The South East Asian Journal of Management

Volume 18 | Number 1 Article 3

4-30-2024

Integrity and Legitimacy of Halal Products: The Urgency of Halal Supply Chain Management Technology Adoption in Halal Product Authentication Traceability Evidence from Indonesia

Ari Agung Nugroho
Bangka Belitung University, rma.agungnugroho@gmail.com

Sumiyati Sumiyati
Bangka Belitung University, sumiyati.lec2019@gmail.com

Hamsani Hamsani
Bangka Belitung University, hamsani.babel@gmail.com

Recommended Citation

Nugroho, Ari Agung; Sumiyati, Sumiyati; and Hamsani, Hamsani (2024) "Integrity and Legitimacy of Halal Products: The Urgency of Halal Supply Chain Management Technology Adoption in Halal Product Authentication Traceability Evidence from Indonesia," *The South East Asian Journal of Management*: Vol. 18: No. 1, Article 3.
DOI: 10.21002/seam.v18i1.1485
Available at: https://scholarhub.ui.ac.id/seam/vol18/iss1/3

Integrity and Legitimacy of Halal Products: The Urgency of Halal Supply Chain Management Technology Adoption in Halal Product Authentication Traceability Evidence from Indonesia

Cover Page Footnote

This work has been funded by Bangka Belitung University under the Research and Community Service Grants 2023 programme.

The South East Asian Journal of Management
Vol. 18 No. 1, 2024
pp. 54-80
ISSN: 1978-1989
E-ISSN: 2355-6641

Integrity and Legitimacy of Halal Products: The Urgency of Halal Supply Chain Management Technology Adoption in Halal Product Authentication Traceability Evidence from Indonesia

Ari Agung Nugroho
Master of Management Program, Universitas Bangka Belitung, Bangka, Indonesia

Sumiyati*
Department of Accounting, Universitas Bangka Belitung, Bangka, Indonesia

Hamsani
Master of Management Program, Universitas Bangka Belitung, Bangka, Indonesia

Abstract

Research Aims: This research aims to determine how technology, integrity, and the environment affect traceability of halal product certification and its relationship with Halal Value Chain (HVSC) Management in micro, small and medium processing industries.
Design/Methodology/Approach: The quantitative research utilised survey data from 285 respondents who are processing industry players throughout Indonesia. Structural Equation Modelling-Partial Least Square (SEM-PLS) is applied for data analysis.
Research Findings: The study's findings indicate that technology adoption and environmental factors have a significant effect on HVSC traceability. The authentication and legitimacy of halal products are positively impacted by technology adoption, among others, which contributes to the overall product integrity. The research findings also indicate government support as an important factor.
Theoretical Contribution/Originality: This research is one of the first studies related to supply chain legitimacy and authentication in the context of micro, small, and medium businesses in Indonesia, a country with a Muslim majority and many micro-businesses where these businesses have direct contact with "from farm to fork or table" end customers.
Managerial Implication in the South East Asian Context: This research offers valuable contribution for managers and policymakers in South East Asia in formulating authentic halal product policies in terms of HVSC.
Research Limitations & Implications: This research can benefit from a larger sample size, preferably from larger companies, for generalisation. Moreover, expanding the research across borders and employing a mixed-method approach could offer further insights to overcome supply chain challenges in the future.

Keywords*:* Halal Value Chain Management, Technology Adoption, Environment, Integrity, Authentication, Legitimacy

*Corresponding author: sumiyati.lec2019@gmail.com
Received: October 2023 / Revised: January 2024 / Accepted: January 2024 / Published: April 2024

INTRODUCTION

According to the Pew Research Center's Forum on Religion and Public Life in 2022 (Pew Research Center, 2011), Indonesia has the world's largest Muslim population, reaching 238 million people, accounting for 87% of its total population. This large Muslim community has established Indonesia as the global leader in the halal product market share (Riaz & Chaudry, 2019). Bank Indonesia (BI) noted that Indonesia's halal food exports reached USD13.36 billion, with a significant growth of 46%. The Indonesian government also prioritises the Halal Value Chain (HVSC) sector, which consists of agriculture, halal food and beverages, fashion, and Muslim-friendly tourism. Projections indicate an expected growth of 4.5 - 5.3% for the HVSC sector in 2023. In addition, BI is also preparing strategies to strengthen the Islamic economy and finance sectors, including the development of the Halal Value Chain through increasing the capacity of stakeholders, strengthening Sharia business models, and accelerating halal traceability using blockchain technology (IHLC, 2021).

Halal food production requires a meticulous understanding of the entire supply chain. Presently, Muslim consumers seek assurance that the products they consume adhere to the halal standards and comply with the principles of being *tayyib*, meaning the food is healthy, pure, wholesome, nutritious, and good. Therefore, it is necessary to have the ability to trace where and how the supply is generated. The traceability of supply origin is a form of commitment to halal products, as every Muslim desires (Ab Rashid & Bojei, 2020; Zulfakar et al., 2014).

Several studies on HVSC have explored various aspects, including traceability systems (Rejeb et al., 2021), integrity (Ali & Suleiman, 2018; Mohamed et al., 2020; Soon et al., 2017; Zulfakar et al., 2014), certification process (Adekunle & Filson, 2020; Tieman et al., 2012; Zainuddin et al., 2019), technology adoption (Ahmad Tarmizi et al., 2020; Ben-Daya et al., 2020; Bouzembrak et al., 2019; Rejeb et al., 2021;), HVSC blockchain application (Abidin & Perdana, 2020; Duan et al., 2020; Tan et al., 2022) HVSC issues and challenges (Hashim & Shariff, 2016), sustainability (Khan et al., 2021). These studies employed both qualitative methods (Ab Talib, 2017; Indarti et al., 2020; Khan et al., 2022; Rejeb et al., 2021) and quantitative methods (Ab Rashid & Bojei, 2020; Azmi et al., 2020). However, all these studies show that traceability within the HVSC remains a complex and unresolved question.

The challenge of tracing the origin of products is a complex matter. HVSC demands a commitment to integrity throughout the supply chain, spanning from farmers or breeders as the main producers to the end consumers. Roughly 80% of the farmers, breeders or producers are controlled by non-

Muslims who may have different perspectives on the standard of halal products. Abidin & Putera Perdana's study (2020) states that 65% of the world's halal meat originates from non-Muslim countries such as New Zealand, Australia, Brazil, and India. Another study found that products with Arabic writing mostly come from non-Muslim majority countries like the Netherlands, China, Spain, India, Vietnam, and Thailand (Abidin & Perdana, 2020). This indicates a potential vulnerability, where falsification of halal certification and other related issues may lead to increasing doubt about the integrity status of halal products (Zulfakar et al., 2014).

Blockchain technology is one of the alternative solutions that can improve the integrity of HVSC (Yanti et al., 2022). Letourneau and Whelan (2017) define blockchain technology as a system chain that stores transaction data using computer technology with a direct access system between sellers and buyers without intermediaries. There have been few studies on blockchain technology for HVSC (Ben-Daya et al., 2020; Tarmizi et al., 2020; Rejeb et al., 2021). Bouzembrak et al. (2019) have conducted studies on the adoption of the Internet of Things (IoT) aimed at tracking the supply chain of halal products. In this context, IoT aims to increase the efficiency of the food industry's supply chain management, particularly by implementing supply chain traceability for agricultural products for small and medium businesses. These studies explored the potential of IoT for HVSC traceability, but there are currently no empirical study results on the precise role of IoT in the industry.

HVSC blockchain technology, in particular, has been studied with various approaches. For example, Tan et al. (2022) conducted a literature study focusing on the implementation of blockchain technology for HVSC traceability. An empirical study on HVSC traceability involving technology adoption was conducted by (Ab Rashid & Bojei, 2020). This study concluded that the adoption of halal product traceability systems is closely related to environmental factors and supply chain integrity within the processed food and beverage industry. Similarly, the study conducted by (Azmi et al., 2020) concluded that integrity is one of the factors that influence companies in Malaysia to adopt HVSC technology. Both studies are confined to specific industry sectors, limiting the generalizability of their findings to other industries. In addition, respondents in these studies primarily consisted of Muslim company owners, who tend to have a better understanding of halal products than non-Muslim company owners.

The study conducted in Indonesia presents an interesting perspective on HVSCs. Although Indonesia is the largest Muslim country in the world, most company owners, especially the largest manufacturing companies, are non-Muslims. The majority of products available for purchase in Indonesia have been certified by the Indonesian Council of Ulama. The certification process

requires a product to adhere to halal criteria, starting from the ingredients' origin to the packaging process. Large companies typically have adopted HVSC technology, allowing easier tracking of the source of raw materials. However, it differs in the case of micro, small and medium industries, where the management relies on simpler technology. As a result, traceability of raw material sources is very difficult to do.

Tarmizi et al. (2020) found that small and medium industries face difficult challenges in adapting to HVSC technology. In addition to conducting surveys, in-depth interviews are also needed to determine the authenticity of halal certification obtained by business owners associated with HVSC. In addition, although Indonesia has the Indonesian Council of Ulama, the function is to provide halal certification, Malaysia is the only Southeast Asian country that has taken a proactive measure to support halal assurance through the establishment of a dedicated website called Jakim Halal Portal as an effort to track halal products (Zainuddin et al., 2019).

Azmi et al. (2020) identified the manufacturing process as the most significant factor that affects consumer perceptions of halal products. Their study also noted that integrity and organisational support are important considerations in the adoption of halal verification and certification mechanisms (HVCM). On the other hand Ag Majid et al. (2021) highlighted the significance of logistics processes in shaping consumer perceptions of halal products, with consumer knowledge significantly influencing the decision to choose halal products. Meanwhile, Adekunle and Filson (2020) argued that consumers are more likely to trust halal products if they are deemed authentic and their source can be traced. Despite these findings, there is still no consensus on the factors influencing the adoption of technology for tracing halal products to ensure their legitimacy and authenticity.

This study aims to examine the effect of technology, integrity, and the environment on the tracking of authentic legitimacy of halal product certification and its relationship with HVSC in micro, small and medium processing industries. The study is appropriate for the Indonesian context, given the important role of micro, small, and medium enterprises in the national economic growth. In addition, there is a notable gap in the literature regarding HVSC integrity through IoT in the processing industry. Integrity is always related to religion, where religion plays an important role in a person's life (Akhtar et al., 2020; Azmi et al., 2020; Indarti et al., 2020). Research needs to be done to explore the relationship between authentication in HVSC and the legitimacy of halal products. This research seeks to make a substantial contribution to the formulation of authentic halal product policies in terms of HVSC, especially for micro, small, and medium processing

industries. Additionally, the research also explores the role of technology in facilitating HVSC traceability.

LITERATURE REVIEW

Halal Value Supply Chain Management (HVSC Management)

Ahi & Searcy (2013) focused on Value Chain Management (VCM) keywords such as flow, coordination, stakeholders, relationships, value, efficiency, and performance. Thus, VCM can be broadly interpreted as a product flow or process that involves coordination between interconnected stakeholders to increase product value, efficiency, and quality. Meanwhile, Halal Value Chain Management (HVSCM) follow the principles of halal, *tayyib,* and "farm to fork," as cited in (Khan et al., 2018). It can be concluded that HVSCM is a product flow that must comply with Sharia compliance from the first process to the consumer's plate.

Shariah compliance in the supply chain focuses on the principles of halal and *tayyib*. Halal is related to the source, while *tayyib* is related to the method. Halal supply chain management, or in this case is also called Halal Value Chain Management (HVSCM), can be considered to be successful when there are collaborative efforts between farmers/breeders/producers and consumers (Aghwan et al., 2016; Arif & Sidek, 2015; Halaseh & Sundarakani, 2012; Manzouri et al., 2013; Tieman et al., 2012). Khan et al., (2018) elaborated that halal signifies that the product is produced in accordance with Sharia rules, while *tayyib* signifies that the process of producing products has met nutritional standards, adhered to safety and hygiene regulations, avoided harm to animals and the environment, and gone through a fair-trade process.

Effective HVSCM must involve stakeholders such as consumers, governments, suppliers, and manufacturers. In addition, the focus of halal and *tayyib* principles should be applied to raw materials, services, information, and capital. In order to satisfy the needs of both halal and non-halal customers, Tieman et al., (2012) defined HVSC as the process of managing halal food products from various supplier points to various buyer/consumer points involving various parties located in different places. From this definition, it can be interpreted that HVSC is a process of product management that adheres to the Islamic Sharia rules, starting from planting/raising, cutting, packaging, storing, shipping, and selling to become a product ready for consumption.

Halal Product Traceability System Adoption

Today, with the rapid advancement of technology and automation, tracing the origin of halal items has become increasingly feasible. As previously mentioned, the HVSC process involves

producers/suppliers, production processes, shipping (logistics), and purchasing (consumers). Ab Rashid and Bojei (2020) stated that technology plays a vital role in increasing the traceability of all flows in HVSC. Notably, blockchain technology is one of the leading technologies that improve the tracing process. Blockchain is a digital report or database shared within a network that cannot be modified or deleted, effectively allowing people to get information with integrity and authenticity. Blockchain technology shortens the supply chain. In general, blockchain technology adopts a similar structure to that of DNA, where people, particularly consumers, can access information from various sources (Abidin & Perdana, 2020; Tieman & Darun, 2017).

The capability to trace and track products at each stage of the supply chain, from manufacturing to distribution, is referred to as the halal product traceability system. Manufacturers or suppliers are the first stage in the chain and act as the primary source of raw materials for halal products. The ability to trace supplier traceability increases confidence in halal products for consumers, especially those at the end of the supply chain who enjoy final products. An adequate technology system simplifies the tracing process, allowing consumers to effortlessly access this information by scanning the Halal QR Code provided on the product. Thus, the hypothesis can be stated as follows:

H_{1a}: Traceability of halal product suppliers is easy to do with the adoption of technology systems.

The second stage of the supply chain is related to the production process. The production process does play an important role in maintaining the halal quality of a product (Ab Rashid & Bojei, 2020). In the production process, raw materials must be ensured that they come from halal sources. Moreover, production machinery and tools should be clean and not contaminated by non-halal materials. At this stage, producers must also ensure that the packaging follows Sharia rules, meaning that the halal label on the packaging must be authentic and traceable (Samsi et al., 2011). With the adoption of a technology system, the tracing process at the production stage is also much easier, so the hypothesis is stated as follows:

H_{1b}: Traceability of the halal product production process is easy to do with the adoption of technology systems.

The delivery or distribution process within the supply chain also requires certainty of halalness. Proper precautions must be taken to prevent contamination of halal products with non-halal products during the logistics transportation of both finished and semi-finished products. Beyond

transportation, proper attention to storage is also required. Limited availability of warehouse space could lead to inadvertent mixing of halal and non-halal products. This logistics activity needs to be closely monitored so that the mixing of these products does not occur (Tieman et al., 2012). A technology-based tracking system can monitor the critical points during the distribution process, including when products cross countries or regions. The system can provide detailed information during the process (Zulfakar et al., 2014). For this reason, the following hypothesis can be stated:

H_{1c}: Traceability of halal product shipments is easy to do with the adoption of technology systems.

Consumers are the last link in the HVSC to receive most of the finished products. As the final target, end consumers have a high demand for assurance regarding the halal status of the products they consume. Perceived integrity and trust in a product increase when consumers believe that the product is halal (Adekunle & Filson, 2020). Consequently, consumers need to know where their food comes from. Technology development has allowed easier tracking of the halal status. Presently, consumers can easily trace the source of the product and its process to reach their hands by using a cell phone. Therefore, the hypothesis can be stated as follows:

H_{1d}: Traceability of halal products by consumers is easy to do with the adoption of technology systems.

Halal Industry Environment

Another factor that strongly supports the halal industry's sustainability is environmental factors, which consist of various elements such sociocultural environment, organisations, government support, economic conditions, and technological developments (Rashid et al., 2018). Socio-cultural elements influence a person's behaviour and interest in adopting a philosophy. Muslim communities, for example, tend to adhere to the rules of religious sharia, which often permeate their social life. These religious values then drive a commitment to ensure that every attitude and behaviour, as well as the food and drink consumed, follow the Islamic guidelines.

According to Mukhtar & Butt (2012), Muslims should protect themselves from *subhat* (doubtful) items rather than giving in to their desires. So when Muslims choose a product, they prefer it if the food and drinks are halal. Akhtar et al. (2020) mentioned that Muslim tourists often feel uncomfortable visiting non-Muslim majority countries due to the difficulty in obtaining halal food. Gupta and Gupta (2019) concluded that community culture will affect commitment and integrity in maintaining the supply chain. Countries with collectivist cultures,

such as those in Asia, tend to choose suppliers with long-term commitments. Thus, the hypothesis can be stated as follows:

H_{2a}: Socio-culture affects technology adoption for authentic traceability of halal status.

Government support is another factor that influences the authentic tracking of halal status, particularly its role in logistics support (Talib, 2015). Infrastructure development supports supply chain performance to be easier and shorter. Infrastructure is related to more than just logistics but also other aspects such as ports, airports, and warehouses. Effective infrastructure minimises the potential for damaged products during distribution, which may impact the suitability of the food for consumption. This aspect aligns with the principles of *tayyib*. The government's support in providing information technology and a robust internet network also contributes to the ease of product traceability. In addition, the government must provide the availability of laboratories and experts to test the quality and halalness of products (Ali & Suleiman, 2018a). Consequently, the hypothesis can be stated as follows:

H_{2b}: Government support affects technology adoption for authentic traceability of halal status.

Halal Value Chain (HVSC) Integrity

Integrity has been a form of halal assurance for consumers of halal products, ensuring confidence that they have adhered to Islamic values. Integrity is also a major factor in HVSC. Halal product integrity results from various activities in HVSC (Tieman et al., 2012). However, in the context of HVSC, maintaining the integrity of a product's halal status is the most difficult challenge. Integrity refers to halal products that are devoid of actions and procedures that obstruct halal procedures throughout the entire supply chain, from upstream to downstream (Muhamed et al., 2022). A significant aspect of halal integrity is the raw ingredients used in halal products. Trade globalisation makes it challenging to track the source of raw ingredients in the food supply chain. Manning and Soon (2016) identified four important elements of halal integrity: products, processes, people, and data. It can be concluded that the integrity of a product involves many processes, data, and people. In line with what Ali et al. (2017) stated in their study, integrity involves raw materials, production, services and information. It shows that integrity is a complicated commitment involving many parties (Ali & Suleiman, 2018). To preserve the integrity of halal products, it is crucial to incorporate technology to improve traceability.

The utilisation of a system or technology in HVSC simplifies the tracing process, as well as enhances the consumers' trust in the halal status of products they purchase. Consumers are more

likely to believe in halal products that utilise a system or technology rather than solely relying on a halal certificate (Aung & Chang, 2014). The halal product traceability system is said to enhance the quality of the product, according to Hassan (2011) and Hasan (2021). Thus, it can be concluded that the adoption of technology makes it easier to guarantee the integrity of halal products and conduct authentic traceability of the halalness of a product, so the following hypothesis is stated:

H_{3a}: Technology adoption for authentic traceability of halal status affects HVSC integrity.

The demand for halal products comes from the community as the main consumer group. The demand for a product is strongly influenced by the socio-culture that prevails in society. Socio-culture is related to intuition and the role of belief, and religion is a form of belief (Fellow & Liu, 2020). Integrity in the provision of halal products is also a determinant of HVSC's success. The demand for halal products, which includes adherence to Islamic slaughtering procedures, is still a problem today (Mohamed et al., 2013). Customers are willing to pay more for a product when they recognise the importance of consuming halal products (Ag Majid et al., 2021). Supply chain strategists must proactively understand the end-user mindset to detect potential problems, as socio-religious tensions in society can influence the minds of end-consumers (Hewege & Perera, 2020). This indicates that consumer preferences depend on the prevailing social and religious culture, while institutions serve as the guarantors of the halal status of the supply chain. This argument supports the following assertion:

H_{3b}: Socio-culture has a positive effect on HVSC integrity.

H_{3c}: Government support has a positive effect on HVSC integrity.

Halal Product Authentication and Legitimacy

Product authentication is a product verification process, especially food, that aims to confirm the accuracy of the food ingredients listed on the packaging. Several criteria related to product authentication must be satisfied, including quality, country or place of origin, the technology used in production and the technical processing of the product. This process ensures safe and quality products (Danezis et al., 2016; El Sheikha et al., 2017). For Muslims, products must also satisfy halal criteria in addition to safety and quality. It is important to distinguish between product authentication and product traceability. Authentication is part of the quality component, as evidenced by a certificate issued by an authorised party. Meanwhile, traceability is the ability to trace food or products produced through all stages of production, process, and distribution (Galanakis, 2020).

The process of halal legitimisation through the inclusion of the halal logo on packaging authorised by the halal certification agency changes society's general perception. The presence of the halal logo signifies that the product has gone through a rigorous process to obtain the halal certification, which makes it a reference for the community in selecting halal products. According to (Anir et al., 2008), traditional indicators such as barcodes, raw material information and labels may not necessarily indicate the validity of the legitimacy of the halal status. This authentication problem cannot be solved because tracing the authentication of halal products requires real-time technology. Authentication is an analytical process for verifying and validating information on product packaging labels related to food sources and production processes (Danezis et al., 2016; Rejeb et al., 2021).

Research on Radio Frequency Identification (RFID) as a traceability technology has been proposed by several experts, although some argue that RFID technology is not entirely effective due to the rapid development of technology. According to (2016), combining Internet of Things (IoT) technologies, RFID tags, and quick response (QR) codes is a more effective approach for validating the halal status of products. Various techniques have been introduced to tackle authentication and traceability issues, including nuclear magnetic resonance (NMR), infrared spectroscopy (IR), isotopic techniques, DNA-based methods, mass spectrometry (MS), and chromatographic (GC-LC) procedures. These measures are utilised to confirm the product's authenticity, particularly its halal status (Dimitrakopoulou & Vantarakis, 2021). Beyond seeking legitimacy for halal products, authentication also serves as an effort to gain public recognition, thereby influencing companies' commitment to comply with the rules. It implies that the company's pursuit of halal product certification responds to external factors, typically mandated by government regulations, industry norms, and consumer demands (Ab Talib, 2017). Thus, halal certification from the government is a form of legitimisation of halal products. Meanwhile, authentication serves the purpose of to tracking or tracing to ensure the alignment of the HVSC with the obtained legitimisation. Therefore, to become an effective support to legitimisation, authentication requires the adoption of technology. Based on this background, the following hypothesis can be stated:

H_{4a}: Technology adoption affects halal status authentication.

Legitimacy relates to the mechanism of acceptance and recognition of policies taken by leaders in society (Abtalib et al., 2019). The leadership in question can be the head of government or an influential religious figure. In countries with a predominantly Muslim population, *ulama* are religious figures who have enormous influence in society. Legitimacy is realised in the form of

standard regulations. Indonesia is one of the countries where the Indonesian Council of Ulama actively cooperates with the Halal Product Assurance Organizing Body and the Ministry of Religious Affairs to issue legitimacy for halal product guarantees (Hasan, 2021). The regulation of halal products in Indonesia in terms of Halal Product Guarantee is governed by Law Number 33 of 2014. There are three articles that address halal logistical challenges. The first of which indicates that halal products must adhere to Islamic law to be deemed halal. The halal product process is a sequence of operations that ensure the halal status of a product, including material acquisition, processing, storage, packaging, distribution, sales, and product presentation. Article 50 states that supervision of halal product assurances is carried out on the location, storage, packing, distribution, sale, and presentation of both halal and non-halal items.

H_{4b}: Legitimacy affects the authentication of the halal status of products.

Collaboration of various entities is required to maintain the integrity of halal status. Apart from producers, the government, through specialised institutions, ensures the integrity of halal status by issuing halal certification. Unfortunately, not all segments of the supply chain have the same level of commitment to maintaining integrity (Ab Rashid & Bojei, 2020). To prevent contamination of halal products with non-halal products throughout the HVSC process, the government issues halal certification and ensures that the HVSC runs properly (Khan et al., 2021; Maman et al., 2015). Indonesia has experienced several incidents involving products with halal logos that were later found to contain pig DNA. This indicates that government commitment is needed to maintain the integrity of HVSC (Ali & Suleiman, 2018; Ali & Suleiman, 2019; Wang et al., 2017). The next hypothesis is stated as follows:

H_{4c}: Legitimacy affects HVSC integrity.

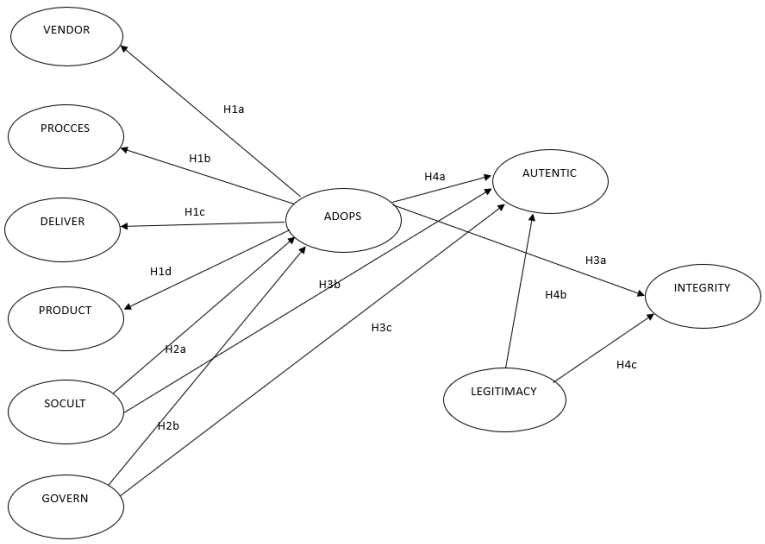

Figure 1. Research Model

RESEARCH METHOD

Samples and Data Collection Technique

This research is an explanatory research that comprehensively explains the research object within a certain scope. Adopting the quantitative method, the data is collected using surveys and documentation techniques, with samples taken from the population of micro, small, and medium enterprises (MSME) in Indonesia, particularly those in the food and beverage processing industry. This type of industry is considered relevant for this study due to the low awareness of MSMEs towards the halal status of the supply chain and the challenges they face in adhering to the halal regulations mandated by the government, including the management of halal assurance certification. The sample size was determined using Slovin's Formula. Thus, the number of samples obtained based on the formula above amounted to 285 respondents with a significance level of 5%.

According to Jogiyanto (2012), a questionnaire is a data collection tool where participants or respondents fill out questions or statements a researcher gives. This study used a questionnaire distributed using manual forms distributed to MSME owners in Indonesia. Documentation is a data collection technique by obtaining data from relevant sources, including reports, records and documents related to the research conducted, such as organisational profiles, employee data, attendance and other information related to the research.

Variable Measurement and Operational Definition

Endogenous Variable

According to Hair et al. (2010), endogenous variables are latent variables whose values are determined by factors in the model and are dependent on their variables or other constructs. This dependency is represented visually by the path from exogenous to endogenous variables (marked with an arrow. See Figure 1). In this study, there are two endogenous variables: authentication and legitimacy. Authentication is the process of product verification, especially food, that aims to confirm the accuracy of the food ingredients listed on the packaging. On the other hand, legitimacy is legal recognition obtained through the issuance of halal certification from an authorised body.

Exogenous Variables

Exogenous variables are latent variables determined by factors external to the model that cannot be explained by other structures or variables (not marked with arrows). These exogenous variables are also known as independent variables (Hair et al., 2010). There are two exogenous

variables in this study: technology adoption and HVSC environment. HVSC technology adoption represents the utilisation of technology for the halal product supply chain flow from suppliers, production processes, and delivery to the hands of consumers. Meanwhile, the HVSC environment is a factor that comes from socio-cultural influences and governmental support in the adoption of technology in order to maintain HVSC integrity.

Mediating Variables

The mediating variable is an intermediate variable positioned between the exogenous and endogenous variables so that the independent variable does not directly affect the change or the emergence of the endogenous variable. The intervening variable in this study is integrity. HVSC integrity signifies the honest behaviour and attitudes concerning products, processes, people, and data in the halal product supply chain.

Variable Measurement

This study uses a research instrument in the form of closed-ended questions on a questionnaire using a Likert scale (5 points). The Likert scale is used to measure the attitudes, opinions, and perceptions of a person or group of people about social phenomena, which, in this research, have been specifically determined by researchers and called research variables (Jogiyanto, 2013). The scale, ranging from 1 to 5, entails gradations from very positive to very negative. Operational variables can be seen in Table 2.

Data Analysis Technique

This study employs the analysis method for variable testing, namely SEM-PLS (Hair et al., 2010). Structural Equation Modeling (SEM) is a statistical technique used to test and estimate causal relationships by integrating factor analysis and path analysis. SEM technique is suitable for measuring confirmatory research. Meanwhile, PLS is a statistical method within the broader SEM framework that compares the dependent and independent variables of multiple regressions. The PLS technique is particularly useful to assess relationships between latent variables despite having specific data problems, such as small research sample sizes. This argument is the basis for the decision to utilise SEM-PLS in this research.

Hypothesis Test

Hypothesis testing in this study uses the Structural Equation Model (SEM) with several stages of analysis, namely (a) model specification or determining the form of the model based on established theories, which are then used to develop models that describe the relationship between variables; (b) model identification (model identification) related to the problem of whether the model developed in (a) can be measured by its parameters; (c) model estimation

(model parameter calculation) by calculating the correlation (covariance) matrix derived from the sample with the theoretical correlation (covariance) matrix developed from the parameter function; (d) model testing (model testing) aims to test whether the parameters resulting from the previous step are statistically significant and whether the developed model is fit; (e) model modification (model modification) will be made to enhance the model's fit guided with Goodness of Fit Index (GFI) indicator. A model is considered a good fit if GFI exceeds 0.90. The following are some criteria for the Absolute Fit Measure used in the study. GFI is a measure of model fit that describes the amount of variance and covariance in the sample covariance matrix predicted by the estimated covariance matrix. So, this index is equivalent to the coefficient of determination R^2 in conventional regression analysis. The value of GFI ranges from 0 to 1, where a higher value indicates a better fit alpha.

The Chi-Square value serves as an indicator of any deviation between the sample covariance matrix and the fitted covariance matrix. If the Chi-Square value is zero, the model has a perfect fit. The expected result of $\chi 2$ is a value as small as possible or $P_{value} > \alpha$, where α is equal to 0.05. Mediation analysis testing is carried out by testing the direct effect between the dependent variables and the mediating variable and the indirect effect between the independent and dependent variables through the mediating variable. Hair et al. (2010) stated that there are three stages of the model to test the mediation effect, namely (1) test the effect of exogenous variables on the dependent variable, which must be significant at t-statistic > 1.96, (2) test the effect of exogenous variables on mediating variables, which must be significant at t-statistic> 1.96, (3) test the effect of mediating variable on endogenous variables. The effect of the mediating variable on the endogenous variables must be significant at the t-statistic> 1.96.

RESULTS AND DISCUSSIONS

Descriptive Analysis

Out of the total 285 respondents, 36.1% were male, and 63.9% were female. Based on the level of education, 42.5% of the company owners had completed senior high school (SMA). In comparison, 29.1% had a bachelor's degree, and 28.4% had more than a bachelor's degree. Concerning the size of the companies, 95.1% of them have less than five employees; the remaining 4.9% have 11-49 employees. Regarding the annual turnover, the majority (84.6%) of companies reported less than 50 million, 10.5% or 30 companies reported annual turnover between 50 million and 300 million, and 4.9% or 14 companies had a turnover exceeding 300 million. Furthermore, 175 companies (61.8%) have been in business for 1-5 years, 89 companies (31.2%) have been in business for less than a year, and 20 companies (7.0%) have

been in business for more than five years. Geographically, the majority of respondents are located in the Pangkalpinang City Region with 79 companies (27.7%), followed by Belitung Regency with 31 companies (10.9%) and Bangka Regency with 29 companies (10.2%). North Jakarta and West Sumatra each have 21 companies (7.4%). Central Bangka Regency has 18 companies (6.3%). Jakarta, DKI Jakarta, Central Java and Tasikmalaya each have 15-16 companies (5.3-5.6%). The remaining regions, including Bandar Lampung, East Kutai and South Tangerang, have 7-9 companies (2.5-3.2%). Table 2 presents the profile of respondents in this study.

Table 1. Statistic Descriptive of Samples

Characteristics	Number of Respondents (N=285)	(%)
Gender		
Male	103	36.1
Female	182	63.9
Education Level		
>S1	83	29.1
S1	81	28.4
High School	121	42.5
Number of Workers		
<5 people	271	95.1
11 - 49 people	14	4.9
Turnover/Month		
<50 Million	241	84.6
50 - 300 Million	30	10.5
>300 Million	14	4.9
Business Age		
< 1 year	89	31.2
1 - 5 years	176	61.8
>5 years	20	7.0
Business Location		
Bandar Lampung	9	3.2
DKI Jakarta	15	5.3
Jakarta	16	5.6
Central Java	15	5.3
Bangka Regency	29	10.2
Central Bangka Regency	18	6.3
Belitung Regency	31	10.9
North Jakarta City	21	7.4
Tasikmalaya city	16	5.6
East Kutai	8	2.8
Pangkalpinang	79	27.7
Sumatera Barat	21	7.4
South Tangerang	7	2.5

Table 2. Dimension and Validity

Dimension	Item	Source	Communalities	Factor Loading
VENDOR	Guarantees that the products are legal and meet sharia requirements, namely good, clean, halal and nutritious.	Abrashid (2019); Khan et al., (2018); Norasekin et al., (2018)	0.89	0.81
	Has an identification number on each farm animal or other raw material.		0.90	0.56
	Responsible for the process of slaughtering, packaging, and operations in accordance with Sharia rules and Halal requirements.		0.90	0.75
	Packaging and labelling are critical to ensure non-Halal contamination.		0.90	0.50
PROCCES	Food manufacturers must be able to trace raw materials to prevent unsafe and un-halal.		0.94	0.53
	Responsibility to ensure that there is a review mechanism to identify the halal status of food ingredients coming from suppliers.		0.87	0.53
	Halal food manufacturers need to ensure they are using Halal ingredients and equipment for packaging and ensure that all labelling is correct.		0.92	0.69
	Clear information on origin and process, transparent to their customers.		0.93	0.80
	Employees must understand practising the concept of cleanliness permitted by Islamic law.		0.95	0.76
DELIVER	The inflow of vehicles (i.e. trucks and containers) should be monitored to avoid mixing Halal and non-Halal products.		0.96	0.80
	Separation in containers and warehouses is required if there are non-halal and halal products in the same container or warehouse.		0.87	0.76
	The process of managing the procurement, movement, storage and handling of materials, spare parts, livestock, and semi-finished or finished supplies of both food and non-food is documented.		0.91	0.63
PRODUCT	Traceability activities that retailers and stores can implement.			
	In maintaining the freshness, cleanliness, and safety of Halal products to be sold.		0.90	0.68
	Retailers should monitor product shelves to avoid mixing with non-Halal products.		0.92	0.69
	Implementation of customer-to-customer traceability is done by looking for customer complaints.		0.81	0.63
	Improve service quality by providing customers with a website or customer service centre for halal products.		0.95	0.53
SOCULT	Halal products are a form of human relationship to God (worship).	Abrashid (2019); Khan et al. (2018b)	0.93	0.88
	Greater awareness of products that implement Sharia. Principles in relation to slaughtering animals, production, and processing.		0.92	0.39
	Acceptance of Halal products and services among Muslims and non-Muslims.		0.81	0.61
	Increased due to the perception that Halal is a symbol of a healthier lifestyle and hygienic preparation.		0.89	0.53
	Products with the Halal logo are considered and recognised as a symbol of cleanliness, safety, and high quality.		0.90	0.77
	Trust and confidence have become important aspects of buying halal products and services.		0.92	0.51

Table 2. Dimension and Validity (Continued)

Dimension	Item	Source	Communalities	Factor Loading
GOVERN	The government has developed IT infrastructure through Tax reform and business digitalisation.		0.89	0.77
	The Government has supported multifaceted Halal awareness through policies and compliance related to Halal products by the Government or its designated institutions.		0.93	0.86
	The government motivates the Halal industry to adopt traceability technology by providing funding, technology, training, equipment, and tax concessions.		0.89	0.93
	The government supports the adoption of traceability systems through effective government policies.		0.87	0.55
INTEGRITY	Halal integrity is assured and maintained through the original Halal logo/certification.	Asmi et al., (2019); Khan & Haleem (2019); Zailan et al (2015)	0.92	0.526
	Halal integrity is assured and maintained when the final product is healthy and safe/non-toxic/free from prohibited items.		0.86	0.46
	The company understands the legal aspects to ensure halal practices are carried out in accordance with the sharia principles required by MUI.		0.93	0.72
	Product assurance will be secured with halal certification from MUI.		0.93	0.78
AUTENTIC	The Internet helps companies track and trace products along the production line.	Rejeb, 2021; Tarmizi et al, 2020	0.92	0.91
	Internet improves the authentication of materials selected for production.		0.85	0.82
	Efficient halal supply chain traceability using the internet.		0.93	0.64
	Internet improves efficiency among supply chain players in managing halal products.		0.94	0.93
	The Internet helps in the analysis of halal food supply chain trends.		0.94	0.50
	Information sharing by internet devices can be trusted 100%.		0.91	0.41
	The company is willing to invest in an internet system for halal production.		0.86	0.61
	Internet systems are the most practical approach to halal supply chain integrity.		0.88	0.61
LEGITIMACY	The company is eager to become certified because it wants to standardise internal operations and procedures.	At Talib (2017)	0.90	0.58
ADOPS	Halal mobile tagging app is easy to use.	Rahman (2016)	0.89	0.87
	Easily get the results from a mobile app to check halal status.		0.93	0.70
	Have the necessary resources to use the mobile app for a halal status check.		0.90	0.78
	Have the necessary knowledge to use the mobile application to check halal status.		0.87	0.77
	The mobile app for halal status checks is compatible with other technologies that use		0.96	0.75
	Mobile app difficulty assistance is available to check the halal status		0.82	0.70
	Using a mobile application to check halal status will improve the quality of my shopping experience because it provides easy access to information.		0.93	0.68
	Use the service to retrieve information if there is a mobile service to check halal status that is user-friendly.		0.88	0.80
	Use the halal mobile marking application whenever I feel suspicious about the halal status of a product.		0.85	0.78
	Use a halal mobile tagging application (QR code) if the product is placed next to a non-halal product.		0.89	0.621

Cronbach's Alpha was computed to establish reliability, while Kaiser-Meyer-Olkin (KMO) was calculated to ensure sample adequacy. Cronbach's Alpha (α) and KMO values are 0.937 and 0.862, respectively. Both values surpass the acceptable threshold of 7.0 (Kim & Mueller, 1978; Nunnally & Bernstein, 1967). Table 3 presents the statistical analysis, which includes Bartlett's test result of 3518.694 with a significance value (rho value) of 0,00.

Table 3. Reliability Analysis

Statistical Analysis	Value
Cronbach's Alpha (α)	0.937
No. Item	12
The Kaiser-Meyer-Olkin (KMO)	0.862
Bartlett's test	3518.694
df	45
Significance ($\rho - value$)	0.00

The composite reliability rating > 0.6 implies that all variables meet the dependability standards. And the AVE value is more than 0.5. Composite reliability > 0.7 and AVE value > 0.6 are required so that research variables (constructs) can be accurately evaluated and used as variables in research.

Table 4. Average Variance Extracted (AVE)

Dimension	Composite Reliability	Average Variance Extracted (AVE)
VENDOR	0.935	0.744
PROCCES	0.928	0.726
DELIVER	0.955	0.877
PRODUCT	0.934	0.781
SOCULT	0.922	0.669
GOVERN	0.962	0.837
ADOPS	0.960	0.670
AUTENTIC	0.928	0.724
INTEGRITY	0.949	0.628
LEGITIMACY	0.742	0.635

Path Analysis for Hypothesis Testing

Structural Model Testing

Analysing the coefficient of determination (R squared/R^2) to determine a structural model's prediction accuracy is a crucial initial step in evaluating it. The value of R square indicates the proportion of the variance in the dependent variable, which can be explained by the independent variable. A correlation test is carried out to obtain this value with the criteria that the R Square value of 0.67 or more is strongly correlated, 0.33 is moderate, and 0.19 is weakly correlated (Chin, 1998). As shown in Figure 2, the R Square values of variables such as VENDOR, PROCESS, and SOCULT moderately correlate with ADOPS and LEGITIMACY to

AUTHENTIC. Meanwhile, DELIVER, PRODUCT, AND GOVERN strongly correlate with ADOPS, and AUTENTIC is strongly correlated with INTEGRITY and INTEGRITY to LEGITIMACY.

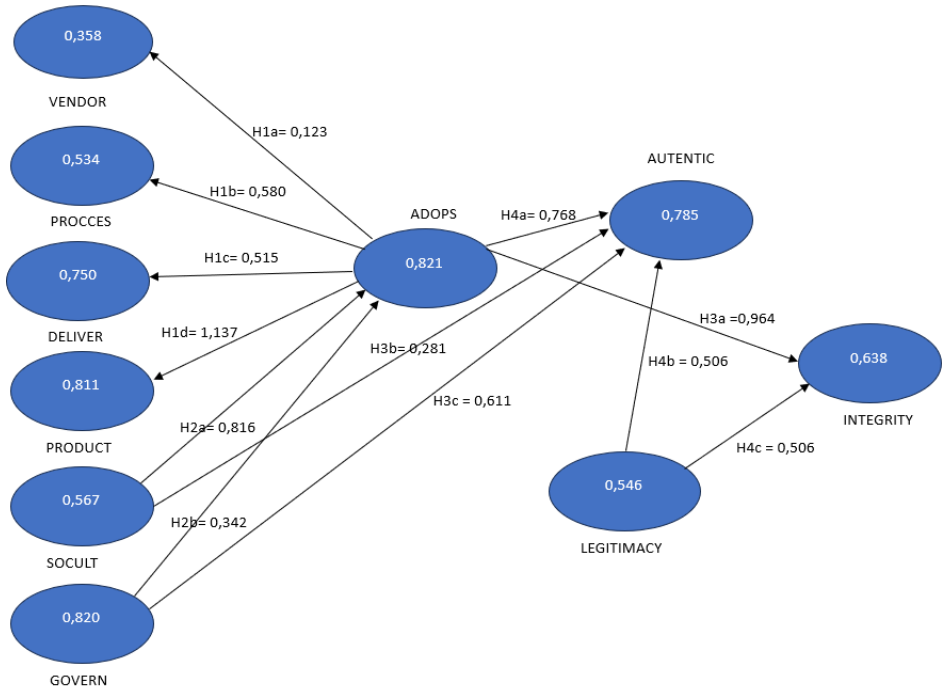

Figure 2. Structure Equation Model Diagram

Path Analysis

The path coefficients between constructs are assessed to support the suggested hypotheses and structural model. Hair et al. (2010) suggested that a path coefficient should be at least 0.1 in order to include the effect in the model. The results of the hypotheses testing in this study, as shown in Table 4, support all of the proposed hypotheses. The supported hypotheses have path coefficient (b) values ranging from 0.358 to 0.821. These coefficients are not only significant at the 0.01 level but also show a positive direction. According to the findings listed below, the most important factor in the search for halal goods is the implementation of a technology system.

Table 5. Direct Effect & Indirect Effect

Relationship	t	P-Value	Std. Error	Decision
Direct Effect				
ADOPS→ VENDOR (H_{1a})	4.342	0.000	0.028	Supported
ADOPS→ PROCCES (H_{1b})	10.619	0.000	0.055	Supported
ADOPS→ DELIVER (H_{1c})	9.636	0.000	0.053	Supported
ADOPS→ PRODUCT (H_{1d})	18.731	0.000	0.061	Supported
ADOPS→ SOCULT (H_{2a})	17.182	0.000	0.050	Supported
ADOPS→ GOVERN (H_{2b})	10.971	0.000	0.027	Supported
ADOPS→ AUTHENTIC (H_{4a})	24.170	0.000	0.031	Supported
ADOPS→ INTEGRITY (H_{3a})	28.430	0.000	0.034	Supported

Table 5. Direct Effect & Indirect Effect (Continued)

Relationship	t	P-Value	Std. Error	Decision
LEGITIMACY → AUTENTIC (H_{4b})	9.141	0.000	0.054	Supported
LEGITIMACY→ INTEGRITY (H_{4c})	13.951	0.000	0.056	Supported
Indirect Effect				
SOCULT→ ADOPS→ AUTHENTIC (H_{3a})	14.933	0.000	0.140	Supported
GOVERN→ ADOPS→ AUTHENTIC (H_{3c})	17.917	0.000	0.044	Supported

Based on the results of direct effects, the adoption of the halal traceability system demonstrates the highest effect ($t = 28.430$; $p < 0.01$), followed by halal product authentication ($t = 24.170$; $p < 0.01$), halal product traceability ($t = 18.731$; $p < 0.01$) Meanwhile, the environmental factor that contributes the most is socio-culture ($t = 17.182$; $p < 0.01$). Subsequently, legitimacy ($t = 13.951$; $p < 0.01$) comes next, followed by environmental factors of government support ($t = 10.971$; $p < 0.01$), traceability of halal product processes ($t = 10.619$; $p < 0.01$), halal product delivery traceability ($t = 9.636$; $p < 0.01$), HVSC traceability authentication ($t = 9.141$; $p < 0.01$) and halal product supplier traceability ($t = 4.342$; $p < 0.01$).

These findings align with earlier research conducted by Bouzembrak et al. (2019), Ben-Daya et al. (2020), Tarmizi et al. (2020), and Rejeb et al. (2021) which concluded that the adoption of technology systems for halal product traceability strengthens the Halal Value Chain (HVSC) and can enhance the integrity of halal products. Additionally, Abrasyid and Bojei's research (2020) emphasised the critical role of adopting HVSC traceability systems to ensure the traceability of halal goods in order to maintain the integrity of the HVSC. Meanwhile, the highest indirect effect is the adoption of a halal traceability system ($t = 25.489$; $p < 0.01$), government support environmental factors ($t = 17.917$; $p < 0.01$), and socio-cultural environmental factors ($t = 14.933$; $p < 0.01$). Adopting a halal product traceability system aims to ensure authentication of product origin and ultimately will increase overall integrity. This result also corroborates the direct effect conclusion.

Discussion

Several steps in the supply chain contribute to a product's integrity as Halal. In order to guarantee Halal integrity, the supply chain approach is equally crucial (Tieman, 2018). The adoption of technology systems, according to observations, ensures that products pass through a traceable HVSC. In addition, environmental factors are also very important in ensuring that products go through a proper process in HVSC. Bergeaud-Blackler et al. (2016) asserted that product integrity consists of several factors, including safety, ethics, health, and product origin, which ultimately contribute to product safety assurance. Food producers should underline this technique in maintaining the integrity of halal food. In a study by Azmi et al. (2020), the

successful operation of HVSC in Malaysia can be attributed to the commitment to integrity among food producers in the country, a significant portion of whom are Muslims.

There are four important elements in halal integrity, namely, products, processes, people, and data (Manning, 2016). Integrity is a form of commitment of many parties (Ali & Suleiman, 2018), and technology makes the process of achieving HVSC traceability simpler. Together, integrity and technology are crucial for maintaining the quality of halal products. In addition to halal certificates, the adoption of technology increases consumers' confidence that the products they purchase are guaranteed to be halal. Therefore, the halal product traceability system will improve product quality (Aung & Chang, 2014; Hasan et al., 2011; Zulfakar et al., 2014). The results of this study are also in line with the study conducted by Khan et al. (2020), where they showed that information technology plays a role in mitigating risks related to product planning and production. Implementing a tracking system is shown to reduce risk and improve HVSC's overall performance.

The majority of the MSMEs in this research are located in Indonesia, significantly contributing to the nation's GDP. These MSMEs are a component of the supply chain with a vital role in providing halal products for the end-consumers. These end-consumers opinion of halal products is influenced by the halal status of their items. Meanwhile, MSMEs' role is crucial in providing halal food, catering not only to Muslim customers but also to non-muslim customers. In order for the halal food MSMEs to stay competitive in the global market and stay on par with other industries, it is important to adopt modern technology. MSMEs operating in the halal food sector should recognise the advantages of implementing IoT in managing their halal business operations (Tarmizi et al., 2020). Given that a relatively small percentage of the halal-based MSMEs in this study exhibited a high degree of IoT expertise, the relevant authorities ought to start working to increase MSMEs' awareness of cutting-edge technology. Simultaneously, halal food MSMEs are urged to take independent steps to stay up to date with current business trends and remain aligned.

Tan et al. (2020) and Soon et al. (2017) illustrated the feasibility of implementing an integrated Blockchain framework in the halal food chain to improve traceability. QR codes can capture accurate and real-time information captured from each stage of the supply chain. This approach can solve the problem of halal compliance by ensuring the integrity of the information captured from the supply chain is transparent and traceable. In addition, it is worth noting that QR technology does not require special software. It is accessible with just a computer or smartphone device. This accessibility ensures that even micro-enterprises that have many limitations can

also leverage the technology and perform simple searches. That said, it is acknowledged that search technology with smartphones is not highly sophisticated.

MANAGERIAL IMPLICATIONS IN THE SOUTH EAST ASIAN CONTEXT

An interesting finding from this study is that the adoption of HVSC traceability systems is strongly influenced by environmental factors, especially government support (GOVERN). Indonesia has the largest number of Muslims worldwide and is classified as a developing nation where most people's dependency levels and economic activities are quite high. Similar to the case of Malaysia (Abrashid & Bojei, 2020; Azmi et al., 2020), which has JAKIM, Indonesia also has a certification body known as the Assessment Institute for Food, Drug and Cosmetics of Indonesian Council of Ulama (LPPOM MUI). This body is tasked with reviewing, researching, analysing and determining the safety of food products and their derivatives, medicines, and cosmetic products. This evaluation considers both health and Islamic doctrinal perspectives, especially their halal status or lawful consumption of Muslims. In the health sector, LPPOM MUI provides recommendations and assists in the formulation of provisions and guidelines for public services.

Predominantly Muslim countries in Southeast Asia, such as Indonesia, Malaysia and Brunei Darussalam, face a demand for halal product guarantees. Moreover, since all three countries are involved in international trade, they need to ensure a properly functioning halal food supply chain, not only through government organisations in each country but also through inter-country traceability mechanisms, enhancing halal product certainty across borders.

THEORETICAL IMPLICATIONS

Khan et al. (2018) define Halal Value Supply Chain Management (HVSCM) as a process-oriented strategy that involves strategic coordination and collaboration among stakeholders to control the flow of materials, information, and capital. The goal is to improve supply chain performance and expand Halal and Tayyib. Many researchers have conducted the study about HVSCM, but no one has to definition of HVSCM. This study provides evidence that not only stakeholders play a role in controlling the halal supply chain but also the role of technology is very important. So that, technology should be part of the halal supply chain flow. The technology should be provided by the government, which plays a major role in supporting micro, small and medium enterprises due to the limitations of this business sector in technology adoption. QR Code technology is one of the easiest ways of blockchain technology. The government should be able to put pressure on upstream supplier to provide such technology. So, the definition of HVCM is not limited to the flow of raw

materials, information, and capital but also to the technology applied. More concisely, HVSCM is a process strategy that involves all stakeholders to control the flow of raw materials through technology-based information.

CONCLUSION

This study identifies the benefits of adopting a technology system in implementing HVSC traceability. According to the analysis, technology system adoption is an important factor, among others, in improving product integrity. Based on the survey, adopting a traceability system will yield better results when government support is provided. The majority (61.8%) of business owners in this research expect positive and consistent growth of their business in the future, reporting that their businesses age are still 1-5 years old. This trend suggests that they want their business to be sustainable in the future.

Given that their business operation is located in a country with the largest Muslim population, halal food is recognised as one of the competitive advantages that must be owned. Consequently, this motivated them to adopt halal standards. Ali and Suleiman (2018) stated that small industries, especially those in the halal food sector, are relatively immature and still depend heavily on consumers' confidence in the integrity of their food; thus, the responsibility falls upon HVSC actors to guarantee the halal integrity of their products.

This research exclusively focuses on micro and small industries in Indonesia because, based on the survey, the average monthly industry turnover is less than 50 million. The micro industry category is unlikely to focus its attention on HVSCs due to their limited ability to conduct tracing of the product's origin. This is true, especially with the perception that HVSC tracing requires the use of high and sophisticated technology. Most of them still rely on halal certifications that authorised institutions have issued. Future research should explore each category in larger, medium-sized businesses. Additionally, it is advised that future research be conducted with a considerably larger sample size to permit generalisation of the findings, even though the sample size (N = 285) may be adequate in some cases. The larger sample size will enable scientists to draw more accurate results. Furthermore, a comparative analysis of HVSC traceability technology adoption across different nations will broaden the research's geographical scope beyond Indonesia. A mixed-method approach is also an option because it can offer further insights into the problems and challenges related to supply chain integrity among food producers.

ACKNOWLEDGEMENT

This work has been funded by Bangka Belitung University under the Research and Community Service Grants 2023 programme.

References

Ab Rashid, N., & Bojei, J. (2020). The relationship between halal traceability system adoption and environmental factors on halal food supply chain integrity in Malaysia. *Journal of Islamic Marketing*, *11*(1), 117–142.

Ab Talib, M. S. (2017). Motivations and benefits of halal food safety certification. *Journal of Islamic Marketing*, *8*(4), 605–624.

Abidin, N. Z., & Perdana, F. F. P. (2020). A proposed conceptual framework for blockchain technology in Halal food product verification. *Journal of Halal Industry & Services*, *3*, 1–8.

Adekunle, B., & Filson, G. (2020). Understanding halal food market: Resolving asymmetric information. *Food Ethics*, *5*(1–2), 1–22.

Ag Majid, D. K. Z., Abdul Hanan, S., & Hassan, H. (2021). A mediator of consumers' willingness to pay for halal logistics. *British Food Journal*, *123*(3), 910–925.

Aghwan, Z. A., Bello, A. U., Abubakar, A. A., Imlan, J. C., & Sazili, A. Q. (2016). Efficient halal bleeding, animal handling, and welfare: A holistic approach for meat quality. *Meat Science*, *121*, 420–428.

Ahi, P., & Searcy, C. (2013). A comparative literature analysis of definitions for green and sustainable supply chain management. *Journal of Cleaner Production*, *52*, 329–341.

Ahmad Tarmizi, H., Kamarulzaman, N. H., Abd Rahman, A., & Atan, R. (2020). Adoption of internet of things among Malaysian halal agro-food smes and its challenges. *Food Research*, *4*(1996), 256–265.

Akhtar, N., Jin, S., Alvi, T. H., & Siddiqi, U. I. (2020). Conflicting halal attributes at halal restaurants and consumers' responses: The moderating role of religiosity. *Journal of Hospitality and Tourism Management*, *45*(October), 499–510.

Ali, M. H., & Suleiman, N. (2018a). Eleven shades of food integrity: A halal supply chain perspective. *Trends in Food Science and Technology*, *71*(December 2017), 216–224.

Ali, M. H., & Suleiman, N. (2018b). Eleven shades of food integrity: A halal supply chain perspective. *Trends in Food Science and Technology*, *71*(November 2017), 216–224.

Ali, M. H., Tan, K. H., & Ismail, M. D. (2017). A supply chain integrity framework for halal food. *British Food Journal*, *119*(1), 20–38.

Anir, N. A., Nizam, M. D. N. M. H., & Masliyana, A. (2008). The users perceptions and opportunities in Malaysia in introducing RFID system for Halal food tracking. *WSEAS Transactions on Information Science and Applications*, *5*(5), 843–852.

Arif, S., & Sidek, S. (2015). Application of halalan tayyiban in the standard reference for determining Malaysian halal food. *Asian Social Science*, *11*(17), 116–129.

Aung, M. M., & Chang, Y. S. (2014). Traceability in a food supply chain: Safety and quality perspectives. *Food Control*, *39*(1), 172–184.

Azmi, F. R., Abdullah, A., Musa, H., & Wan Mahmood, W. H. (2020). Perception of food manufacturers towards adoption of halal food supply chain in Malaysia: Exploratory factor

analysis. *Journal of Islamic Marketing*, *11*(3), 571–589.

Bergeaud-Blackler, F., Fischer, J. and Lever, J. (2016). *Halal Matters*. London: Routledge.

Ben-Daya, M., Hassini, E., Bahroun, Z., & Banimfreg, B. H. (2020). The role of internet of things in food supply chain quality management: A review. *Quality Management Journal*, *28*(1), 17–40.

Bouzembrak, Y., Klüche, M., Gavai, A., & Marvin, H. J. P. (2019). Internet of Things in food safety: Literature review and a bibliometric analysis. *Trends in Food Science and Technology*, *94*, 54–64.

Danezis, G. P., Tsagkaris, A. S., Brusic, V., & Georgiou, C. A. (2016). Food authentication: state of the art and prospects. *Current Opinion in Food Science*, *10*, 22–31.

Dimitrakopoulou, M. E., & Vantarakis, A. (2023). Does traceability lead to food authentication? A systematic review from a European perspective. *Food Reviews International*, *39*(1), 537-559.

Duan, J., Zhang, C., Gong, Y., Brown, S., & Li, Z. (2020). A content-analysis based literature review in blockchain adoption within food supply chain. *International Journal of Environmental Research and Public Health*, *17*(5), 1784.

El Sheikha, A. F., Mokhtar, N. F. K., Amie, C., Lamasudin, D. U., Isa, N. M., & Mustafa, S. (2017). Authentication technologies using DNA-based approaches for meats and halal meats determination. *Food Biotechnology*, *31*(4), 281–315.

Galanakis, C. M. (2020). Food authentication and traceability. *Food Authentication and Traceability*, 1–396.

Gupta, M., & Gupta, S. (2019). Influence of national cultures on operations management and supply chain management practices—A research agenda. *Production and Operations Management*, *28*(11), 2681–2698.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010), *Multivariate Data Analysis: A Global Perspective*. Englewood Cliffs, NJ: Pearson Education.

Halaseh, L. Al, & Sundarakani, B. (2012). Study on quality attributes of halal food supply chain. *International Journal of Logistics Economics and Globalisation*, *4*(1/2), 20.

Hasan, Z. (2021). Making Indonesia as integrated halal zone and world halal sector hub through the implementation of halal supply chain. *Journal of Islamic Economic and Business Research*, *1*(1), 1–14.

Hashim, H. I. C., & Shariff, S. M. M. (2016). Halal Supply chain management training: Issues and challenges. *Procedia Economics and Finance*, *37*(16), 33–38.

Hasnah Hassan, S. (2011). Consumption of functional food model for Malay Muslims in Malaysia. *Journal of Islamic Marketing*, *2*(2), 104–124.

Hewege, C., & Perera, C. (2020). The impact of religio-cultural institutional hegemony on sri lankan (halal) supply chains: Theorising the Interplay between the certification body, social institutions and the government. *Journal of Muslim Minority Affairs*, *40*(3), 351–370.

IHLC, Dinar Standard, & Bank Indonesia. (2021). *Indonesia Halal Markets Report 2021/2022*. 1–118.

Indarti, N., Lukito-Budi, A. S., & Islam, A. M. (2020). A systematic review of halal supply chain research: to where shall we go? *Journal of Islamic Marketing*, *12*(9), 1930–1949.

Jogiyanto, H, M. (2013). M*etodologi Penelitian Bisnis: Salah Kaprah dan Pengalaman-Pengalaman*. Yogyakarta: BPFEBUGM.

Jogiyanto, H, M. (2012). *Pedoman Survei Kuesioner Edisi Ke 2*. Yogyakarta: BPFEBUGM.

Khan, M. I., Haleem, A., & Khan, S. (2018). Defining halal supply chain management. *Supply Chain Forum*, *19*(2), 122–131.

Khan, M. I., Haleem, A., & Khan, S. (2022). Examining the link between halal supply chain management and sustainability. *International Journal of Productivity and Performance Management*, *71*(7), 2793–2819.

Khan, S., Haleem, A., & Khan, M. I. (2021). Risk management in halal supply chain: an integrated fuzzy Delphi and DEMATEL approach. *Journal of Modelling in Management*, *16*(1), 172–214.

Letourneau, K. B., & Whelan, S. T. (2017). Blockchain: Staying ahead of tomorrow. *The Journal of Equipment Lease Financing (Online)*, *35*(2), 1-6.

Maman, U., Mahbubi, A., & Jie, F. (2018). Halal risk mitigation in the Australian–Indonesian red meat supply chain. *Journal of Islamic Marketing*, *9*(1), 60-79.

Manning, L., & Soon, J. M. (2016). Food safety, food fraud, and food defense: A fast evolving literature. *Journal of Food Science*, *81*(4), R823–R834.

Manzouri, M., Nizam Ab Rahman, M., Saibani, N., & Rosmawati Che Mohd Zain, C. (2013). Lean supply chain practices in the halal food. *International Journal of Lean Six Sigma*, *4*(4), 389–408.

Mohamed, Y. H., Abdul Rahim, A. R., & Ma'aram, A. (2020). The effect of halal supply chain management on halal integrity assurance for the food industry in Malaysia. *Journal of Islamic Marketing*, *12*(9), 1734–1750.

Mohamed, Z., Shamsudin, M. N., & Rezai, G. (2013). The effect of possessing information about halal logo on consumer confidence in Malaysia. *Journal of International Food and Agribusiness Marketing*, *25*(SUPPL1), 73–86.

Muhamed, A. A., Mat Halif, M., Abu Bakar, M. Z., Hassan, M. F., & Abd Rahim, N. N. (2022). Non-Conventional strategic supply chain management towards halal perspective. *International Journal of Academic Research in Business and Social Sciences*, *12*(1), 1454-1477.

Mukhtar, A., & Butt, M. M. (2012). Intention to choose halal products: The role of religiosity. *Journal of Islamic Marketing*, *3*(2), 108–120.

Nunnally, J. and Bernstein, I. (1967). *Psychometric Theory*. New York: McGraw-Hill.

Pew Research Center. (2011). The future of the global Muslim population. Projections for 2010-2030. *Population Space and Place*, *13*(1), 1–221.

Rahman, A. A., Hanafiah, M. H., Abdul, M., & Ruslee, A. A. (2016). Assessing consumers' willingness to use tagging technology in tracing halal status. *International Journal of Islamic Marketing and Branding*, *1*(3), 272-284.

Rashid, N. A., Supian, K., & Bojei, J. (2018). Relationship between halal traceability system adoptions on halal food supply chain integrity and performance. *International Journal of Asian Social Science*, *8*(8), 569–579.

Rejeb, A., Rejeb, K., Zailani, S., Treiblmaier, H., & Hand, K. J. (2021). Integrating the Internet of Things in the halal food supply chain: A systematic literature review and research agenda. *Internet of Things (Netherlands)*, *13*(2021), 100361.

Riaz, M. N., & Chaudry, M, M. (2019). *Hand Book Of Halal Food Production*. Milton Park, Abingdon: Taylor & Francis.

Samsi, S. Z. M., Tasnim, R., & Ibrahim, O. (2011). Stakeholders' role for an efficient traceability system in halal industry supply chain. In *Annual International Conference on Enterprise Resource Planning and Supply Chain Management (ERP-SCM 2011)*, 14-15.

Soon, J. M., Chandia, M., & Regenstein, J. Mac. (2017). Halal integrity in the food supply chain. *British Food Journal*, *119*(1), 39–51.

Syazwan, M., Talib, A., Hamid, A., Bakar, A., & Too, A. C. (2019). Contemporary management and science issues in the halal industry. In *Contemporary Management and Science Issues in the Halal Industry*. Gateway East: Springer Singapore.

Talib, M. S. A. (2015). Motivations and benefits of halal food safety certification. *Journal of Islamic Marketing*, *8*(4), 605–624.

Tan, A., Gligor, D., & Ngah, A. (2022). Applying blockchain for halal food traceability. *International Journal of Logistics Research and Applications*, *25*(6), 947–964.

Tieman, M., & Darun, M. R. (2017). Leveraging blockchain technology for halal supply chains. *ICR Journal*, *8*(4), 547–550.

Tieman, M., van der Vorst, J. G. A. J., & Ghazali, M. C. (2012). Principles in halal supply chain management. *Journal of Islamic Marketing*, *3*(3), 217–243.

Wang, C. S., Van Fleet, D. D., & Mishra, A. K. (2017). Food integrity: a market-based solution. *British Food Journal*, *119*(1), 7–19.

Yanti, R., Febrianti, M. A., Qurtubi, & Sulistio, J. (2022). Halal blockchain: Bibliometric analysis for mapping research. *Asian Journal of Islamic Management (AJIM)*, *4*(1), 72–85.

Zainuddin, N., Saifudin, A. M., Deraman, N., & Mahidin, N. (2019). Effect of halal certification and labelling process on halal supply chain performance. *International Journal of Supply Chain Management*, *8*(4), 1075–1081.

Zulfakar, M. H., Anuar, M. M., & Ab Talib, M. S. (2014). Conceptual framework on halal food supply chain integrity enhancement. *Procedia-Social and Behavioral Sciences*, *121*, 58-67.