meet technical requirements but also reflect more global ethical principles that are respected across countries (Ismaeel & Blaim, 2012; Tariqullah Khan, 2019).

Abdullah et al. (2017) highlighted three aspects that may hinder the implementation of global halal regulations, namely, the variation in financing needs in the halal sector and the limitations of existing financing models. Challenges in harmonising the financing needs of halal microenterprises in different countries. Standards in halal regulations must be able to accommodate differences in local needs and practices; otherwise, consistent global standards will be difficult to apply widely or across countries (Abdullah & Oseni, 2017).

Research by Solehudin, Ahyani and Putra (2024) highlights the need for clearer and globally standardised guidelines in the implementation of the global halal industry. The study by Sutono et al. (2024) revealed vagueness and a lack of technological adaptation in the supply chain of the halal industry. Harwati et al. (2023) highlighted the importance of halal integrity and mandatory regulations as key indicators in strengthening the halal supply chain. Santoso and Rachman (2023) identified the need for digitalisation to improve efficiency and compliance in the halal certification process (Santoso & Rachman, 2023; Solehudin, Ahyani, & Putra, 2024; Sri Asih & Sopha, 2023; Sutono, Rahtomo, Puksi, & Permana, 2024).

As awareness and demand for halal products and services continue to grow on a global scale, the need for the harmonisation of halal standards has also become increasingly urgent. Inconsistent regulations and diverse barriers can impede the expansion of the halal industry on a global scale. Therefore, collective and coordinated international efforts must be made to overcome these barriers.

Table 1 : The Challenges of Implementing the Global Halal Standard

Classification	Variable Barriers	Description
Institutional Capacity	Ethical commitment & Global Halal Standardisation Guidelines.	This affects consistency and diversity in the global framework.
	Minimal adaptation of Technology in the Halal Supply Chain	Lack of technological adaptation in the supply chain hinders development and efficiency in the global halal industry.
Diversity of Standards	Financial Needs and sustainability of the halal industry	Differences in financing needs in the halal sector, especially for microenterprises in various countries.
	Integrity of Halal regulations and certification	Integrity in halal regulations to avoid doubts in compliance with halal standards.
Awareness and Technology Gap between Countries	Urgency of digitalising Halal Certification processes	The need to adopt digital technology to increase efficiency
	Minimal research on halal additives and raw materials	Lack of research on halal materials in the economic and business context

The aforementioned table identifies critical areas that require resolution to overcome the barriers to the implementation of global halal standards and ensure more consistent and effective implementation across countries. The interconnectivity of these concepts demonstrates that the establishment of an effective global halal standard necessitates a comprehensive approach that encompasses ethical commitment, transparent guidelines, technological adaptation, financial support, transparent regulation, digitalisation of processes, and in-depth research. Each of these elements is mutually supportive and collectively constitutes the foundation for the consistent and reliable implementation of halal standards on a global scale.

To comprehend the manner in which blockchain guarantees the transparency and verifiability of each stage in the halal production and distribution process for all stakeholders, it is possible to utilise the research data of Sumarliah et al. (2022) as a fundamental framework, comprising the following stages: first, blockchain records each transaction and process that occurs in the halal supply chain on a permanent basis. Each stage of the process, from production to distribution, is recorded in cryptographically linked blocks. The immutable nature of these records ensures data integrity and reduces the risk of fraud (Feng & Zhao, 2017; E. Sumarliah, Li, Wang, Fauziyah, & Indriya, 2022).

Second, the blockchain system permits any stakeholder (e.g., manufacturers, suppliers, service providers, or consumers) to access and verify transaction records. This facilitates transparency, thereby enabling all parties to monitor compliance with halal standards (Freitag et al., 2021; Nelaturu, Mavridou, Stachtiari, Veneris, & Laszka, 2023).

Third, smart contracts are computer programs that run on the blockchain and execute automated agreements on the basis of predefined conditions. In the context of halal certification, smart contracts can guarantee that all processes in production and distribution comply with the requisite halal standards before proceeding to the subsequent stage (Nelaturu et al., 2023).

Fourth, Lex Informatica encourages the active participation of a variety of stakeholders in the development and implementation of halal standards. Blockchain technology offers a solution to this problem by providing open and transparent records that can be accessed by all relevant parties. Such participation is crucial for the establishment of trust and accountability within the system (Amelin et al., 2022; Calderón Marenco et al., 2024; Koos, 2022).

Furthermore, blockchain facilitates more straightforward and transparent auditing procedures. The ability to trace each transaction back to its source enables inspectors and auditors to verify that all processes comply with the established halal standards (Saifudin, Othman, & Elias, 2017; Solehudin et al., 2024).

Those engaged in the implementation of blockchain technology for global halal standards include a diverse range of stakeholders, including actors in the supply chain, regulators, technology developers, and consumers. The aforementioned actors include food manufacturers, distributors, retailers, halal certification authorities, and end consumers. Regulators and certification authorities are responsible for establishing and overseeing halal compliance standards. The role of technology developers is to implement and maintain the blockchain infrastructure (McMenemy, 2023).

The scope of regulated behaviour encompasses the entire process of managing and verifying halal products, from the initial raw materials stage to the final product. This encompasses monitoring the provenance of ingredients, production processes, storage, distribution, and sales. Blockchain technology is employed to document and validate each stage of the supply chain, thereby guaranteeing that all the requisite procedures for halal compliance are fulfilled. The utilisation of this technology is intended to deter the production and sale of counterfeit products and guarantee transparency throughout the supply chain (Amelin et al., 2022).

Normative conditions encompass the temporal and spatial parameters of halal standard implementation, in addition to any exceptional stipulations that may be applicable. The implementation of blockchain technology in the context of halal certification can be tailored to align with the specific regulations and policies established by halal certification authorities in different countries. Furthermore, norm conditions may encompass responses to particular circumstances, such as disease outbreaks, which necessitate supplementary verification to guarantee product safety. This is exemplified by the measures taken to mitigate the risk of contamination from coronavirus disease 2019 (COVID-19) in the meat supply chain (Alamsyah, Hakim, & Hendayani, 2022).

Those operating within the norms are required to adhere to the established procedures for utilising blockchain technology for halal verification purposes. These procedures encompass the accurate collection of data, transparent reporting, and the maintenance of data integrity. It is prohibited from falsifying information, disregarding established procedures, or misuse data collected through the blockchain. All parties in the supply chain

must comply with all relevant standards and regulations to ensure that products are produced and distributed in accordance with the requirements of the halal industry.

Figure 1: Design of the Halal Standard Global Based on the Blockchain
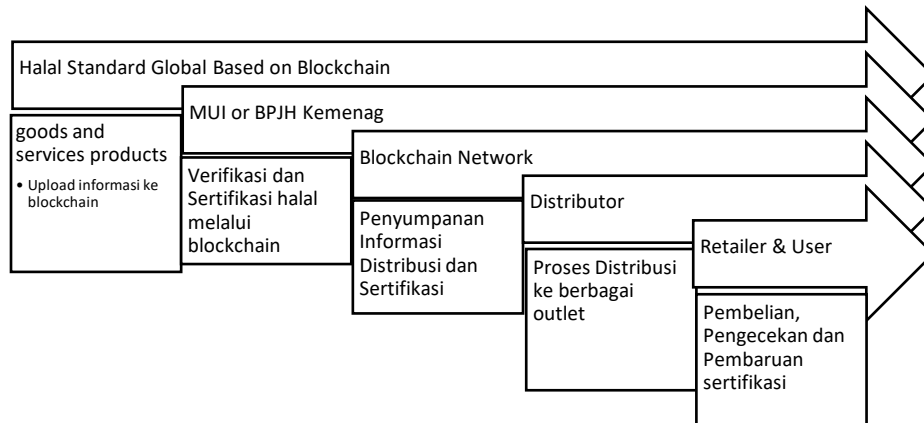
Source: Personal elaboration by the authors.

The design of the blockchain-based global halal standard mechanism commences with the uploading of product and service information into the blockchain network. This information encompasses all pertinent details regarding the raw materials and production processes that are crucial to the determination of the halal status of a product. Institutions such as MUI or BPJPH subsequently conduct halal verification and certification through the blockchain system, thereby ensuring transparency and accuracy in this process (Calderón Marenco et al., 2024).

Upon completion of the verification and certification process, all pertinent distribution and certification data are stored within the blockchain network. The dataset includes halal certificates, product distribution flows, and transaction histories, thereby providing a secure and transparent platform for the storage of all such information. The verified and certified products are subsequently distributed by distributors to various outlets, and information regarding the distribution process is also recorded in the blockchain. This guarantees that each phase of the supply chain can be monitored and verified. Retailers procure products from distributors and subsequently offer them for sale to end consumers. The blockchain system enables consumers to purchase products and to verify and renew certifications. Consequently, consumers are able to ascertain that the products they purchase are genuinely halal and have undergone a comprehensive verification procedure (Amelin et al., 2022).

This mechanism offers numerous advantages, including enhanced transparency. The blockchain provides a secure and verifiable record of all transactions, enabling interested parties to track and verify information with precision. Furthermore, the immutable nature of blockchain data ensures the integrity of halal certificates, reducing the risk of falsification. Furthermore, the digitalisation of the verification and certification process leads to greater efficiency. Consumers are able to verify the halalness of a product directly, which increases their confidence in the process. Consequently, the implementation of blockchain technology in global halal standards offers a more secure, transparent, and efficient solution.

ENHANCING HALAL STANDARDS AND GLOBAL ALIGNMENT

Operator norms encompass the responsibility to adhere to established procedures pertaining to the utilisation of blockchain technology for halal verification purposes. These procedures encompass the accurate collation of data, transparent reporting, and the maintenance of data integrity. It is prohibited from falsifying information, disregarding established procedures, or misuse data collected through blockchain. All parties in the supply chain must comply with all relevant standards and regulations to guarantee that products are manufactured and distributed in accordance with the requirements of the halal certification process.

The implementation of blockchain in halal certification has several significant advantages. The blockchain ensures transparency and traceability in the supply chain, as every step in the production process can be tracked and verified in real time. This reduces the risk of data manipulation and increases consumer confidence in halal products, especially packaged food products. Research by Sumarliah et al. (2021) shows that although halal awareness among halal producers does not directly affect their perception of blockchain technology, institutional pressure, namely, halal authorities, plays a significant role. This is evidenced by the statistical number of halal fashion and textile manufacturers adopting the blockchain for halal fashion and textile systems (Eli Sumarliah, Li, Wang, Fauziyah, & Indriya, 2021).

The data indicate that blockchain technology not only enhances halal standards through enhanced traceability but also facilitates the harmonisation of global halal standards through cross-border collaboration and ensures compliance with institutional pressures.

Table 2 : Halal certification bodies on Europe scale

Country	Muslims (%)	ACB
Turkey	89.50%	2
Bosnia Herzegovina	50.70%	1
France	8.00%	5
Austria	8.00%	2
Belgium	7.60%	1
United Kingdom	6.30%	3
Denmark	5.40%	1
Netherlands	5.10%	2
Germany	5.00%	13
Italy	4.80%	1
Spain	2.60%	1
Poland	0.10%	1

Source: (E. Sumarliah et al., 2022)

Blockchain technology has the potential to significantly contribute to the harmonisation of global halal standards, particularly in European countries with minority Muslim populations but a notable presence of authorised classifying bodies (ACBs). For example, in Germany, where Muslims make up only 5.00% of the population yet the country has the highest number of ACBs (13), blockchain can play a pivotal role in

ensuring transparency, traceability, and trust in halal certification processes (Makhdoom, Zhou, Abolhasan, Lipman, & Ni, 2020; Niya, Willems, & Stiller, 2022).

By utilising blockchain, the entire halal certification process can be recorded on an immutable ledger, providing a transparent and verifiable history of each product's journey from production to consumption. This ensures that all stakeholders, from producers to consumers, can trust the authenticity of halal certifications. For countries such as France and the United Kingdom, where the Muslim population is also a minority (8.00% and 6.30%, respectively) but the number of ACBs is relatively high (5 and 3, respectively), blockchain can help streamline certification procedures and enhance the credibility of halal products in the market (E. Sumarliah et al., 2022).

In these countries, the integration of blockchain can facilitate the harmonisation of halal standards by enabling ACBs to collaborate more effectively. With a shared, decentralised database, certifying bodies can ensure consistency in their criteria and methods, reducing discrepancies and potential conflicts. This harmonised approach can be particularly beneficial in regions such as the Netherlands and Austria, which also have minority Muslim populations (5.10% and 8.00%, respectively) and few ACBs (2 each). Blockchain can help align their certification standards with global practices, promoting the uniformity and mutual recognition of halal certificates (Del Re, 2020).

Moreover, in countries with very small Muslim populations, such as Poland (0.10%), the adoption of blockchain can bolster the confidence of both Muslim and non-Muslim consumers in the integrity of halal products. It can also provide a competitive advantage to local businesses seeking to cater to the halal market by demonstrating a commitment to transparency and quality. Overall, the implementation of blockchain technology in halal certification across Europe can foster a more cohesive and trustworthy system, ensuring that halal standards are consistently met and recognised worldwide. This not only benefits Muslim consumers but also enhances the marketability and acceptance of halal products in countries where Muslims constitute a minority (Giyanti, Indrasari, Sutopo, & Liquiddanu, 2021).

CONCLUSION

The gaps between global halal standards and empirical practices include differences in ethical commitments, funding requirements, guidelines, technological adaptation and digitisation of certification processes. The state and readiness of the global regulatory infrastructure to support the adoption of blockchain technology for halal standards show different levels of readiness in different countries. In Europe, for example, countries with a Muslim minority but many Authorised Certifying Bodies (ACBs), such as Germany, with 13 ACBs and a Muslim population of 5%, show high readiness to adopt blockchain to ensure transparency and traceability of halal certification. France and the UK, with 8% and 6.3% of the Muslim population and 5 and 3 ACBs, respectively, also show significant readiness to adopt this technology.

This adoption of blockchain enables effective collaboration between ACBs and ensures the uniformity of halal certification standards, reducing conflicts and differences. In a country with a very small Muslim population, such as Poland (0.1%), blockchain can increase consumer confidence in the integrity of halal products. Overall, the implementation of blockchain in halal certification will strengthen a more consistent and trustworthy system,

ensuring compliance with halal standards globally. Technology and regulatory infrastructure readiness varies, with countries such as Germany and France showing high readiness, increasing transparency and consumer confidence. The adoption of blockchain strengthens the trust and harmonisation of standards, but countries with small Muslim populations, such as Poland, still need to improve their infrastructure. Positive impacts include the growth of the global halal market and increased consumer confidence through traceability and data integrity.

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