

Impact of Halal Supply Chain Management on Halal Integrity in Malaysia's TVET Food Industry

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Abstract

Ensuring the integrity of halal food is among the concerned issues of many Muslim consumers around the world especially on the authenticity of halal food products status. They are keen to know all the activities involved whether the products they purchase are genuinely halal along the supply chain. Although the issue of halal integrity is widely discussed within the halal food industry, the factors attract the attention of both the academic and halal practitioners remain ambiguous. Thus, this paper intends to assess the existing halal food supply chain management (HFSCM) and its influence on halal integrity assurance (HIA). Using quantitative approach, an industry pilots were empirically experimented to test the concepts and provide practical solutions for halal industry players to optimize their HIA in food and beverages (F&B) industries. The survey data was acquired from 121 halal F&B industries. Multiple linear regression technique was used to analyze the data. It was found that the HFSCM of F&B industries have a direct impact on HIA. The findings are set out to argue that new solutions are required to reduce the vulnerability for better optimization of HFSCM thus enhancing the HIA. Significantly, this study seen Technical and Vocational Education and Training (TVET) is critical in ensuring the sustainability of HFSCM specially to cater demands among Muslim population.

1. Introduction

The global halal industry is estimated to be worth around USD3.0 trillion, and it includes categories such as confectionery, bakery and snacks, dairy products, chilled and frozen food, canned and bottled food and convenience foods. Malaysia, without any doubt, is the leading global halal hub with an annual export value of RM59 billion for halal products in 2023. To tap the advantage of halal food industry, Technical and Vocational Education and Training (TVET) plays a crucial role in the supply chain industry by providing individuals with specialized skills and knowledge necessary to effectively manage and operate various facets of the supply chain. TVET programs focus on practical training in key areas such as logistics, inventory management, procurement, and transportation, which are fundamental to ensuring the smooth functioning and efficiency of supply chains. TVET not only equip human capital with hands-on skills but also prepare them to navigate the complexities of

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modern supply chains, which are increasingly shaped by rapid technological advancements and global interconnectedness. By addressing the skills gap within the supply chain sector, TVET contributes to improved operational efficiency, reduced costs, and enhanced competitiveness for businesses (Smith, 2021).

Meanwhile, Malaysia's halal food industry is experiencing significant growth and positioning itself as a global leader in halal products. Supported by a comprehensive halal ecosystem overseen by the Department of Islamic Development Malaysia (JAKIM) and the Halal Development Corporation (HDC), Malaysia aims to achieve substantial economic contributions, projecting a market value of USD 113.2 billion by 2030 (The Star, 2023; HDC, 2023). This growth trajectory is driven by increasing global demand for halal products, spurred by a rising Muslim population worldwide, heightened awareness of halal certification standards, and trends in halal tourism (Van Amstel, 2021). Technological advancements such as blockchain and IoT are also playing pivotal roles in enhancing halal verification processes and facilitating the development of innovative halal convenience foods (Van Amstel, 2021). Malaysia's halal sector extends beyond food and beverages to include pharmaceuticals, cosmetics, and logistics, significantly boosting exports and reinforcing its status as a leading halal hub in the global market, with exports totaling RM 59.46 billion in 2022, marking a substantial increase from previous years (MIDA, 2023; HDC, 2023).

Nonetheless, despite the promising sector of halal industry, Malaysia faces challenges in maintaining its reputation as a trustworthy halal hub due to reported incidents of non-compliance and integrity issues within the halal food supply chain management (HFSCM) (Hamdan et al., 2021). In 2019, Malaysia faced a significant challenge to its reputation as a halal hub due to a major scandal involving the halal meat supply chain. Reports emerged that some companies were fraudulently labeling non-halal meat products as halal. The scandal involved importing frozen meat from non-halal certified sources and repackaging them with fake halal logos. This not only undermined the integrity of Malaysia's halal certification process but also shook consumer confidence in the halal food supply chain. The authorities conducted extensive investigations, and several companies were penalized. This incident highlighted the critical need for stricter enforcement and oversight to ensure compliance and maintain the integrity of Malaysia's halal certification system. This case demonstrates the importance of rigorous monitoring and enforcement mechanisms to uphold Malaysia's reputation as a trustworthy halal hub (Mohd Riza et al., 2022). Hence, issues around halal sphere have raised concerns among Malaysian Muslim consumers regarding the authenticity and reliability of halal food products. To address these issues, there is a growing need for rigorous oversight and effective management of the halal certification process throughout the supply chain. Hamdan et al. (2021) argue that it is pertinent to explore the impact of (HFSCM on ensuring halal integrity assurance (HIA), focusing on how Malaysia can strengthen its efforts to uphold halal standards and restore consumer confidence. Research on halal supply chain is pivotal in shaping future strategies and policies to safeguard the authenticity of halal products produced in Malaysia, ensuring they meet stringent halal certification requirements (Hamdan et al., 2021). This study, therefore, intends to assess the existing HFSCM and its influence on HIA.

2. Literature Review

2.1 Integrity Assurance

Halal products are distinguished by their adherence to halal integrity, ensuring they remain halal from production to consumption, free from any activities compromising their halal status, whether intentional or not (Zulfakar et al., 2012). This concept is vital in establishing a trusted halal food supply chain (Tieman et.al, 2022). Halal integrity provides detailed assurance that halal requirements are met (Khan, 2020), with Alserhan (2010) highlighting the necessity of a flawless supply chain to guarantee compliance with Shariah law. Compared to other products, halal items adhere to the *halalan-toyyiban* concept, which encompasses Islamic principles and health standards, ensuring products are good, hygienic, clean, high quality, and safe for consumption. This holistic approach addresses both physical attributes and moral conduct throughout the halal food supply chain (DOSM, 2010a, 2010b, 2010c), with *toyyiban* meaning good, pure, wholesome, healthy, and nutritious.

Food integrity goes beyond traditional concerns of safety and quality, encompassing both deliberate and unintentional threats to consumer confidence. Systems like Hazard Analysis and Critical Control Point (HACCP) are scrutinized for their limitations in thwarting deliberate contamination, prompting a call for a comprehensive strategy integrating traceability and technology. There is a study discusses the inherent limitations of the HACCP system in addressing food defense issues, particularly deliberate contamination. It suggests that while HACCP is effective for accidental contamination, it falls short in addressing intentional acts, which require additional measures and strategies. Grounded in supply chain management, the "house of food integrity" framework elucidates food integrity as a complex concept merging quality, safety, and defense. This framework underscores the interconnectedness of these facets and underscores the significance of transparency and communication throughout the supply chain. Technologies such as Radio Frequency Identification (RFID), Near Field Communication (NFC), isotope analysis, chemometrics, and blockchain play crucial roles in enhancing

traceability and verification processes, thereby ensuring food integrity meets regulatory standards and aligns with consumer expectations (Ling & Wahab, 2020).

The exploration of food chain integrity emphasizes empowering consumers within the food system, advocating for a consumer-centric approach that reshapes production, processing, and transparency norms to meet evolving consumer demands. While traditional discussions on food chain integrity have primarily addressed fraud and criminality in combating intentional contamination, the integration of food safety and quality perspectives remains underdeveloped. This study examines the current landscape of food chain integrity and highlights the gap in integrating food safety and quality management systems. It discusses how traditional approaches have primarily focused on addressing food fraud and criminal activities. However, the authors argue that a comprehensive strategy should also incorporate food safety and quality perspectives to ensure a holistic approach to food chain integrity. The paper provides insights into the benefits of such integration and proposes a framework for implementing combined food safety and quality management systems. This conceptual review bridges this gap by framing the interaction between food chain integrity, food safety, and food quality through the lens of supply chain governance. It underscores the pivotal role of governance strategies focused on safety and quality in fostering consumer-centric processes within the food chain, drawing insights from disciplines such as food sector management, logistics, supply chain management, marketing, and general management. This review outlines key themes shaping this interaction space, proposing avenues for future research aimed at enhancing consumer-centric governance and ensuring food integrity (Roy & Srivastava, 2021).

2.2 Halal Certification

Halal certification is crucial for companies aiming to market their products internationally and is required in many countries (Talib et al., 2010). This certification, indicated by a logo, sign, or certificate, verifies that products meet Islamic dietary guidelines, as determined by specific institutions. It ensures that the entire production process, from raw material procurement to sale, occurs in a hygienic and safe environment (Abdul et al., 2014). Halal certification serves as evidence that all supply chain stages adhere to halal standards, providing consumers with assurance that products are halal according to Sharia (Zannierah, 2012). Products intended for Muslim consumers typically display a halal logo to indicate their credibility and safety for consumption.

A study by Abd Latif et al., (2014), compares Halal certification bodies worldwide, focusing on nine categories for certification criteria. It particularly examines JAKIM, Malaysia's main certification body, known for its stringent certification standards. The proliferation of Halal certification bodies globally reflects the increasing demand for Halal products, necessitating robust standards to uphold consumer rights and market integrity. JAKIM, operating under Malaysian government oversight, sets a benchmark in Halal certification practices, influencing global standards recognized by bodies like the Codex Alimentarius Commission. Malaysia's revised Halal standard, MS 1500:2004, underscores its commitment to quality and safety, incorporating feedback from international stakeholders (DOSM, 2009). Despite challenges in achieving a unified global Halal standard, collaboration among international authorities remains crucial for enhancing global Halal market acceptance and consumer confidence.

Malaysia also pays concerted efforts to establish itself as a global hub for Halal food, emphasizing the importance of enhancing Halal certification services to maintain credibility and market share (Noordin et al., 2009). The Malaysian Standard Halal Food (MS1500:2004) has been recognized by the Codex Alimentarius Commission as exemplary worldwide. To strengthen Halal certification, the Malaysian government has entrusted the Halal Industry Development Corporation (HDC) with managing both local and international certification processes. Noordin et al., (2009) study highlight inefficiencies in the certification process, governance conflicts between federal and state authorities, and the need for focused research to resolve these issues and further develop Malaysia's Halal ecosystem. This includes future research directions that should explore improvements in Halal certification operations and governance in Malaysia.

2.3 Supply Chain Management

The supply chain management (SCM) plays a critical role in managing unprecedented disruptions, necessitating enhanced resilience and adaptability in SCM practices (Smith, 2021). Meanwhile, the development of logistics and supply chain management (L&SCM) as a mature discipline relies on establishing a unified perspective centered on responsiveness, crucial for navigating environmental changes and stakeholder dynamics (Raj et al., 2022). Additionally, predictive analytics has emerged as a transformative tool in SCM, enhancing efficiency and decision-making through applications in demand forecasting, inventory optimization, and supply chain visibility, albeit with challenges such as data privacy and ethical considerations (Handayani et al., 2022).

When halal principles are applied to SCM, it becomes Halal Supply Chain Management or known as HFSCM, covering all stages from origin to consumption. This includes sourcing, product handling, transportation, warehousing, inventory management, procurement, and order management, all adhering to Shariah guidelines. Unlike conventional SCM, HFSCM incorporates Shariah law as the guiding principle for all processes and

procedures, ensuring halal integrity. This means keeping halal ingredients and products separate from non-halal items, like those containing alcohol or pork, throughout the supply chain. Due to concerns about food integrity, including safety, health, nutrition, and quality, it is crucial to monitor, maintain, and sustain the integrity of halal food, ensuring Muslim consumers and stakeholders can trust the authenticity of halal products (Handayani et al, 2022).

Furthermore, the intersection of sustainability and halal business underscores the need for sustainable supply chain management (SSCM) practices in Brunei's halal food sector, aiming to mitigate environmental impacts while supporting economic and social goals (Sulaiman & Abdullah, 2023). These studies collectively emphasize the evolving landscape of SCM, from crisis management strategies to sustainable practices and technological advancements, shaping the future of supply chain operations and management.

2.4 Technical and Vocational Education and Training (TVET)

Sustainable Consumption and Production (SCP) are vital for achieving sustainable development in Agenda 2030. This study investigates sustainable food processing practices among TVET students and TVET's role in achieving SDG 12. Using a deductive descriptive design and a cross-sectional survey of 298 respondents, the study found moderate sustainable practices, with high-level processing practices (4.20), moderate pre-processing (2.97) and post-processing practices (3.17). The findings highlight the need to optimize natural resource use, manage solid waste proactively, and emphasize hygiene and safety. The study underscores TVET's critical role in enhancing sustainable practices, suggesting that other institutions adopt the validated instrument used for broader evaluations. While the research is specific to students in Food Processing and Quality Control, expanding to related fields would provide a more comprehensive understanding of sustainable food processing practices (Abu Nasir et al., 2022).

Research and development in halal food management are growing alongside the increasing demand for halal cuisine. Scholars have examined various aspects of halal food administration, focusing mainly on transportation, supply chain efficiency, and administration. However, the integrity of halal food has been compromised by counterfeit certifications and improper handling. Understanding the complexities of the global food chain can help address these issues and improve the halal food supply chain, especially in non-Muslim countries. A study by Zailani et al., (2010) provides a comprehensive review of the challenges faced in the halal food supply chain. It discusses the increasing demand for halal food and the growing interest in halal food management research. The study also highlights various aspects of halal food administration, including transportation, supply chain efficiency, and overall management. The study points out that the integrity of halal food is often compromised due to counterfeit certifications and improper handling practices. The paper also explores the complexities of the global food chain and suggests that better understanding and management can help address these issues, particularly in non-Muslim countries where awareness and enforcement of halal standards may be less stringent. Gezgin et al., (2023) posits that a critical component for managing the global halal food chain is a reliable halal warranty framework. The sector faces significant challenges due to a lack of integrity in halal methods, making the development of comprehensive training programs essential. Although research on halal food supply chains is limited, areas such as conceptual model development, integration with lean and green practices, and enhancing halal professionals' competencies offer promising directions for future research. As global demand for halal products rises, effective training becomes increasingly important. The demand for halal products and services has surged over the past two decades, significantly impacting the logistics value chain.

3. Research Methodology

Quantitative study via questionnaire was employed. Data was collected from 121 halal food and beverages (F&B) in Malaysia. A respondent with knowledge related to halal FB were selected to answer the question. The global halal industry is estimated to be worth around USD3.0 trillion, and it includes categories such as confectionery, bakery and snacks, dairy products, chilled and frozen food, canned and bottled food and convenience foods. Malaysia, without any doubt, is the leading global halal hub with an annual export value of RM59 billion for halal products in 2023 (HDC, 2023). Purposive sampling was used in this study. It is a non-probability sampling technique where researchers select participants based on specific characteristics or qualities relevant to the study. This method is often used when the researcher wants to focus on particular subsets of a population that are best suited to provide the needed information. Creswell and Poth (2018) ascertained this sampling is used to obtain information from the specific target group. This technique is suitable for the study for the reason that the content of the questionnaire requires complete or in-depth information, which cannot be expected from general respondents. Besides, it is acceptable and most suitable for unique cases in which specific information is required by the researcher. Tabachnick and Fidell (2019), proposed the rule of thumb for determining sample size whereas the sample size should be several times (10 times or more) as large as the number of variables in the study. The dependent variable (DV) of this study was Halal Integrity Assurance (HIA). Meanwhile, there were five (5) independence variables (IV) that make up Halal Food Supply Chain Management (HFSCM) namely (i)

Supply Chain Objective (SCO), (ii) Supply Chain Logistic Control (SCLC), (iii) Supply Chain Resources (SCR), (iv) Supply Chain Business Processes (SCBP), and (v) Supply Chain Network Structure (SCNS). HIA in the context of the HFSCM is paramount for ensuring that products maintain their halal status from production to consumption. HIA entails adherence to Islamic principles of lawfulness, purity, and transparency throughout the entire supply chain process, as outlined by Khan (2020). The HFSCM involves various dimensions, beginning with the establishment of a clear halal policy at the organizational level, which outlines responsibilities for maintaining halal integrity, scope of certification, and assurance methods, including oversight mechanisms like halal committees and compliance officers (DOSM, 2010a, 2010b, 2010c). Logistics control emerges as a critical control point in the HFSCM model, ensuring the segregation of halal and non-halal products throughout warehousing, transportation, and distribution, thereby enhancing halal integrity (Chopra and Meindl, 2021).

Chopra and Meindl (2021) posit that the SCNS in halal food production underscores the importance of integration and collaboration among interconnected organizations to manage material and information flows effectively. This integration is essential for aligning processes across sourcing, manufacturing, and distribution phases while ensuring compliance with halal standards throughout. Effective management of SCBP further supports HIA by integrating halal control activities into customer order fulfillment and manufacturing flow management, thereby safeguarding the halal status of products until they reach consumers (Chopra and Meindl, 2021). Overall, these dimensions of the HFSCM model emphasize the need for rigorous adherence to halal principles and comprehensive management practices to uphold HIA throughout the supply chain. Multiple Linear Regression (MLR) analysis was employed to test the hypotheses on the relationship between HFSCM dimensions and HIA of the study. Using MLR technique, the association between a single DV and a set of IV is analyzed (Sarstedt, 2020). Besides, the relative importance of each IV to the change in the DV scores is evaluated by MLR (Sarstedt, 2020). This technique was also used to determine the influence of IV in predicting the DV. In this study, MLR analysis was used to determine the influence of HFSCM on HIA. In specific, the MLR was used to test the effect of SCO, SCLC, SCR, SCBP, and SCNS on HIA.

4. Findings and Discussion

Statistical software STATA 13.0 was employed to analyze the data. The results of multiple regression analyses were summarized in Table 1. Ordinary Least Square (OLS) regression showed that the main hypothesis was supported, i.e., HFSC had a positive effect on HIA. The F statistic was significant ($F=16.51, p<.05$) where HIA was the criterion variable, and the predictor variables (HFSCM dimensions) explained 42% (where $R^2 = .42$) of the variation in HIA.

The findings in Table 1 revealed that the effect of SCO ($\beta=0.001, p>.1$), SCLC ($\beta=-0.100, p>.1$), and SCR ($\beta = 0.035, p>.1$) on HIA was not significant, but the effect of SCBP ($\beta=.293, p<.05$) and SCNS ($\beta=.313, p<.05$) was significant and positively influenced HIA. It showed that there was a positive relationship between SCBP-HIA and SCNS-HIA. The results of multiple regression indicated that the hypotheses were supported, i.e., SCBP and SCNS positively affected HIA. The non-significant effects of SCO, SCLC, and SCR on HIA indicate that having clear SCO alone is insufficient to ensure halal integrity, as strategic objectives do not directly translate into operational practices. Similarly, the negative, non-significant impact of SCLC suggests that existing logistic controls may not adequately address the specific needs of halal assurance, such as segregating halal and non-halal items during transportation and storage. The non-significant positive effect of SCR implies that merely having resources available does not guarantee halal integrity; instead, specific resources tailored to maintaining halal standards, such as dedicated halal storage facilities and trained personnel, are necessary.

Thus, it was concluded that Hypotheses H1d and H1e were accepted. These results suggested that industries with a high focus on SCBP and SCNS were expected to have better HIA. According to the results in Table 1, the effect of HFSC on HIA was significant because the p-value was less than .05. It was safely concluded that Hypothesis H1 was accepted. This finding suggested that there was a positive effect of HFSC on HIA. These findings underscore the importance of meticulously designed and well-implemented supply chain processes and robust network structures in maintaining halal standards. The significant effect of the HFSCM on HIA ($p<.05$) reinforces the critical role of a comprehensive and integrated approach to managing the halal supply chain. This suggests that industries need to focus on both the operational aspects (business processes) and the structural components (network structure) of their supply chains to ensure halal integrity.

Table 1 The result of the ordinary least square (OLS) regression along with the OLS with robust standard errors to examine the Effect of SCO, SCLC, SCR, SCBP and SCNS on HIA

Variables	The Least Square Regression		Least Square Regression with Robust Standard Errors	
	Coefficient	p-value	Coefficient	p-value
SCO	0.001	0.995	0.001	0.996

SCLC	-0.100	0.377	-0.100	0.480
SCR	0.035	0.672	0.035	0.699
SCBP	0.293	0.012**	0.293	0.077*
SCNS	0.313	0.001**	0.313	0.001***
CONS	1.976	0.000	1.976	0.001
R ²	0.422		0.422	
F-Value (Sig.)	16.51 (0.0000)		6.71 (0.0000)	

Note. N =121, * significant at 10 percent level; ** significant at 5 percent level; *** significant at 1 percent level

Furthermore, the results in Table 1 above showed that the main hypothesis and several of its dimensions were supported, i.e., HFSC had a significant effect on HIA. Specifically, SCBR and SCNS were found to have a significant effect on HIA. However, SCO, SCLC, and SCR were found to have no significant effect on HIA. It could be safely concluded that H1a, H1b, and H1c were rejected. Both SCBP ($\beta=.293, p<.05$) and SCNS ($\beta=.313, p<.05$) were significantly influenced by HIA, but the influence of SCNS was the strongest. This indicates that ensuring comprehensive and interconnected supply chain networks can more effectively uphold halal standards compared to other dimensions.

Table 2 VIF and tolerance tests

Variable	VIF	Tolerance
SCO	2.25	0.44
SCLC	2.26	0.44
SCR	2.36	0.42
SCBP	3.42	0.29
SCNS	2.29	0.43
Mean VIF	2.52	

The equal variance of a dependent variable (homoscedasticity) and multicollinearity were assumptions of applying the linear regression. Table 2 showed the results of multicollinearity and homoscedasticity tests. The VIF and tolerance values, which distinguish the multicollinearity problem between independent variables, were revealed by the findings presented in Table 2. These results showed no evidence of a multicollinearity problem between predictor variables since the tolerance value of variables was more than 0.10, and the variable inflation factor (VIF) value was less than 10 (Netter et al., 1996). The Breusch-Pagan or Cook-Weisberg test (Breusch & Pagan, 1979) was performed to determine the homoscedasticity of the residual variance, yielding a p-value of 0.000 with a Chi2 of 48.55. Since the p-value was less than 0.05, the assumptions of ordinary least square regression were not fulfilled, necessitating the use of least square regression with robust standard errors to address the heteroscedasticity issue (Froot, 1989; Hamilton, 2012; Wooldridge, 2010). Multiple regression analyses using this method, summarized in Table 1, indicated that HFSC had a significant effect on HIA, with an F statistic of 6.71 ($p<.05$) and predictor variables explaining 42.0 percent ($R^2 = .422$) of the variation in HIA. The detailed results in Table 1 showed that while SCO ($\beta=.001, p>.1$), SCLC ($\beta=-.100, p>.1$), and SCR ($\beta=.035, p>.1$) did not significantly affect HIA, SCBP ($\beta=.293, p<.05$) and SCNS ($\beta=.313, p<.05$) had a significant positive influence. This supported the hypotheses that SCBP and SCNS positively affect HIA, leading to the acceptance of Hypotheses H1d and H1e. Thus, industries with a strong focus on SCBP and SCNS are expected to achieve better HIA, confirming Hypothesis H1.

The study’s findings align with previous research, indicating a significant relationship between HFSCM and HIA. This relationship is supported by Tieman et al. (2012), who emphasized the importance of clear halal definitions, strict process adherence, and comprehensive tracking and collaboration for successful HFSCM. Additionally, ensuring no cross-contamination between halal and non-halal products is crucial, as highlighted by Zulfakar et al. (2012), who found that protecting halal food integrity requires preventing contact with non-halal materials throughout the supply chain. Interestingly, only SCBP and SCNS significantly influenced HIA, while SCO, SCLC, and SCR did not. This could be due to the greater impact of business processes and network structures on HIA compared to other supply chain factors. For instance, the lack of a relationship between SCO and HIA might stem from unclear intentions regarding SCO within companies. Effective halal supply chain implementation requires clear objectives and top-level management support, as indicated by Chuang and Shaw (2000) and Alserhan (2010), emphasizing the need for a well-defined halal policy.

It is worth to note that, the significant relationships between SCBP, SCNS, and HIA underscore the importance of SCBP and SCNS in achieving HIA. These findings suggest that trust, mutuality, and clear communication among supply chain partners are essential for successful halal supply chains, as proposed by Barratt (2004), Näslund and Hulthen (2012), and Tieman et al. (2022). Therefore, companies aiming to enhance

HIA should focus on robust business processes, dedicated halal assets, and collaborative network structures to ensure the integrity of their halal supply chains. Conversely, the non-significant effects of SCO, SCLC, and SCR suggest that these elements, while important, may not directly contribute to halal integrity unless they are specifically tailored towards halal compliance. These findings prompt on reevaluation of strategies focusing on objectives, logistics control, and resources, emphasizing the need for these elements to integrate more closely with halal assurance practices. The study underscores the necessity for a holistic approach, ensuring that all facets of the supply chain are aligned with halal requirements to achieve overall integrity.

5. Conclusion and Recommendation

This study makes several significant contributions to the understanding as well improved management of HFSC in Malaysia. Firstly, it highlights the critical role of TVET in bridging the skills gap within the supply chain sector, emphasizing the importance of practical training in logistics, inventory management, and procurement. By equipping graduates with the necessary skills to navigate modern supply chains, TVET programs contribute to improved operational efficiency, reduced costs, and enhanced business competitiveness. By integrating TVET into the halal food supply chain sector, Malaysia can address the skills gap and improve the overall effectiveness of its supply chains. TVET programs provide the practical, hands-on training needed to implement and maintain best practices in SCBP and SCNS, which are crucial for upholding halal integrity. Additionally, by addressing non-significant factors such as SCO, SCLC, and SCR through targeted training, TVET can contribute to a more holistic improvement of the HFSC. This strategic alignment between education and industry needs ensures that the halal food supply chain in Malaysia can meet both current and future challenges, maintaining its reputation as a trustworthy halal hub.

Secondly, the study addresses the rapid growth and global positioning of Malaysia's halal food industry. It underscores the role of technological advancements like blockchain and IoT in enhancing halal verification processes, which are essential for maintaining Malaysia's reputation as a trustworthy halal hub. This insight is particularly relevant given the industry's projected market value of USD 113.2 billion by 2030, driven by increasing global demand and the rising Muslim population. Furthermore, findings of the study impliedly pointed out the possible challenges Malaysia faces in upholding halal standards and consumer confidence due to incidents of non-compliance within the halal food supply chain. By exploring the impact of HFSCM on ensuring HIA, the study provides crucial insights into how Malaysia can strengthen its halal certification processes. This contributes to shaping future strategies and policies aimed at safeguarding the authenticity of halal products. In addition, the study delves into the broader concept of food integrity, integrating perspectives on food safety, quality, and consumer empowerment within the food system. It introduces a comprehensive "house of food integrity" framework, which emphasizes the interconnectedness of these facets and the importance of transparency and communication throughout the supply chain. This framework, supported by advanced technologies for traceability, offers a robust strategy for ensuring food integrity aligns with regulatory standards and consumer expectations.

Lastly, the research's methodological approach, using MLR analysis, provides empirical evidence on the influence of HFSCM dimensions on HIA. By identifying significant factors such as SCBP and SCNS, the study offers actionable insights for industries aiming to enhance halal integrity. These findings reinforce the necessity for clear halal policies, effective logistics control, and collaborative supply chain networks to maintain the halal status of products from production to consumption. Statistical analysis using STATA 13.0 revealed significant findings regarding the impact of HFSCM on HIA. The study confirmed that HFSC has a positive and significant effect on HIA, particularly through SCBP and SCNS. Conversely, other factors such as SCO, SCLC, and SCR did not show significant influence on HIA. These results highlight the critical role of well-defined business processes and collaborative network structures in ensuring the integrity of halal practices throughout the supply chain. To strengthen HIA, organizations should focus on refining their supply chain operations. This includes optimizing SCBP to uphold transparency and adherence to halal standards. Implementing stringent quality control measures and fostering robust communication among supply chain partners are crucial steps to prevent contamination and maintain Halal integrity. Additionally, cultivating strong SCNS can enhance trust and collaboration across the supply chain, thereby reinforcing efforts to uphold HIA.

Looking ahead, continuous improvement in halal supply chain management is essential. Firms operated under F&B related industries should establish regular audit protocols and feedback mechanisms to monitor and enhance compliance with halal standards. Leadership commitment is pivotal, necessitating clear halal policies supported by top management. Investing in research and technology to innovate halal supply chain practices can further streamline operations and bolster integrity assurance. By implementing these strategies, businesses can not only meet regulatory requirements but also build consumer trust in their halal products, positioning themselves competitively in the halal market. Further, by integrating IoT and blockchain technologies can revolutionize halal supply chain management by enhancing transparency, traceability, and trust. This study

underscores the importance of continuous improvement, regular audits, and robust feedback mechanisms, which can be significantly bolstered through the adoption of these technologies.

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Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this research. No financial, personal, or professional affiliations have influenced the conduct or conclusions of this study. All sources of funding have been disclosed, and the research was conducted with complete academic independence.

Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Yusaini Hisham Mohamed and Mohd Faiq Abdul Fattah; **data collection:** Abdul Mutalib Hassan, Mohd Husaini Rani and Fadilah Puteh; **analysis and interpretation of results:** Yusaini Hisham Mohamed and Mohd Faiq Abdul Fattah; **draft manuscript preparation:** Abdul Mutalib Hassan, Mohd Husaini Rani and Fadilah Puteh. All authors reviewed the results and approved the final version of the manuscript.

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