JOURNAL OF TECHNOLOGY AND OPERATIONS MANAGEMENT
http://e-journal.uum.edu.my/index.php/jtom

KNOWLEDGE MANAGEMENT, TECHNOLOGY, STRATEGY, AND ENVIRONMENT IN HALAL FOOD INDUSTRY GREEN SUPPLY CHAIN AND LOGISTICS MANAGEMENT PERFORMANCE

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ABSTRACT

The green supply chain and logistics management (GSCLM) in the halal food industry from upstream to downstream is to ensure systems integrity as the performance output. The issues in the GSCLM for the halal food industry are mainly costs, quality, non-segregation, and cross-contamination of halal-haram goods in supply chain processes. Therefore, the paper reveals the knowledge of the key factors for GSCLM in the context of the halal food industry. The research is hypothetically deducted from a transactional cost economic (TCE) and used a quantitative approach. A survey questionnaire was distributed to the halal food industry managers across the country. The key findings from PLS-SEM analysis indicated that technology, strategy, and environment affected the GSCLM through knowledge management. Nevertheless, technology had a small effect on GSCLM. The limitations of the research as it was conducted in the halal food industry, hence the generalizability of our findings is contingent on the validation of the findings with the non-specific halal certification industry. Practical implications are realized in which the industry could enhance the knowledge management in GSCLM effectively. Government should also support the industry with new policies and regulations that could fulfill the halal market demand. Future research may apply other theories to be tested in the context of GSCLM in other non-specific halal certification industries. The paper provides a new model of GSCLM in the halal food industry. Specifically, it applies TCE in GSCLM which demonstrates how knowledge management can affect the GSCLM performance.

Keywords: Green, supply chain, logistics, food industry, halal

INTRODUCTION

Supply chain and logistics management (SCLM) attract the interest of both academics and practitioners (Martuscelli et al., 2020; Tamam et al., 2020). The supply chain is a broader context, and logistics play a significant role in the supply chain (Ghadge et al., 2020; Quah & Udin, 2011). SCLM is a complex process that involves primarily manufacturers and suppliers, with logistics dealing with modes of transportation, storage capacity or warehouse, third-party logistics (3PL), and customers. In the halal food industry, the ability to perform halal supply chain and logistics is considered "green". For example, Haleem et al. (2020) discussed the GSCLM label contributes significantly to the perception of the high quality and trustworthiness of halal products. The supply chain focuses on activities from upstream to downstream, and it includes logistics such as transporting, warehousing, distributing, handling materials, and procuring goods/products. In halal perspectives, green is involved in SCLM parts, as Khan et al., (2020) emphasized on *riba-free* and Martuscelli et al. (2020) Halal and non-Halal products segregation. In food industry involved manufacturing processes, administration, procurement, distribution, storage, handling, and logistics operations.

GSCLM could improve stock availability, and customer satisfaction, and reduce costs for food manufacturers. Tan et al. (2020) emphasize the significance of logistics for many businesses worldwide. Martuscelli et al. (2020) proposed detection methods for halal and non-halal products, such as lard detection and protein-based methods for halal authenticity analysis. This study investigated various food sub-sectors such as meat, bakery, and farm. The current research uses this basis by identifying that GSCLM necessitates a strategy that proposes integration along SCLM, which ensures system integrity (Bahar et al., 2020; Shahabuddin, et al., 2020). GSCM could not be implemented without innovation (Djemilou & Bayat, 2018). Indarti et al. (2020) examined quality assurance control throughout green for the entire SCM, including both inbound and outbound logistics. GSCM emphasizes value-added in green practices, such as required mandatorily that the output is safe (non-toxic), proven harmful, secure, hygienic, and law permitted from the point of origin to the final consumption, as in halal assurance systems. GSCM depends also on technology such as radio frequency identification (RFID), and Artificial Intelligence (AI) (Bahar et al., 2020 Rakhmawati et al. (2019).

LITERATURE REVIEW

Supply Chain and Logistics Management

A supply chain relates to a process of flow of goods, services, and information from original suppliers to the final customers. A supply chain is a wide concept, that involves relationships within and between organizations consisting of material suppliers, purchasing, production facilities, logistics, marketing, and related functions. Hence, logistics is defined as: "*The part of the supply chain process that plans, implements and controls the efficient, effective flow and storage of goods, service, and related information from the point-of-to the point of consumption to meet customer requirements.*" (Poirier & Reiter, 1996, p.10). SCLM involves parts and products, supplies, cash flow, and knowledge delivered within the business, which is transported by the incoming and outgoing materials and products in the supply chain cycle. SCLM involves the management of inbound and outbound shipments, stock storage, warehouse management, warehousing, retail order fulfillment, delivery of goods, and third-party logistics. SCLM in the area of function of the company is responsible for planning, management, and monitoring of the physical flow of items in the logistic processes, and needs strategies for coordination of the complex activities (Negi, 2020). The goal of SCLM's performance is to integrate the key players in the supply chain and logistics and eliminate inefficiencies in transporting products and commodities. In this context, efficiency relates to product and service quality, halal compliance, individual attitude, warehousing, and

transport cost minimization across the chain. The overall supplies and movement of parts and materials' effectiveness.

Industry Context on GSCLM

The word "green" is associated with sustainability. Previously, GSCM emphasized the supply chain across industries, which included logistics. Green, also known as sustainable supply chain management, closed-loop supply chains, environmental supply chain management, reverse logistics, and green manufacturing (Abbasi & Nilsson 2012; Ahi & Searcy 2015), is a value chain that incorporates environmentally conscious processes while building on the tenets of the traditional value chain. GSCM is being promoted (Rosa et al., 2019; Barbieri & Santos, 2020). This study identified logistics as a core component of the supply chain, which has become an interesting topic for many scholars. For example, Christopher (2016) revealed that the global logistics industry's business value has increased over the years and is expected to be more than $12 trillion in 2023. Logistics accounts for approximately 12% of the world's gross domestic product (GDP). Therefore, integrating both supply chain and logistic concepts, GSCLM is defined as the inter-organizational coordination of entire value chain processes that combine economic, ecological, and societal considerations for enhancing business sustainability. Green value chain addition processes such as green logistics, green manufacturing, and green procurement are examples of GSCM practices (Chin et al. 2015). The sustainable supply and logistics of delivery and practices such as ordering, materials planning, capacity allocation, warehousing, and transport promote the transportation of goods and items from the point of production to the point of use and vice versa (Mukolwe &Wanyoike, 2015).

This improvement applies to the halal food industry, in terms of supply-to-demand distribution, which delivers an abrupt response to the consumers (Randeree, 2019; Talib et al., 2020). As far as green concerns, such as environment-friendly operations, materials, procedures, and processes, waste management, green awareness, and workplace, reducing carbon emissions linked to the transportation of goods are among the practices by the industry (Mafini & Muposhi, 2017). In the halal food industry, Mansur et al. (2017) emphasize operational risk, the contamination risk during transportation. Maman et al. (2018) identified the risk event, and risk agent in the Halal red meat supply chain and provided the mitigation strategies for all stages in the beef supply. There is still a neglected area in the field of GSCLM performance. In the supply chain, it still vague the connection of strategy to lower the cost of the operations, speed up the return on investment, and improve the operation (Rashid & Bojei, 2019). In SCLM networks, the companies continue to ensure halal integrity for ultimate efficiency (Djemilou & Bayat, 2018). The use of advanced technology to transition to green, as well as environmental factors, have an impact on the level of performance of the business. The performance of GSCLM involves cost reductions, raising the value to end consumers, halal compliance, and profit increase for each point.

Key Factors and GSCLM Performance

Increased failure in the use of cutting-edge technology to implement green processes. The company must also obtain current information on new environmentally friendly technology (Mafini & Muposhi, 2017). It is critical to use technology to redesign operations to meet consumer desires based on their lifecycle periods (e.g. Dallasega et al., 2020). GSCLM is facing severe environmental challenges as a result of technological activities and industrialization. Industrial pollution is caused by harmful emissions and toxic packaging materials. GSCM is thought to be an effective method for reducing these and other environmental hazards (Afum, et al., 2020). Quality control systems assurance is critical in the context of halal management systems (Haleem & Khan, 2017). It required innovation practices, service innovation, and quality enhancement are required to adapt to the complexities of consumer requirements. LSP Lifecycle Model was built to increase customer loyalty over the entire supplying services lifecycle, including lifecycle states such as style, test, supplying process, after-sales service, service review, and

decomposition. Green supply chain management (GSCM) promotes sustainable development (Lahane et al., 2020), and eco-innovation is a major component of GSCM (Fehrer & Wieland, 2021). The sourcing framework expanded the supply chain to shorter delivery lead times for a customer order by including vendors in capacity management. To gain versatility, and pace, and minimize time to market requirements, the strategic planning stage, decentralized operations choices, multinational procurement, or strategic partnership with clients. Adequate awareness of the management system would be needed for the strategic incorporation of managerial support for value development (Khalifa et al., 2008). The current research postulates, based on comprehensive literature reviews, that the versatility of the value chain should consist of an operating, production, and logistics network that is enabled by aligning, adapting, and modifying the organization's supply chain enablers. The environment was made up of the government, market demand, and other stakeholders. GSCM evolves gradually into an ecological modernization tool for businesses seeking to balance environmental concerns with productivity gains. Previously, most researchers considered government subsidies to be a direct influence factor (Barman et al., 2021; Huang & Chen, 2022). Han et al. (2022) were inspired by the role of government subsidy policies in alleviating the cost pressures imposed on businesses by the green transformation. With the government and local communities exerting pressure on mining companies, GSCM could be sustained (Ofori et al., 2022).
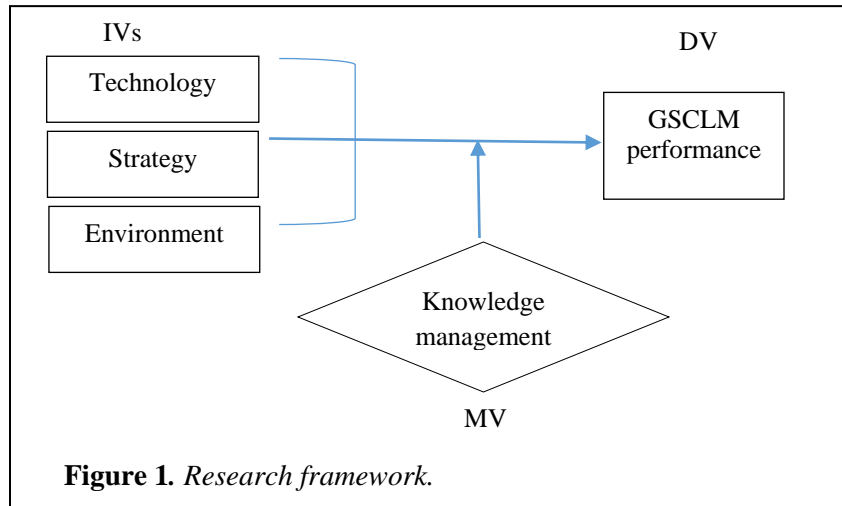
The exchanges of knowledge in GSCLM are important, as in production, product requirements, and distribution among all players from upstream to downstream. This enables lead times based on real data to be scheduled, tracked, and projected. Han et al. (2022) discovered the joint resources, skills, and knowledge to strengthen GSCM by the entire SCM. Afum et al. (2020) emphasized GSCM, which Omara et al. (2019) discussed in detail, which involves collaborative planning for cleaner production, green packaging, and better environmental goals with customers and suppliers. The GSCLM's long-term performance includes economic, environmental, and social outcomes (Abdul-Rashid et al., 2017). Profit, market share, sales, and assets are all indicators of economic performance. Energy consumption, hazardous materials, and environmental impact are all factors in environmental performance. Work safety, social quality, and work environment are all aspects of social performance.

Hence, the hypotheses are developed based on the literature review:
H_1: Technology has a significant and positive impact on GSCLM in the food industry
H_2: Strategy has a significant and positive impact on GSCLM in the food industry
H_3: Environment has a significant and positive impact on GSCLM in the food industry
H_4: Knowledge management moderates the effect of technology on GSCLM.
H_5: Knowledge management moderates the effect of strategy on GSCLM.
H_6: Knowledge management moderates the effect of environment on GSCLM.

Underpinning Theory and Research Framework

The study draws based on transaction cost economics (TCE) (Rindfleisch & Heide, 1997). TCE is used to develop the conceptual understanding of the model. TCE argues that all purchases should be able to eliminate or at least mitigate the transaction costs inherent in the mechanism, particularly inter-organizational communications. Inter-organizational interactions are recommended to maximize the efficiency of GSCLM.

Figure 1. *Research framework.*

This framework incorporates the moderating role of knowledge management and GSCLM performance. The framework shows the inter-organizational interactions of technology, strategy, and environment, moderated by knowledge management which is still left unexplored.

RESEARCH METHODS

The research methods used a quantitative approach, which allows statistical analysis to ensure that the collected information is valid. A quantitative approach was used in this research mainly for determining reasons and effects, decreasing particular variables and hypotheses, measurements, and observations. The researcher has determined that a quantitative survey study was the optimal strategy for addressing the research problem. In line with McCormack and Hill (1997), the study employed a cross-sectional survey, which was economical, efficient, flexible, and generalizable. The data used are primary (essential), which was a survey questionnaire, and secondary (optional) sources from the literature review, secondary documents, news, and press release. Cross-sectional data were used, and this type of design is uncomplicated, inexpensive, and allows for a relative shortstop to the data collection. The sample was taken from the database of the Federation of Manufacturers Malaysia (FMM. Three hundred and ten (310) respondents were chosen randomly from large companies in the food industry certified as halal. The formula used, $nz=(Nz/N)$ x n, in which the "nz" is the sample size for sector "z", "N" is the total population size, and "n" is the total sample size. The questions were measured on a five-point Likert scale. In examining the hypothesized model, Partial-Least squares (PLS) were used. First, the validity and reliability of the instrument were checked. Second, the hypothesized relationships were examined and reported. PLS offers as few parameters as possible for a given quality of model estimation results. Hair et al., (2017) suggested investigating the relationships of a construct directly with the dependent variable (criterion variable), rather than assessing the dependent variable with the higher-order component directly.

FINDINGS AND DISCUSSIONS

The research examines the relationships between the constructs (technology, strategy, and environment) and the criterion variable (GSCLM) with knowledge management as the moderator. The evaluation of the structural model shows direct relationships. In total, six hypotheses were tested, three posed a direct effect

and the three assessed the moderating effects between the constructs and the criterion variable. The direct effect of the latent variables on the criterion variable (GSCLM) is in Table 1, showing path co-efficient, t-values, and standard error and the decisions on either significant or insignificant.

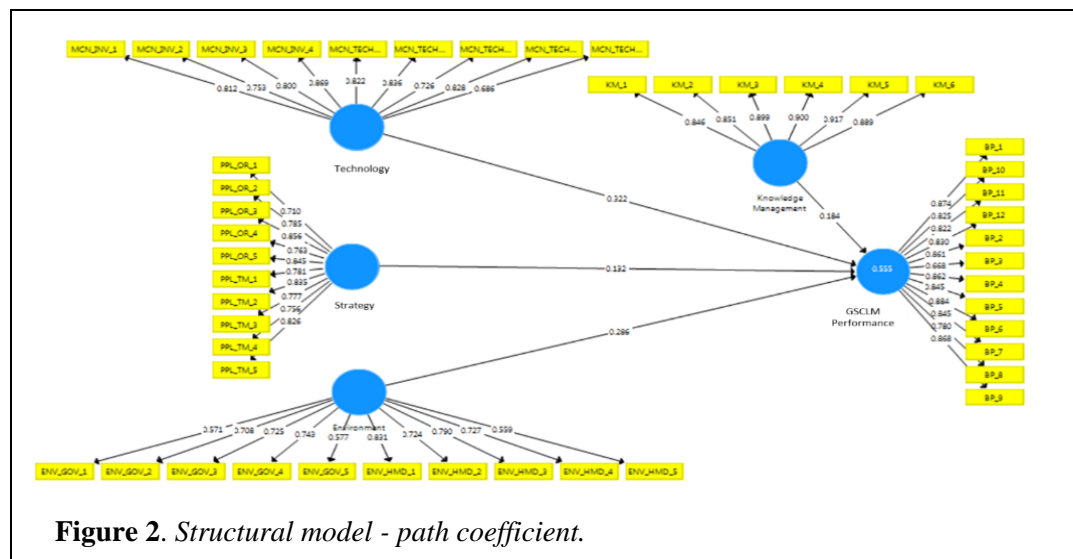**Structural Model Path Coefficients Assessment**

In the current study, the significance level is selected to be 5%. Besides, the 95% confidence interval (CI) provides information about the significance of the path coefficients. If the range of CI revealed does not include a zero value, it indicates the statistical significance of the value under consideration.

Table 1

Structural Model Significance Results - Path Coefficient

Relationship	Path Coefficients (Beta)	T Values	P Values	Confidence Intervals (97.5%)	Significant
Technology--GSCLM	0.322	4.026	0.000	0.478-0.485	Yes
Strategy--GSCLM	0.132	1.644	0.042	0.284-0.293	Yes
Environment--GSCLM	0.286	3.206	0.001	0.453-0.476	Yes

The first construct which is technology shows a positive and significant effect with values of (β=0.322, t=4.026, p=0.000, CI significant). The second construct, strategy exhibits a significant effect (β = 0.132, t= 1.644, p=0.042, CI significant). The final construct, environment demonstrates a significant and positive effect on GSCLM (β = 0.286, t = 3.206, p = 0.001, CI significant). Therefore, H_1, H_2, and H_3 are supported empirically by the findings. In addition to the above analysis, Figure 2 illustrates the findings taking into consideration Hair et. al. (2017)'s work emphasizes the importance of assessing the relevance of the significant relationships of a model under consideration.

Figure 2. *Structural model - path coefficient.*

The findings are consistent with the GSCM and green logistic studies on the importance of technology and the environment for green transformation in businesses to achieve sustainability. Thus, in conjunction with Afum et al. (2020), highlighted the critical roles of customers, government, and technology in improving supply chain performance. Furthermore, the GSCM has been heavily involved with government assistance (Barman et al., 2021; Huang & Chen, 2022).

Coefficient of Determination (R^2) Assessment

Table 2 shows R^2 values for all the constructs, which are technology (0.413), strategy (0.354), and environment (0.362). Technology explained variance by 9 items, whereas strategy and environment explained variance by 10 items respectively. Hence, GSCLM has a moderate value of R^2 (0.555), which its variance is explained by the three driver constructs of technology, strategy, and environment.

Table 2

Endogenous Variables' R^2

Endogenous Latent Variables	R^2 Value	Description
GSCLM	0.555	Moderate
Technology	0.413	Moderate
Strategy	0.354	Moderate
Environment	0.362	Moderate

Effect Size (f^2) Assessment

Table 3 shows the f^2 effect size of technology on GSCLM (f^2technology--GSCLM) has a pronounced small value of 0.047. On the other hand, the effect size of strategy on GSCLM (f^2strategy--GSCLM) is medium at 0.103. Finally, the f^2 effect size of the environment on GSCLM (f^2environment--GSCLM) has a medium effect of 0.119.

Table 3

Effect Size f^2 of Latent Constructs

Latent Constructs	Effect Size (f^2)	Size
Technology	0.047	Small
Strategy	0.103	Medium
Environment	0.119	Medium

Tseng et al. (2019) reported that businesses have been incorporating green elements into their supply chain operations in response to pressures from a variety of stakeholders, including market customers, policymakers, government officials, and non-governmental organizations concerned about environmental issues, in GSCM practices and performance. Coercive pressures on organizations from buyers,

government agencies, regulatory norms, and policies, as stated by Chiarini (2017), are critical for the successful implementation of GSCLM. GSCLM benefits from its strategy, which is aided by low-cost labor and raw materials, more lucrative investment opportunities, emerging export markets, and, in many cases, incentives provided by host governments.

Moderating Effect Assessment

The results were obtained from the analysis of knowledge management on the relationships between technology, strategy, and environment. The effect size, in general, is small in studying the moderation as indicated largely in literature (e.g. Hair et al., 2017) which the p-value of 0.005 is small, 0.010 is medium, and 0.025 is said to have a large effect size on the criterion variable. Table 4 shows the moderating effect of knowledge management on the relationships between technology--GSCLM, strategy--GSCLM, and environment--GSCLM.

Table 4

Path Coefficients for Moderating Effect of Knowledge Management

Moderating Constructs	Path Coefficients	t Values	p Values	Significant
Technology*knowledge management--GSCLM	0.087	0.829	0.004	Yes
Strategy*knowledge management--GSCLM	0.077	0.719	0.036	Yes
Environment*knowledge management--GSCLM	0.031	0.318	0.045	Yes

Table 4 shows the interaction of knowledge management and technology, strategy, and environment have positive significant effects with GSCLM at (β=0.087, $p<$ 0.004) and (β=0.077, $p<$0.036), and (β=0.318, $p<$0.045) respectively. Therefore, the moderating effect of knowledge management exists in the relationships between technology and GSCLM, strategy and GSCLM, and environment and GSCLM. Table 5 summarizes the hypotheses test for moderating constructs.

Table 5

Summary of Moderating Hypotheses

Relationship	P Values	Significant	Findings
Technology*knowledge management--GSCLM	0.004	Yes	Supported
Strategy*knowledge management--GSCLM	0.036	Yes	Supported
Environment*Knowledge Management--GSCLM	0.045	Yes	Supported

Knowledge management is about the exchange of information for sustainability-related guidelines, regulations, and programs in GSCLM becoming a broad concept and could not be determined as one element by itself as also discussed in studies (such as Di et al., 2021; Lee et al., 2020).

CONCLUSION

GSCLM is influenced mostly by the environment because processes create the value chain in the company. Strategy integration could improve their skills to run the complicated processes for GSCLM. Hence, technology aids the processes and strategy integration of self-managed operations. A cleaner SCLM with mutual collaborations and partnerships with customers and suppliers could achieve sustainable performance in economic, environmental, and social outcomes. The originality of the research is in terms of the understanding of the enablers for GSCLM. The research provides a significant contribution to the industry and manufacturers as they could consider the synchronization of the enablers toward GSCLM implementation. The limitations of the research as it was conducted in the halal food industry, hence the generalizability of our findings is contingent on the validation of the findings with the non-specific halal certification industry. Future research may apply other theories to be tested in the context of GSCLM in other non-specific halal certification industries. It could further look into the emerging trends in this field and the advancement in GSCLM.

ACKNOWLEDGMENT

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