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Operational supply risks of halal food manufacturer: A mitigation approach to supply chain risks

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This study aims to investigate the strategies employed by halal food manufacturers in Malaysia to mitigate operational supply risks. This study selected a sample of 369 respondents using a simple random sampling method to participate in the main survey. The collected dataset was analysed using covariance-based software (AMOS-SEM)) to test the study hypotheses. The findings of this research highlight that halal food manufacturers in Malaysia proactively adopt measures to manage operational supply risks from suppliers. Notably, they utilize behaviour-based and buffer-based strategies to effectively minimize the impact of these risks. This study focused on supply-related risks. To secure the integrity of halal, the firms must address demand-related risks and governmental and organizational risks to ensure the halalness of halal products. Therefore, it is crucial to consider risk management for all parts of the supply chain to guarantee the halal compliance of food products. The study highlights halal firms' need for behaviour-based and buffer-based risk management strategies to mitigate price, quality, and delivery risks while ensuring brand reputation and consumer trust through collaboration, information sharing, and supplier performance evaluation. This study presents a comprehensive analysis of the operational supply risks faced by halal food manufacturers, offering insights into the unique challenges and vulnerabilities within the halal food supply chain. By specifically focusing on Malaysia, this research contributes to the limited existing literature in this specific context, further enriching our knowledge in this field.

1. Introduction

Addressing challenges in the halal food supply chain entails tackling potential contamination of non-halal ingredients or products, whether intentional or unintentional. One effective solution is the implementation of robust verification and monitoring programmes, including regular supplier audits to ensure adherence to halal standards (Tieman, 2017). However, the lack of traceability and transparency in the halal food supply chain poses difficulties for manufacturers in ensuring the halal integrity of their products, and for consumers in verifying the halal status of their purchases (Tan et al., 2020). In addition to concerns about food safety, sustainability issues also plague the halal food supply chain. The risk of suppliers engaging in unethical practices, such as worker exploitation or unsustainable ingredient sourcing, is a significant challenge. To address these risks, food manufacturers can foster strong relationships with suppliers and enforce social and environmental standards (Tieman, 2017). Therefore, it is crucial for food manufacturers to implement effective risk management strategies (Purwanto et al., 2020), encompassing measures to prevent contamination, ensure compliance with halal standards, and establish social

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and environmental criteria for suppliers (Rashid & Bojei, 2019). By taking these steps, food manufacturers can not only safeguard the quality and safety of their products, but also uphold consumer trust and contribute to the growth of the halal food industry.

In essence, the key to preserving the integrity of the halal food supply chain and fostering a more robust, sustainable food industry lies in the implementation of effective risk management strategies (RMS) and adept supplier management. By tackling these challenges head-on, the halal food industry can create a secure environment for producing halal food products that are both safe and of high quality, adhering to established halal standards and regulations. This research aims to investigate the strategies implemented by Malaysian halal food manufacturers to mitigate operational supply risks, with the ultimate goal of contributing to the establishment of a resilient and sustainable halal food supply chain that caters to consumer needs and aligns with industry standards. The research aims to enrich the body of knowledge on halal supply chain management and provide valuable insights to halal food manufacturers, enabling them to produce safe and high-quality products in accordance with halal standards and regulations.

2. Operational supply risk management

Operational supply risks (OSR) pertain to the likelihood associated with challenges in inbound supply, stemming from supplier failures or an inconsistent supply market (Chowdhury et al., 2019). Such circumstances may result in the principal's inability to meet demand or pose threats, especially to consumer life and safety (Cheng et al., 2012). According to (Chowdhury et al., 2019), any deviations in upstream supply from the initial objectives are considered OSR and may yield unfavourable outcomes. OSR manifests directly through aspects like quality (e.g., supplied raw materials), price and cost (e.g., raw material and logistics costs), and delivery (e.g., compliance with delivery standards) (Assefa et al., 2017; Cheng et al., 2012; Dani & Deep, 2010).

This study specifically focuses on OSR, recognizing their propensity to gradually escalate over time (Guertler & Spinler, 2015; Zhao et al., 2020), thereby constituting the primary research focus. Given the critical importance of maintaining halal integrity in the halal food industry, effective OSR management becomes even more paramount. The supply chain stands out as the most vulnerable segment in the food chain, susceptible to potential consequences such as product contamination, recalls, loss of access, supplier losses, delivery failures, and stock shortages. Consequently, this study concentrates on OSR to assist managers in ensuring halal integrity within the supply side.

2.1 Conceptualisation of operational supply risk management for halal food manufacturer

Prior to the empirical testing, the study develops a research model and hypotheses about OSR for halal food manufacturers based on the supply chain risk management framework by Jüttner et al. (2003) and agency theory (Eisenhardt, 1989). The rationale for employing the supply chain risk management framework and agency theory is to understand agency uncertainties (agency problems between firms and suppliers) and manage the risk that favourably influences the source of risks. Jüttner, Peck, and Christopher (2003) suggest that it is relevant to distinguish four basic constructs: supply chain risk sources, risk consequences (RC), risk drivers, and risk mitigation strategies (RMS). The term "risk" is complex and perceived as multidimensional, referring to both uncertain internal and external environmental variables that reduce outcome predictability and the consequences of those uncertainties. In the context of supply chain risk management, Jüttner et al. (2003) define risk as any threat to information, material, and product flows within the supply chain. It encompasses the possibility and impact of a mismatch between supply and demand. Risk sources are unpredictable variables affecting supply chain outcomes, while RC includes focused outcome variables like costs, quality, and delivery. The study makes a distinction between supply chain risk drivers and RMS, recognising that factors such as outsourcing and global supply chain growth make risks more likely and cause more disruptions. Firms, driven by competitive pressures, adopt strategies to enhance competitiveness, reduce risks (e.g., costs, quality, and delivery), and maintain profitability. RMS aims to isolate and minimise the severity of issues arising from various risk sources, particularly for high-probability and low-impact risks. In the halal food industry, risks mainly stem from quality and delivery issues, as identified by Fujiwara and Ismail (2018).

The agency theory, as articulated by (Eisenhardt, 1989), is applicable when one party, referred to as the principal, delegates tasks to another party, termed the agent. This theory has been adopted in numerous studies to analyze the strategies used by both entities in the supply chain for handling risks. The buyer is often seen as the principal, delegating decision-making and tasks to the supplier, acting as the agent (Huma et al., 2020). However, the major challenge for the principal lies in selecting the right agent and establishing a trust-based relationship, as incomplete information about the agent's behavior necessitates a degree of trust. Despite previous principal-agent studies in supply chain management focusing on performance improvements, price and cost risks, supplier performance, and logistic risks, there is a gap in the application of agency theory in the context of halal food supply chain risk management. This study conceptualizes the halal-based food manufacturing firm as the principal and the supplier as the agent, recommending agency theory-aligned efforts to mitigate the likelihood and impact of adverse events on the relationship. The study emphasizes two risk mitigation techniques: behavior-based management (BBM) and buffer-based management (BFM). BBM initiatives focus on proactive measures targeting activities and tasks to reduce supply-side risks, such as quality management programs, supplier certification and development, and quality audits. In contrast, BFM strategies are reactive, involving maintaining safety stock, ensuring multiple supply sources, and requiring suppliers to maintain inventory, with the goal of minimizing the adverse effects of supplier activities. These

buffer-oriented approaches, as noted by (Ho et al., 2015) and (Ivanov et al., 2017), involve using multiple sources of supply, safety stock, and various transportation modes as buffers to address supply risk. This strategic approach benefits principals by providing alternatives in the event that one supplier fails, thereby mitigating supply gaps and reducing overall supply chain risk.

The study proposes a research model to examine the relationships between OSR, RMS, and RC, with the mediating effects of RMS. Based on these relationships, the study formulates 15 hypotheses that aim to make the supply chain more resilient by mitigating risky events. Fig. 1 illustrates the proposed research model of operational supply risk management for halal food manufacturers.

Fig. 1. Proposed research model of operational supply risks management for halal food manufacturers

2.2 Hypotheses development

The research suggests that BBM strategies can effectively manage OSR, which includes price (PR), quality (QR), and delivery (DR) risks. These strategies aim to enhance supplier halal information, trust, and assurance quality, thereby reducing the likelihood of partner opportunism. Companies should establish long-term strategic alliances with key suppliers, engage in information sharing, and employ joint operation strategies to address price risks (Hong et al., 2020). For mitigating quality risks, recommended measures include implementing supplier quality management, sharing information and knowledge with suppliers (I. Ali & Gurd, 2020; Sharma et al., 2020), supplier integration (Radzi et al., 2020), and conducting halal awareness programs (S. Khan et al., 2020). To counter delivery risks, firms can adopt information sharing (Sharma et al., 2020), implement quality management practices (Prakash et al., 2017), foster collaboration with suppliers (Fujiwara & Ismail, 2018), and enhance supply chain visibility (Kurniawan et al., 2017). Therefore, we advocate for the proactive implementation of BBM strategies before risk events occur. This study advances the hypothesis that by adopting a BBM strategy focused on increasing supplier halal information, halal integrity (trust), and assurance quality, operational supply risks (PR, QR, and DR) can be effectively managed and mitigated, thereby minimizing the potential for partner opportunism. Therefore, the study proposes the following hypotheses:

H_1: *Price & cost risk significantly affects behaviour-based management.*
H_2: *Quality risk significantly affects behaviour-based management.*
H_3: *Delivery risk significantly affects behaviour-based management.*

Adopting BFM techniques is recommended as a proactive approach to address uncertainties in buyer-supplier relationships arising from agency issues, emphasizing the use of buffers to diminish the impact of risk events (Z. Ali et al., 2023). Firms can effectively manage supply risks by implementing strategies such as leveraging multiple supply sources, maintaining safety stock, and diversifying delivery routes for the same commodities (Ivanov et al., 2017). For halal food manufacturers, BFM techniques prove advantageous because they provide alternative suppliers in the event that one supplier fails to meet delivery timelines. So, the study suggests that companies that make halal food should use BFM techniques to lessen the bad effects of agency flaws. This can be done by making sure that they have access to a variety of halal supply sources, transportation facilities that follow halal rules, and certified halal supplier facilities.

To address PR, QR, and DR issues, firms can employ BFM strategies, including engaging multiple suppliers with high raw material standards, product substitution, supply chain flexibility, effective inventory management, and the maintenance of safety (Fayezi et al., 2019). Collaborative efforts with suppliers can also be strategically organized to guarantee the halal integrity of products (M. H. Ali et al., 2022). This proactive implementation of strategies occurs before the occurrence of risk events. The study suggests that a BFM strategy, which improves procurement, production, and distribution flexibility and acts as a regulator for uncertainties in buyer-supplier interactions, can effectively manage and mitigate operational supply risks (PR, QR, and DR). Consequently, the study presents the following hypotheses:

H_4: *Price & cost risk significantly affects buffer-based management.*
H_5: *Quality risk significantly affects buffer-based management.*
H_6: *Delivery risk significantly affects buffer-based management.*

OSR manifests directly through dimensions such as quality (pertaining to the supplied raw materials), price (encompassing the cost of raw materials, logistics, etc.), and delivery (compliance with delivery standards) (Assefa et al., 2017; Cheng et al., 2012; Dani & Deep, 2010). PR risks in halal food production, as highlighted by Radzi, Saidon, and Ghani (2020), result in volatile raw material prices, making it difficult for halal manufacturers to secure fixed prices. This situation leads to heightened production costs, reduced profit margins, and financial instability. Additionally, QR holds crucial significance in halal food production, with the management of raw material quality being essential to ensuring the halal integrity of the final products (M. H. Ali et al., 2022). Challenges arise when the quality of raw materials supplied by vendors falls short of manufacturers' standards, resulting in final products of inferior quality or unsuitable for processing due to contamination by prohibited items. DR emerges as a significant issue in the halal food supply chain, particularly concerning the direct contact of goods with haram elements during transportation and storage. This contact has the potential to render final products haram and unsellable (Zailani et al., 2018). We formulate the following hypothesis based on these observations:

H_7: *Price and cost risk significantly affects risk consequences in the halal supply chain.*
H_8: *Quality risk significantly affects risk consequences in the halal supply chain.*
H_9: *Delivery risk significantly affects risk consequences in the halal supply chain.*

The reactive approach is not designed to preemptively prevent adverse events but rather aims to minimize their negative effects or likelihood after they occur. The primary focus of this approach is to minimize performance loss upon experiencing the full impact of an event. Therefore, having processes that facilitate a swift transition from risk management to crisis and event management is crucial to mitigating the impact of the event (Dani, 2015). While reactivity can be considered a preparatory element of proactivity, it falls short of fully preventing risks since its emphasis is solely on limiting the impact of the event rather than preventing its occurrence altogether (Kilubi, 2016). BBM serves as a technique employed by principals to influence the behavior of agents, ensuring alignment with the principal's interests and minimizing the likelihood of opportunistic behavior (Fayezi et al., 2019). BBM, centered on processes rather than outcomes, relies on trust, information sharing, and incentive alignment as interventions to diminish the potential for misconduct (Cole & Aitken, 2019). The objective of BBM is to ensure that agents conform to the principal's expectations, leading to the desired performance outcomes (Fayezi et al., 2020). In the context of the halal food supply chain, BBM can be applied to monitor agents' behaviors and respond to the RC of Operational Supply Risks (OSR), including Price Risks (PR), Quality Risks (QR), and Delivery Risks (DR). By exchanging information about business operations, both suppliers and firms can foster halal information, halal integrity (trust), and assurance quality to mitigate the risk of OSR. However, BBM is implemented after OSR risks occur and is not considered a proactive approach (Fayezi et al., 2019). As a result, the study introduces three hypotheses about the interplay between operational supply risks and their consequences in the halal food supply chain.

H_{10}: *Behaviour-based management significantly mediates the relationship between price & cost risk and risk consequences.*
H_{11}: *Behaviour-based management significantly mediates the relationship between quality risk and risk consequences.*
H_{12}: *Behaviour-based management significantly mediates the relationship between delivery risk and risk consequences*.

The agency theory suggests that the application of BFM, which involves promoting the availability of halal supply sources, establishing multiple halal production facilities, and ensuring accessible modes of transportation, can alleviate OSR. Furthermore, BFM allows for the replacement of a supply source with an alternative, thereby addressing the risk component of operational supply management. Buffering, a widely employed mitigation strategy, involves firms maintaining sufficient inventory levels to protect their supply chain from disruptions or risks (Manhart et al., 2020). Additionally, BFM contributes to enhancing a firm's capacity to respond to uncertainties and aligns with the concept of functional flexibility (Fayezi et al., 2019). To reduce uncertainty and maintain robust supplier relationships, firms may opt for BFM as a preventative measure against OSR. However, firms should employ a reactive strategy to secure production if OSR occurs. In such scenarios, this study proposes that BFM techniques can assist firms in mitigating the adverse consequences of supplier imperfections without significantly intervening in supplier operations. Thus, the study puts forth the following three hypotheses:

H_{13}: *Buffer-based management significantly mediates the relationship between price & cost risk and risk consequences.*
H_{14}: *Buffer-based management significantly mediates the relationship between quality risk and risk consequences.*
H_{15}: *Buffer-based management significantly mediates the relationship between delivery risk and risk consequences.*

3. Method

The study's dimension was positivist in nature, as it used a deductive approach to derive hypotheses from theories, review the existing literature, and obtain confirmation of the hypotheses. The objective of the study is to investigate the strategies employed by halal food manufacturers in Malaysia to mitigate operational supply risks.

3.1 Population and sampling

This study focused on halal-certified firms in Malaysia, specifically within the food and beverage sector. We derived the sampling frame using the Federation of Malaysian Manufacturers' Food and Beverage Industry directory, which contains information on 1,300 halal food manufacturers certified by MS1500. A probability sampling method, specifically simple random sampling, was utilized to ensure that every member of the population had an equal and independent chance of being selected, ensuring an unbiased process (Kumar, Talib, and Ramayah, 2013). This approach selected respondents based on the directory records of the Federation of Malaysian Manufacturers' Food and Beverage Industry. Following the guidelines suggested by Krejcie and Morgan (1970), a minimum of 297 samples were determined for the main survey from the known population of 1,300. We employed SPSS software to generate random numbers and invited the firms corresponding to these numbers to participate in the survey. The study successfully obtained responses from 369 participants, surpassing the minimum requirement of 297 samples.

3.2 Application of structural equation modelling (SEM)

Following Anderson and DW Gerbing's (1988) recommendation, a two-stage SEM analysis approach was adopted. Initially, the measurement model underwent assessment to determine causal relationships between observed variables and confirm its fit. Confirmatory Factor Analysis (CFA) facilitated this phase. Subsequently, the structural model tested causal connections between exogenous (PR, QR, DR) and endogenous constructs (RMS and RC). RMS comprised BBM and BFM, while RC constituted a single construct.

The dataset underwent preliminary analysis using IBM SPSS Statistics version 25. Later, AMOS, a covariance-based software, was utilized to examine relationships between independent and dependent variables. AMOS, recognized for its capability in analyzing complex relationships, directly assessing theoretical frameworks, identifying the best-fitting models, and exploring the underlying mechanisms in data (Awang, 2015). SEM analysis involves two techniques: covariance-based SEM (CB-SEM) and partial least squares-based SEM (PLS-SEM). Researchers typically make a generic assumption regarding the choice between these SEM-based techniques.

4. Results

This section commences with the findings of the respondents' profiles, followed by an examination of the measurement model and structural model.

4.1 Profile of respondents

This study clustered this analysis based on the characteristics of respondents and the characteristics of halal food firms. In total, the sample consists of 369 respondents. Table 1 presents the characteristics of the respondents. The characteristics of respondents showed the positions of respondents in their firms, managerial experience, managerial experience in the halal industry, and ownership status of firms. Most of the respondents are managers (n = 122; 33%), and most have 5 years or less of managerial experience (n = 192; 52%) in their firms and halal industry (n = 205; 56%). Meanwhile, most of the respondents are non-Muslim manufacturers (n = 369, or 54%).

Table 1
Characteristics of respondents

Classification	No. of respondents (n=369)	Percentage
Designation		
Owner	103	28%
Director	5	1%
Manager (production, operation, procurement, purchasing, etc.)	122	33%
Halal executive	38	10%
Others	101	27%
Managerial experience		
5 years or less	192	52%
6-10 years	106	29%
16-20 years	36	10%
21 years and above	35	9%
Managerial in halal industry		
5 years or less	205	56%
6-10 years	136	37%
16-20 years	24	7%
21 years and above	4	1%
Ownership status		
Muslim manufacturers	169	46%
Non-Muslim manufacturers	200	54%

Table 2 outlines the characteristics of the surveyed firms, classified based on the Malaysian definition of small and medium-sized enterprises (SMEs). The predominant segment comprises medium-sized halal manufacturer firms (n = 252; 68%), characterized by a sales turnover ranging from RM 15 million to RM 50 million and a workforce spanning 75 to 200

employees. Following this, large-sized firms (n = 59; 16%) emerge, featuring a sales turnover exceeding RM 50 million and a workforce exceeding 200 employees. Additionally, a significant proportion of the firms (n = 117; 31.7%) are located in Selangor. Among the 369 responding firms, 215 (58%) engage in the production of food and beverages without specifying particular products; 104 (28%) specialize in beverage manufacturing, and 47 (13%) focus on the production of grain mill products, starches, and starch products. These findings indicate that the surveyed organizations, the majority of which are experienced halal manufacturers in Malaysia, contribute diverse perspectives to the study.

Table 2
Characteristics of firms

Classification	No. of respondents (n=369)	Percentage
Size of firms		
Micro	55	15%
Small	3	1%
Medium	252	68%
Large	59	16%
Total	369	100%
Sales turnover		
<RM 300,000	55	15%
RM 300,000 < RM 15 mill	3	1%
RM 15 mill < RM 50 mill	252	68%
>RM 50 mill	59	16%
Total	369	100%
Number of employees		
< 5 employees	55	15%
5 < 75 employees	3	1%
75 < 200 employees	252	68%
>200 employees	59	16%
Total	369	100%
Location of firms		
Johor	40	10.8%
Kedah	28	7.6%
Kelantan	3	0.8%
Melaka	39	10.6%
Negeri Sembilan	23	6.2%
Pahang	23	6.2%
Perak	8	2.2%
Perlis	3	0.8%
Pulau Pinang	35	9.5%
Sabah	10	2.7%
Sarawak	8	2.2%
Terengganu	9	2.4%
Selangor	117	31.7%
Kuala Lumpur	23	6.2%
Total	369	100%
Type of products produced		
Processing and preserving of meat	31	8%
Processing and preserving of fish, crustaceans and molluscs	14	4%
Processing and preserving of fruit and vegetables	18	5%
Manufacture of vegetable and animal oils and fats	8	2%
Manufacture of dairy products	38	10%
Manufacture of grain mill products, starches and starch products	47	13%
Manufacture of prepared animal feeds	10	3%
Manufacture of beverages	104	28%
Other foods and beverages not elsewhere classified	215	58%

4.2 Measurement model

This measurement model consists of six constructs: an exogenous construct (PR, QR, and DR) and an endogenous construct (BBM, BFM, and RC). The study measured each of the constructs using a list of unique measuring items as presented in Table 3.

Table 3
The measuring items for all constructs in the measurement model

No.	Construct	Measuring Items	Total Items
1.	PR	PR1, PR2, & PR3	3
2.	QR	QR1, QR2, QR4, QR5, QR6, & QR7	6
3.	DR	DR1, DR2, DR3, DR4, DR5, & DR6	6
4.	RC	RC1, RC2, RC3, RC4, RC6, RC7, & RC8	7
5.	BBM	BBM1, BBM2, BBM3, BBM4, BBM5, BBM6, & BBM7	7
6.	BFM	BFM1, BFM2, BFM3, BFM4, BFM5, & BFM6	7

According to the CFA analysis, the examined model confirms unidimensionality and satisfies all the necessary criteria for fitness indexes. As shown in Fig. 2, the measurement model exhibits an excellent fit across several goodness-of-fit (GOF) indices. The GOF measures for the new measurement model are: χ^2 = 897.033, df = 801, χ^2/df = 1.104, p <.050, RMSEA =.017, GFI =.903, CFI =.992, IFI =.992, TLI =.992, AGFI =.890. These results show that the model meets the threshold criteria for most GOF indices (J. F. Hair et al., 2009). Specifically, the factor loadings in this model exceed the minimum threshold of 0.6. The analysis also reveals that the correlation between all constructs is below 0.85 (J. F. Hair et al., 2010; Kline, 2015). Following the recommendation of J. Hair et al. (2017), the study reports at least one index from each of the three-model fitness values—absolute fit, incremental fit, and parsimonious fit—to demonstrate construct validity. In line with this recommendation, the study finds that all fitness indexes have reached the required levels. Thus, the study concludes that the measurement model has achieved construct validity, making it appropriate for parametric analysis of the structural model.

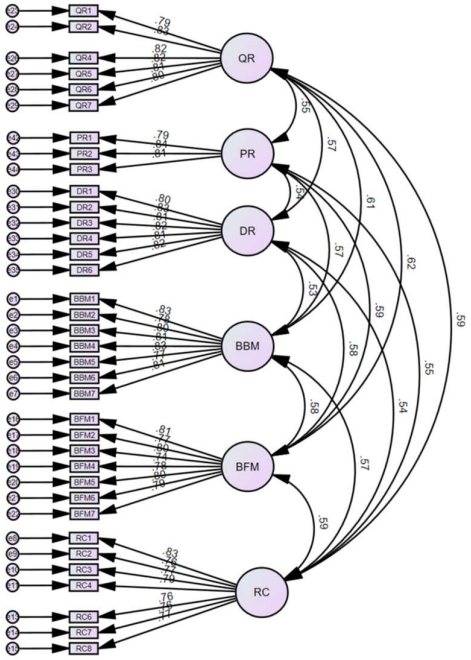

Fig. 2. Measurement model

Once an acceptable overall model fit is established in CFA, the subsequent step involves evaluating the psychometric characteristics of measures, specifically focussing on the reliability, construct validity, convergent validity, and discriminant validity of OSR, RMS, and RC. Reliability, denoting the internal consistency of elements constituting a latent concept, was assessed using Cronbach's coefficient alpha (α), revealing that all constructs' α values surpass the required standard of 0.70 (Nunnally, 1978), as indicated in Table 4. Subsequently, construct/composite reliability (CR) and average variance extracted (AVE) were evaluated to gauge the constructs' reliability. The fact that the CR and AVE values were higher than the suggested levels of 0.60 and 0.50 shows that the tests used in this study were valid and supported construct reliability (Bagozzi & Yi, 2011; Fornell & Larcker, 1981). One important goal in evaluating research measures for theory testing is to make sure they are valid in terms of the latent construct being studied (Bagozzi et al., 1991). The fitness indices for the models in this study fall within acceptable limits, establishing the overall measurement model's convergent and discriminant validity. This, in turn, confirms the attainment of construct validity (Awang, 2015; Hsieh & Hiang, 2004).

Gallagher et al. (2008) use convergent validity to measure how much the indicators of a construct "converge," which means they have a lot of the same variation. This evaluation is based on AVE and factor loadings, with convergent validity confirmed when standardized factor loadings are greater than 0.50 and AVE values meet or exceed 0.50 (Anderson & DW Gerbing, 1988; Awang, 2015; J. F. Hair et al., 2010). Supporting evidence for convergent validity is demonstrated by factor loadings between 0.70 and 0.80, all of which are above the 0.5 threshold and statistically significant ($p < 0.001$). Additionally, AVE values between 0.60 and 0.70 further confirm convergent validity, indicating that the measures are acceptably valid.

The final step involves assessing discriminant validity, which is established when each hypothesized construct is distinct from others and does not measure the same underlying concept (Gallagher et al., 2008; J. F. Hair et al., 2010). We employed two approaches to verify this assertion. First, we calculated the correlation coefficients between latent constructs, following Kline's (2015) advice, to ensure they did not exceed 0.85. According to Table 5, inter-construct correlations were well below this limit, indicating a stronger association between each construct and its indicators than with other constructs. Second, we affirmed the discriminant validity by demonstrating that the square root of the AVE for each construct exceeded the inter-construct correlation values (Fornell & Larcker, 1981). The results show that all AVE square roots are greater than the latent structural correlations. This proves that all the constructs in the measurement model can be used to make decisions. The

measurement model's goodness-of-fit, reliability, construct validity, convergent validity, and discriminant validity have all been proven. In the next section, we will look at the structural model, test the hypotheses of the theoretical model, and present the main results from the path model analysis.

Table 5
Measurement model evaluation from CFA

Constructs	Items	Standardised loading	α	AVE	CR
PR	PR1	0.789	0.855	0.664	0.856
	PR2	0.847			
	PR3	0.808			
QR	QR1	0.789	0.920	0.659	0.921
	QR2	0.828			
	QR4	0.821			
	QR5	0.824			
	QR6	0.814			
	QR7	0.795			
DR	DR1	0.799	0.923	0.668	0.923
	DR2	0.833			
	DR3	0.813			
	DR4	0.820			
	DR5	0.813			
	DR6	0.824			
RC	RC1	0.830	0.914	0.605	0.914
	RC4	0.790			
	RC3	0.772			
	RC8	0.772			
	RC6	0.761			
	RC2	0.759			
	RC7	0.756			
BBM	BBM1	0.829	0.927	0.646	0.927
	BBM2	0.781			
	BBM3	0.802			
	BBM4	0.813			
	BBM5	0.828			
	BBM6	0.767			
	BBM7	0.805			
BFM	BFM1	0.807	0.917	0.613	0.917
	BFM2	0.768			
	BFM3	0.800			
	BFM4	0.743			
	BFM5	0.777			
	BFM6	0.795			
	BFM7	0.790			

Notes: CR=composite reliability; AVE=average variance extracted

Table 5
CFA results summary for discriminant validity

	BFM	PR	QR	DR	RC	BBM
BFM	**0.783**					
PR	0.592	**0.815**				
QR	0.621	0.551	**0.812**			
DR	0.583	0.544	0.574	**0.817**		
RC	0.592	0.550	0.593	0.538	**0.778**	
BBM	0.577	0.567	0.614	0.525	0.573	**0.804**

4.3 Structural model

The research model led to the division of the foundational constructs into two categories: 1) exogenous constructs (QR, DR, and PR); and 2) endogenous constructs (BBM, BFM, and RC). The examination of goodness-of-fit (GoF) indices was integral to evaluating the structural model. This assessment aims to determine whether the proposed structural model aligns with the

collected data. If the model fitting results fall short of expectations, re-specification may be necessary to improve the model fit and align it more closely with the underlying theory (J. F. Hair et al., 2010; Tabachnick & Fidell, 2007). We also scrutinized path coefficient estimates and overall model fit indices to test hypotheses. Parameter estimates play a crucial role in Structural Equation Modeling (SEM) analysis as they contribute to generating the estimated population covariance matrix for the model (Tabachnick and Fidell, 2007). This section initiates the process of evaluating hypothesized relationships and confirming the structural model proposed in the study.

The evaluation of fitness indices for the structural model in Fig. 3 reveals favourable results. The AGFI value of 0.903 surpasses the 0.80 threshold, indicating an acceptable fit. Both TLI and CFI fall within the recommended range of 0.90, and the RMSEA, with a value of 0.018, aligns with acceptable threshold values, implying a reasonable fit (Chau & Hu, 2001). Notably, factor loadings in this model exceed the minimum threshold value of 0.6. Additionally, the analysis reveals that the correlation between all constructs remains below 0.85 (J. F. Hair et al., 2010; Kline, 2015). Moving to the structural model in Figure 4.5, the study directs AMOS to compute values for standardized estimates (β) and unstandardized estimates (B) for the model, presenting a summary of the results in Table 6.

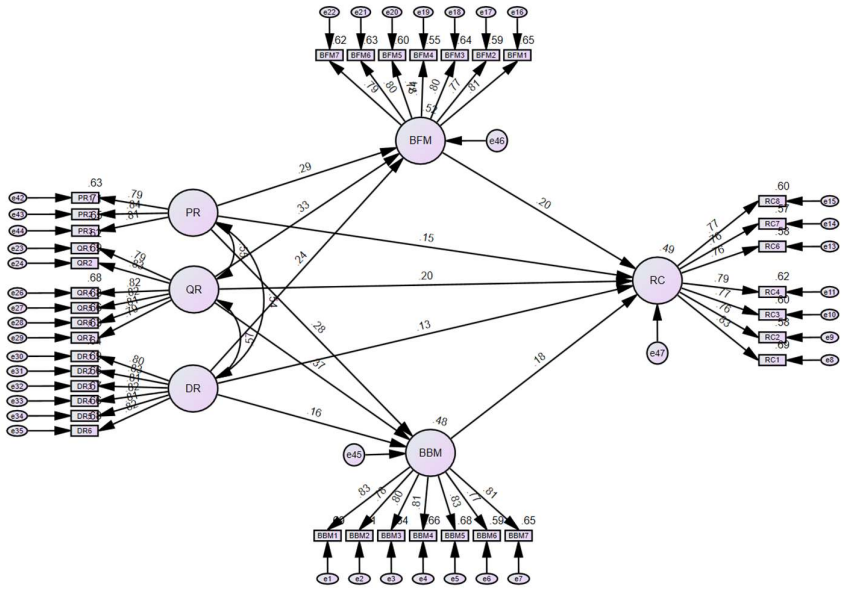

Fig. 3. Structural model

Table 6
Structural model test results

Hypothesized relationship		B	β	t-value	p-value	Results
H1	PR → BBM	.321	.294	4.779	***	Supported
H2	QR → BBM	.378	.369	5.983	***	Supported
H3	DR → BBM	.170	.158	2.700	.007	Supported
H4	PR → BFM	.292	.288	4.769	***	Supported
H5	QR → BFM	.314	.331	5.494	***	Supported
H6	DR → BFM	.238	.238	4.081	***	Supported
H7	PR → RC	.127	.131	1.808	.071	Not supported
H8	QR → RC	.171	.187	2.620	.009	Supported
H9	DR → RC	.116	.121	1.960	.049	Supported

Squared multiple correlation (R^2):

BBM	.485
BFM	.520
RC	.491

Model fit statistics:

χ^2 = 897.033, df = 801, Chisq/df = 1.120, p < .050, RMSEA = .018, GFI = .901, CFI = .991, IFI = .991, TLI = .990, AGFI = .889

Furthermore, the study requires testing the RMS as mediator effects to address research hypotheses H10–H15. Thus, to test the proposed hypotheses, two constructs clustered as mediators (BBM, and BFM) interacted between the causal relationships of OSR and RC. The bootstrap technique is applied to test the mediation effects. Table 7 shows the results of the mediation test.

Table 4
Test for mediation using a bootstrap analysis with a 95% confidence interval

Relationships		Direct effect	Indirect	Confidence interval		p-value	Results	Conclusion
				Low	*High*			
H10	PR → BBM → RC	.127	.049	.015	.101	.007	Supported	Full mediation
H11	QR → BBM → RC	.171	.057	.018	.117	.007	Supported	Partial mediation
H12	DR → BBM → RC	.116	.026	.005	.063	.011	Supported	Partial mediation
H13	PR → BFM → RC	.127	. 055	.017	.109	.004	Supported	Full mediation
H14	QR → BFM → RC	.171	.060	.018	.119	.004	Supported	Partial mediation
H15	DR → BFM → RC	.116	.045	.015	.092	.002	Supported	Partial mediation

Note: unstandardized coefficient reported. Bootstrap sample = 5,000 with replacement

5. Discussion

5.1 The impact of operational supply risk on risk mitigation strategies

The research underscores a robust correlation between PR and BBM. The vulnerability in the supply market for raw materials, especially the reliance on foreign suppliers, can instigate PR, subsequently impacting production costs. In response, fostering close relationships with suppliers emerges as a strategic imperative for firms to alleviate PR-associated risks. To incentivize suppliers towards adopting halal practices, implementing halal awareness programs, policies, and reward systems is recommended (M. I. Khan et al., 2019). Radzi et al., 2020 advocate for a collaborative and proactive engagement between suppliers and firms, fostering knowledge sharing to mitigate the adverse performance impacts of PR. Recognising the recurrent nature of PR and acknowledging the pivotal role of BBM in risk mitigation becomes essential for firms. Concurrently, the study identifies that PR significantly influences BFM efforts, prompting firms to intensify risk mitigation through BFM as PR occurrences rise. The challenge of suppliers associating higher costs with halal raw materials contributes to the inconsistency in raw material expenses. To address this, the study suggests that replacing suppliers with lower costs can serve as a viable strategy. BFM efforts emerge as instrumental in enabling firms to adapt to supplier opportunism by fostering agility through the cultivation of functional flexibility. This aligns with prior research emphasizing the importance of flexible purchasing and rapid resource reconfiguration for firms to position themselves as agile suppliers (Fujiwara & Ismail, 2018; M. I. Khan et al., 2019). Furthermore, the study advocates for the use of multiple and alternate sourcing strategies by halal firms as a buffer against potential supplier failures to meet quality and ethical standards. We deem a proactive and collaborative approach between both parties crucial for enhancing the flexibility of halal firms and mitigating the adverse performance effects of PR.

The study underscores a noteworthy impact of QR on firms' implementation of BBM strategies, with QR exhibiting the most substantial positive contribution among various factors within operational supply risks. This means that as QR intensifies, firms are inclined to implement more BBM initiatives to counteract associated risks. The research emphasizes the pivotal role of maintaining a close and proactive relationship between firms and suppliers to prevent QR from escalating into a significant issue. Collaborative efforts between both entities enhance knowledge sharing and mitigate the adverse performance effects of QR, aligning with findings from prior studies (M. I. Khan et al., 2019; Kumar et al., 2020), highlighting the positive impact of close relationships on the quality of supplied raw materials. The study also proves that QR has a big effect on BFM efforts, with path analysis showing that QR has a positive effect on BFM compared to other factors. Given the stringent quality criteria and ethical standards inherent in halal food manufacturing, the study echoes previous research (M. I. Khan et al., 2019; Maman et al., 2018), emphasizing the necessity of leveraging multiple suppliers to mitigate quality risks. BFM efforts emerge as instrumental in enabling firms to adapt to supplier opportunism by enhancing agility through the creation of functional flexibility (Fayezi et al., 2019). In meeting these rigorous standards, firms must ensure all goods align with halal requirements. Employing multiple suppliers proves effective in reducing quality risks, and BFM efforts enhance agility through functional flexibility. The study advocates that halal firms strategically employ multiple and alternate sources as a buffer against potential supplier failures to comply with quality and ethical standards. A proactive and collaborative approach between both entities is integral to enhancing the flexibility of halal firms and minimising the adverse performance effects of QR.

The study shows that DR has a noticeable effect on the use of BBM. It shows that as DR events happen more often, companies step up their BBM efforts to lower the risks that come with them. Emphasizing the paramount importance of cultivating robust relationships with suppliers, the research underscores the proactive role of suppliers in averting DR-related challenges. The study suggests implementing halal-certified transportation systems and engaging halal-certified suppliers as effective measures to alleviate DR. By fostering proactive collaboration between firms and suppliers, knowledge sharing can be enhanced, thereby mitigating the adverse performance effects of DR. Building on prior research, such as M. I. Khan et al. (2019), the study reinforces the efficacy of halal-certified transportation systems in mitigating DR. Certifying logistical operations according to halal standards ensures the halal status of raw materials, contingent upon the engagement of halal-certified suppliers. The study underscores the crucial need for firms to appoint such suppliers, ensuring alignment with halal standards throughout the delivery system. Furthermore, the research affirms the substantial impact of DR on BFM efforts, particularly within the vulnerable stages of the halal supply chain, namely transportation and distribution. Acknowledging the logistical challenges and lack of collaboration among service providers, the study advocates the adoption of multiple

transportation sources as a strategic approach to reduce delivery risks. BFM efforts emerge as instrumental in facilitating firms' adaptation to supplier opportunism, fostering agility through functional flexibility, and positioning themselves as agile suppliers. This aligns with the consistent findings of previous studies (Busyra & Ardi, 2020; M. I. Khan et al., 2019), emphasizing the significance of employing multiple transportation sources to mitigate delivery risks. The study underscores the criticality of managing delivery risks and advocates proactive collaboration between firms and suppliers, thereby enhancing the flexibility of halal firms and minimizing the adverse effects of DR.

5.2 The impact of operational supply risk on food supply chain

The research findings reveal that PR exhibits no significant influence on RC, thus contradicting Hypothesis 7 (H7). The analysis suggests that PR on the supply side does not impede the operations of halal food manufacturers. In contrast to the common perception that the cost of halal raw materials may escalate production costs and shrink profit margins, this study posits that halal food manufacturers hold distinct views on this matter. Given the heightened sensitivity of Muslim consumers to halal issues, firms seem willing to incur any cost for halal certification, provided that the raw material supply guarantees halal integrity. Previous research has also noted consumers' willingness to pay any price for halal products (Ahmed et al., 2019; Hosseini et al., 2019; Iranmanesh et al., 2020), further emphasizing that the high cost of raw materials is not a decisive factor affecting the operations of halal food manufacturers in this study.

On the other hand, the study establishes that QR significantly impacts the operations of firms within the halal supply chain, aligning with the formulated hypothesis. QR emerges as the most influential factor among overall supply risks, potentially leading to adverse effects on firms' operations, such as compromising the halal status of final products if suppliers face QR issues. This finding resonates with earlier studies highlighting the impact of QR on the halalness of final products. The study recommends a cautious approach towards suppliers with potential quality issues. The insights garnered emphasize the criticality of effectively managing QR for halal food manufacturers, suggesting the implementation of targeted strategies to mitigate its impact on operations.

Furthermore, the research indicates that DR has a significant effect on RC, confirming the hypothesis formulated. SEM analysis underscores the positive relationship between DR and RC, implying that an increase in DR occurrences corresponds to a heightened effect on firms' operations. The study underscores the potential consequences of DR, emphasizing the impact on business operations, such as rendering final products undesirable or even makruh for consumption. Previous studies have highlighted that direct contact with haram elements during delivery can result in the deeming of products as haram. Non-adherence to halal standards during delivery poses a significant risk, potentially disrupting business operations through issues like contamination and poor condition goods. We advise firms to exercise caution when dealing with suppliers prone to delivery issues, given the critical role of delivery in maintaining halal standards throughout the supply chain.

5.3 The mediating effect of risk mitigation strategies

The study reveals that in the absence of BBM, the direct effect of PR on RC is not significant. However, the bootstrapping analysis demonstrates a 0.049-measured indirect effect of PR on RC through BBM. This underscores a fully mediating relationship between PR and RC through the implementation of BBM. Consequently, the adoption of the BBM strategy by halal firms demonstrates a 4.9% reduction in RC for every one-unit increase in PR, supporting the hypothesis that BBM serves as a mediator in the PR-RC relationship. The study contends that BBM proves effective in diminishing RC by mitigating the adverse impact of PR from suppliers, aligning with a reactive approach to managing risk events. The study recommends a reactive approach, emphasizing information sharing to fortify supplier relationships and advocating for long-term cooperation to minimize transaction costs. The results align with earlier findings emphasizing the positive impact of sharing information with suppliers on relationship strength (e.g., (Radzi et al., 2020)). Similarly, the study finds that the direct effect of PR on RC, in the absence of BFM, is not significant. However, bootstrapping results indicate that PR has an indirect effect on RC through BFM, measuring 0.055 and suggesting full mediation. Hence, the implementation of BFM by halal firms demonstrates a 5.5% increase in RC for every one-unit increase in PR. The study concludes that BFM, particularly in collaboration with halal suppliers, can reduce PR and mediate the PR-RC relationship. Additionally, the study shows that BFM is helpful in reducing RC when PR causes operational disruptions. Earlier research (Assefa et al., 2017) demonstrated that firm flexibility can reduce price and cost risks, and firms view BFM as a tool to combat supplier opportunism by enhancing their functional flexibility. Firms can seamlessly replace suppliers at a low cost when the raw material costs offered are inconsistent. The study advocates for a reactive approach to managing risks, asserting that it can enhance the flexibility of halal firms and diminish the adverse performance effects of PR.

Findings from the study highlight a significant direct relationship between QR and RC in the absence of BBM, with a path coefficient of 0.171 and a p-value of less than 0.01. Additionally, bootstrapping results point to a partial mediation effect, with the indirect effect of QR on RC through BBM calculated at 0.057. When BBM is not utilized, QR significantly contributes to RC, with a 17.1% increase for each unit increase in QR. However, employing the BBM strategy clearly reduces RC, as the path coefficient drops to 5.7%. This indicates that a one-unit increase in QR leads to only a 5.7% increase in RC, as opposed to the 17.1% increase without BBM. These results support the idea that BBM acts as a go-between in the connection between QR and RC by lowering the effects of QR from suppliers and, in turn, lowering the RC connected with quality problems. Furthermore, the study underscores the importance of implementing halal awareness programs to mitigate quality risk and

strengthen supplier relationships. It argues that poor relationships may lead to opportunistic behavior and neglect of product quality, posing potential food safety problems. Implementing quality management programs with suppliers becomes crucial to managing supply chain quality and reducing quality risk. The findings align with prior research emphasizing the role of information sharing and close relationships with suppliers in strengthening relationships and mitigating risk (e.g., (Hong et al., 2020; M. I. Khan et al., 2019)). Similarly, the study reveals a significant direct effect of QR on RC in the absence of BFM ($B = 0.171$, $p<0.01$), with bootstrapping results indicating partial mediation through BFM (0.060). The absence of BFM contributes significantly to RC (17.1%), indicating that for every one-unit increase in QR, its effect results in a 17.1%-unit increase in RC. Conversely, with BFM implementation, the reduction in RC is evident, with the path coefficient decreasing to 6%. We find that BFM mediates the relationship between QR and RC, enabling firms to replace suppliers that do not meet halal quality standards. This aligns with the reactive approach to mitigating risk events, emphasizing the use of multiple sources to ensure ongoing processing of food products and coping with changing production plans due to production problems. BFM enhances firms' flexibility in replacing supplier sources, mitigating the impact of QR and playing a critical role in risk mitigation for halal food firms. Managers can use BFM to improve flexibility and reduce QR's negative performance effects.

Furthermore, the results from the study indicate that DR has a significant direct effect on RC in the absence of BBM, with a coefficient of 0.116 and a p-value of less than 0.05. Bootstrapping analysis reveals a partial mediation effect, with an indirect impact of DR on RC through BBM calculated at 0.026. Without BBM, DR plays a substantial role in increasing RC, with an 11.6% rise for every unit increase in DR. However, the implementation of BBM reduces RC, resulting in a path coefficient of 2.6%. This implies that each unit increase in DR leads to only a 2.6% increase in RC when BBM is in use, as opposed to the 11.6% increase observed without BBM. The study supports the hypothesis that BBM mediates the relationship between DR and RC by decreasing DR occurrences from suppliers and mitigating their impact on firm operations. Furthermore, the study emphasizes the significance of BBM as a strategy for managing DR, aligning with the reactive approach to risk management. For example, companies can evaluate their suppliers' halal quality systems to prevent delivery issues from disrupting RC. This aligns with previous studies advocating for supplier quality management to evaluate transportation performance and ensure delivered products comply with quality standards (Handayani et al., 2019; Hong et al., 2020). Re-evaluating suppliers' halal quality systems enhances halal integrity and establishes criteria for maintaining quality assurance. Similarly, the study highlights the significant direct effect of DR on RC in the absence of BFM ($B = 0.16$, $p<0.05$), with bootstrapping indicating partial mediation through BFM (0.045). The absence of BFM substantially contributes to RC (11.6%), implying that for every one-unit increase in DR, its effect results in an 11.6%-unit increase in RC. Conversely, implementing the BFM strategy leads to a reduction in RC, with the path coefficient decreasing to 4.5%. The study concludes that BFM can mitigate the negative effects of risk events on firm performance by mediating the relationship between risk events and risk control. Specifically, BFM enables halal businesses to be more flexible in replacing supplier sources and transportation modes, ensuring adherence to halal standards. The study underscores the challenge of transportation activities in halal logistics and argues that the flexibility of firms to access different transportation modes is crucial. Utilizing a range of transportation options provides a buffer against supplier breakdowns, preventing repeated risky consequences due to delivery issues. The results show that BFM assists halal firms in responding to supplier opportunism and enhancing agility through functional flexibility. These insights contribute to managers' comprehension of the critical nature of risk events and the significant role BFM plays in mitigating their effects.

6. Conclusion

This study aims to investigate the strategies employed by halal food manufacturers in Malaysia to mitigate operational supply risks. In conclusion, this research delves into the intricate dynamics of operational supply risks and their impact on RMS within the halal food supply chain. The study establishes a robust correlation between PR and BBM, emphasizing the vulnerability in the supply market, particularly concerning raw material reliance on foreign suppliers. Close relationships with suppliers emerge as pivotal in mitigating PR-associated risks, and the study recommends incentivizing suppliers through halal awareness programs and proactive engagement. Furthermore, PR significantly influences BFM efforts, prompting the need for firms to intensify risk mitigation through BFM strategies, such as the strategic replacement of suppliers with lower costs. The study underscores the importance of employing multiple and alternate sourcing strategies as a buffer against potential supplier failures. Similarly, QR exhibits a substantial impact on firms' implementation of BBM strategies, highlighting its crucial role among various operational supply risks. We identify proactive relationships and knowledge sharing between firms and suppliers as effective measures to prevent QR escalation. The study reinforces the necessity of leveraging multiple suppliers to mitigate quality risks within the stringent standards of halal food manufacturing. The study demonstrates that BFM efforts play a crucial role in responding to supplier opportunism and promoting agility through functional flexibility. We advocate the adoption of multiple transportation sources as a strategic approach to reduce delivery risks, aligning with prior research. The study also shows that DR has a noticeable effect on the implementation of BBM, focusing on the frequency-dependent link between DR events and increased BBM efforts. We recommend proactive collaboration with halal-certified suppliers and the use of certified transportation systems to mitigate DR. BFM efforts are identified as crucial in addressing the vulnerability of transportation and distribution stages within the halal supply chain. The study advocates the adoption of multiple transportation sources as a strategy to buffer against supplier failure and enhance flexibility in coping with delivery challenges.

In assessing the impact of operational supply risks on food supply chain elements, the study challenges the common perception regarding PR, indicating no significant influence on RC. On the contrary, QR significantly impacts firms' operations, leading to potential adverse effects on the halal status of final products. DR is revealed to have a substantial effect on RC, emphasizing the need for proactive management to prevent undesirable consequences.

The study highlights the mediating effect of RMS, revealing BBM as a fully mediating factor in the relationship between PR and RC. The implementation of BBM is shown to significantly reduce RC by mitigating the adverse impact of PR from suppliers. Similarly, firms identify BFM as a mediator between QR and RC, enabling them to replace suppliers and improve flexibility, thereby aligning with a reactive approach to risk management. BFM is also recognized for mitigating the negative effects of DR on firm performance by fostering adaptability through functional flexibility.

In summary, this comprehensive analysis underscores the intricate relationships among operational supply risks, risk mitigation strategies, and their impact on the halal food supply chain. The findings provide valuable insights for managers, emphasizing the critical role of proactive collaboration, multiple sourcing strategies, and strategic risk mitigation approaches in enhancing the flexibility and resilience of halal firms.

6.1 Contributions

The research provides practical insights for halal food industry practitioners by highlighting the critical importance of developing robust relationships with suppliers to mitigate operational supply risks. The emphasis on fostering close collaboration and proactive engagement aligns with the real-world challenges faced by businesses in ensuring a resilient supply chain. Moreover, the study advocates for practical strategies such as implementing halal awareness programs, policies, and reward systems to incentivize suppliers to adopt halal practices. The recommendation to strategically employ multiple and alternate sourcing strategies serves as a tangible approach for halal firms to buffer against potential supplier failures and ensure adherence to quality and ethical standards. Improving the flexibility of halal businesses is also something that the study looked at: putting in place halal-certified transportation systems as a way to lower delivery risks. This practical contribution provides industry practitioners with actionable insights to navigate the complex landscape of operational supply risk in the halal food supply chain.

The research has implications for policymaking within the halal food industry, particularly in relation to the regulatory frameworks governing supply chain practices. The study's findings underscore the need for policies that encourage and enforce the adoption of halal practices by suppliers. The recommendation to implement halal awareness programs aligns with the potential role of governmental or industry-specific policies to promote standardized practices across the supply chain. Policymakers could consider incentivizing or mandating the use of halal-certified transportation systems to ensure the integrity of halal products during delivery. Moreover, insights into the impact of supply risks on halal food operations contribute to the formulation of policies aimed at managing and mitigating risks within the industry. Policymakers may find value in promoting collaboration and knowledge sharing between firms and suppliers, emphasizing the role of proactive engagement in risk mitigation. By incorporating such recommendations into policies, regulatory bodies can contribute to building a resilient and reliable halal food supply chain.

In academia, the research significantly contributes to the understanding of operational supply risks and risk mitigation strategies within the context of the halal food supply chain. The study provides empirical evidence of the correlation between specific risks (PR, QR, DR) and the implementation of risk mitigation strategies (BBM, BFM) in the halal food industry. The identification of fully and partially mediating relationships between risk factors and firm performance (RC) adds depth to existing literature on supply chain risk management. These insights contribute to the theoretical foundations of risk management, specifically in the context of halal food production. Furthermore, the study's focus on the nuances of PR, QR, and DR, and their differential impact on various risk mitigation strategies offers a nuanced perspective for scholars exploring risk management in different industries. The results encourage more research into how supply chain risks change over time and how well mitigation strategies work. This will add to the body of literature in the fields of supply chain and risk management.

6.2 Limitations

The research, while providing valuable insights into the impact of operational supply risks on risk mitigation strategies in the halal food industry, is not without its limitations. One significant limitation lies in the potential lack of generalizability of the findings. The study predominantly focuses on the specific context of the halal food industry, and the dynamics within this industry may differ significantly from other sectors. Variations in supply chain structures, cultural considerations, and industry-specific practices could limit the broader applicability of the research findings to different business environments. Another limitation arises from the emphasis on the vulnerability of the supply market for raw materials, particularly the reliance on foreign suppliers. While the study emphasizes the potential for production risks to arise due to this reliance, it may overlook the intricate nuances and variations in global supply chain dynamics. Economic, geopolitical, and regulatory factors influencing relationships with foreign suppliers could impact risk scenarios differently, and the study might not capture the full complexity of these external influences. The research recommends fostering close relationships with suppliers as a strategic imperative for risk mitigation. However, the study may not fully account for the challenges of establishing and

maintaining such relationships, especially in a globalized and diverse supply chain landscape. Cultural, language, and operational differences could hinder the effectiveness of collaborative efforts, potentially limiting the feasibility of the proposed risk mitigation strategies. Furthermore, the study suggests replacing suppliers with lower costs as a viable strategy to address challenges associated with the higher costs of halal raw materials. This recommendation assumes a straightforward and seamless transition between suppliers, which may not always be the case. Practical considerations, such as supplier capabilities, industry regulations, and regional constraints, could introduce complexities that the study does not thoroughly address. The study's emphasis on the importance of halal-certified transportation systems and suppliers introduces a potential limitation related to the scalability and availability of such resources. In some regions, the availability of halal-certified options may be limited, raising questions about the feasibility and practicality of implementing these measures universally. The research might benefit from a more nuanced exploration of the logistical challenges and variations across different geographical areas. Additionally, the study's reliance on quantitative methods, such as structural equation modeling (SEM), may limit the depth of understanding regarding the qualitative aspects of risk perception and mitigation. Certain contextual nuances, organizational behaviors, or cultural factors that could influence the effectiveness of risk mitigation strategies may not be fully captured by the quantitative approach employed in the research.

Finally, the study adds useful information to our knowledge of operational supply risks and how to lower those risks in the halal food industry. However, the study's findings would be more reliable and useful in a wider business setting if these problems were recognised and fixed.

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