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Analysis of mitigation strategy for operational supply risk: An empirical study of halal food manufacturers in Malaysia

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A B S T R A C T

This study aims empirically to analyze mitigation strategies for operational supply risk among halal food manufacturers in Malaysia. A survey of 369 halal food manufacturers is used to test a research model that proposes a relationship between operational supply risk and risk consequences as well as the mediating role of risk mitigation strategies. Structural equation modeling reveals that in the absence of a risk mitigation strategy (behavior-based management, buffer-based management, and traceability-based management), operational risk consequences are significantly influenced by operational supply risk. The analysis also showed the mitigation strategies reduce risk events by its interaction between operational supply risk and risk consequences. This study shows significant data about the management of halal food manufacturing. Due to the limitations of this survey, further study is necessary to analyze how other halal's sectors manage their supply chain risk management.

1. Introduction

Recently, the scandals of imported meat cartels from several foreign give a negative vibe to Malaysia. It raised many public attention to the relevance of Malaysia's halal supply chain management system. This is also a significant setback for Malaysia, which is a halal center and a global pioneer in the field. Halal supply chain management solutions are difficult, expensive, and time-consuming in terms of supply, transportation, warehousing, and retail. It allows irresponsible parties at any phase of the chain to provide raw materials (meat) of questionable halal status at lower costs than those offered by halal-certified suppliers (Rahman & Muhamed, 2021). These issues will create more complexity of the halal supply chain whereby it will involve other parts in the supply chain such as the operation side. The halal issues in the market such as products recalled due to the final product were contaminated with the haram (forbidden or proscribed by Islamic law) element. For example, Cadbury Malaysia has recalled two chocolate treats that tested positive for traces of pork DNA (Shuib, 2014; Tan, 2014). A Japanese company (Ajinomoto) suffered from recall and boycott of its halal certification food products in Indonesia in 2001 since it could not perceive the usage of porcine enzyme in its supplier's operations as a supply risk (Fujiwara, 2017). Meat and poultry sold as halal in the United Kingdom may have been sold illegally and not slaughtered according to the requirements of the Muslim faith (Supian, 2018). Such an issue adversely affected the company's reputation.

There are few empirical studies on the topic of halal food supply risk management (Fujiwara & Ismail, 2018; Tieman, 2017) despite it being an important issue. For instance, Fujiwara & Ismail, (2018) conducted qualitative approaches (case study) to identify types of halal supply risk from small and medium enterprises and multinational enterprises, the study found out quality and logistic aspects are the specific risk involved in the halal supply-side. Meanwhile, Khan et al., (2019) performed a fuzzy AHP to identify and prioritize risk elements associated with the halal food supply chain (HFSC). The study found out supply-related risks are the crucial risk in the HFSC, which is costs risks, supplier failures (delivery), and raw material issues

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(quality) as halal food supply risks. There is a lack of attention in these studies on the depth of supply risk management (SRM) and effective risk mitigation to ensure *halalness* of products. Comprehensive SRM research is needed to address the halal food supply risk that may result in adverse risk consequences in the HFSC. This study aims empirically to analyze mitigation strategies for operational supply risk among halal food manufacturers in Malaysia.

2. Literature review and hypothesis

Jüttner et al. (2003) developed a framework for risk sources in the supply chain process risk management, but its primary focus is on network-related risk sources, which are suboptimal connections between companies along the supply chain. Furthermore, network-related sources are reclassified as supply risk sources, which are described as "the uncertainty correlated with supplier processes and in overall supplier relationships" (Jüttner, 2005). The study recommends that while establishing the idea of SRM, three main elements should be distinguished: operational supply risk (OSR), risk consequences (RC), and risk mitigation techniques (RMS). OSR refers to issues with quality (e.g. poor raw material quality), delivery (e.g. delivery failure), and pricing and cost (e.g. increase in acquired product cost) that are caused by a disruptive event that disrupts the supplier's internal operations or because the supplier has vertically integrated and is now a direct competitor of a purchasing firm (Guertler & Spinler, 2015). This then leads to RC at supply-side. RC can be different based on the area of the supply chain (Jüttner et al., 2003). According to Rathore et al., (2020), a firm may suffer losses, damage to the brand and reputation caused by OSR. In a halal context, the firm may face the same effect also including (Tieman, 2019) health risk (Al-ansi et al., 2019), affect a product recall, boycott by Muslim consumers (Fujiwara & Ismail, 2018), and the product is labeled as *makruh* to consume (makruh: something "actions, etc." objectionable but not forbidden (in Islam) (Handayani et al., 2019). So, how can firms dealing with agency uncertainty overcome the OSR challenges? According to current study, a timely mitigation strategy for the adverse effects of uncertainty is critical for the effective operation of a supply chain (Sreedevi & Saranga, 2017). This study conceptualized risk mitigation strategies incorporating three dimensions of strategy – (1) behavior-based management (BBM), (2) buffer-based management, and (BFM) (3) traceability-based management (TBM) – gathered from various sources in the literature. According to agency theory, appropriate risk mitigation techniques are classified as either BBM or BFM to shield the principal from potentially damaging occurrences (Fayezi et al., 2019; Shafiq et al., 2017; Zsidisin & Ellram, 2003). BBM strategies concentrate on activities or tasks that reduce supply-side risk. Firms use BFMs to reduce the impact of risk events because buffer-oriented efforts are more result-oriented. Furthermore, the study emphasized the importance of the TBM in halal management assurance in order to ensure the *halalness* of the products.

2.1. Operational supply risk and risk consequences

The term operational supply risk (OSR) refers to the manifestation of changes in the upstream supply chain's expected outcomes, i.e., variances in time, quality, and quantity (J. Chen et al., 2013). OSR is directly embodied through quality (raw material supplied), price (cost of raw material, logistics, etc.), and delivery (standards delivery compliance) (Assefa et al., 2017; Y.-S. Chen & Chang, 2012; Dani & Deep, 2010). This study focuses on OSR, as these are more likely to expand gradually over time (Ghadge et al., 2012; Guertler & Spinler, 2015), which is the focus of this study. Supply activity is a part of the food chain that is most at risk (Cui & Basnet, 2015). Product contamination, recall, loss of access, loss of supplier, delivery failure, and the stock shortage is the impact of food supply risks (Behzadi et al., 2018). Moreover, effectively managing the food supply risk is important and crucial for food manufacturers (Nakandala et al., 2017). Hence, managing the quality assurance of halal at the main source will secure the *halalness* of the final products (M. H. Ali et al., 2016; Fujiwara & Ismail, 2018; Tieman, 2017). Quality issues are a crucial discussion among scholars in this discipline. The study has found the issue of quality is the most studied recently. The quality of the final product is a determinant factor of the strength of the food manufacturers in the industry. These conditions occur due to the raw material quality supplied by suppliers not fulfilling the standard of manufacturers. Hence, a food manufacturer may face poor quality of final products (Chaudhuri et al., 2016; Khan et al., 2020; Prakash et al., 2017; Rathore et al., 2020; Tuncel & Alpan, 2010; Vlajic et al., 2012). Meanwhile, the delivery issue is also the main problem in HFSC (Zailani et al., 2018). The main issue reported in halal studies is the direct contact of goods with haram elements during transportation and storage. Once the products have contact with the haram element, it turns products into haram and cannot be processed or sell to consumers (Ab Talib et al., 2013; Sham et al., 2017; Tieman, 2011; Zailani et al., 2018; Zulfakar et al., 2014). Furthermore, price and cost risk may cause the inconsistent price of raw materials (Radzi et al., 2020). The halal manufacturer is unable to secure the fixed price of raw material in order to operate their productions. Thus, food manufacturers may face increased production costs (Assefa et al., 2017; Khan et al., 2019; Nyamah et al., 2017). The increasing cost of production may cause a decrease in the profit margin (Lintukangas et al., 2016) and financial instability of firms (Cui & Basnet, 2015). On the basis of this information, it was hypothesized that:

H_1: *Risk consequences on the supply-side are positively influenced by operational supply risk.*

2.2. Risk mitigation strategy

A halal risk mitigation strategy is response management, which involves isolating the problem and minimizing its impact on the integrity of the halal supply chain (Tieman, 2017). There are two types of risk mitigation strategies: proactive and reactive (Ali et al., 2019; Dani & Deep, 2010; Kilubi, 2016; Kırılmaz & Erol, 2017). Proactive approaches are taken to reduce risks before they occur (Gouda & Saranga, 2018). A reactive approach does not act prior to the occurrence of a risky event, rather it is executed after the event to lessen the effect and/or likelihood (Kırılmaz & Erol, 2017). This approach comprises deciding ahead of time to either lessen the likelihood or the effect of a risky event. The study will be focusing on reactive approaches to manage the impact of RC on the supply side. Thus, reactionary tactics may assist to lessen the impact of such occurrences on the firm (Hoffmann et al., 2013). As recognized in the literature and applied in practice, this study employed three major types of risk mitigation strategies: behavior-based management, buffer-based management, and traceability-based management. According to Cheng et al. (2012), behavior-based management (BBM) is a proactive approach that points to the process and emphasizes undertaking the tasks and activities that contribute to the reduction of OSR. These management techniques seek to develop an 'inter-enterprises dependency/cooperation principles' common mindset among buyers and suppliers (Stank et al., 2001). This proactive approach attempts to reduce the probability of occurrence of risk consequences. For example, the firms need human efforts and financial capability to improve processes and reduce the risk consequences (Cheng et al., 2012; Gandhi et al., 2012; Shafiq et al., 2017). Zsidisin & Ellram (2003) mentioned, implementing quality programs is a BBM is a strategy used to enhance suppliers' competencies and operations to meet the purchasing firm's quality requirements. Recent studies mention a quality management program such as halal awareness program (Handayani et al., 2019; Khan et al., 2019), good management practices (Radzi et al., 2020; Rathore et al., 2020), halal quality management program (Maman et al., 2018; Radzi et al., 2020), etc. may improve the effectiveness of supply chains. A study by Hong et al., (2020) investigates the relationships between supply chain quality management and firm performance toward food manufacturers in China. The findings are threefold supply chain quality practices (implement supplier quality management, and internal quality) can increase sales performance of food manufacturers. Kurniawan et al., (2017) also found out quality practices such as supplier development may improve supply chain effectiveness by mitigating the effects of vulnerability causes. Supplier development can be built relationships with suppliers in order to strengthen supply chains (Kumar et al., 2020). Tieman (2017) proposes internal audit, cross-functional team, communication among supply chain partners, and monitoring in order to mitigate risk in HFSC. From the perspective of agency theory, supplier development, quality audit, certification of supplier, and quality management program is BBM strategy. This strategy may promote supplier halal information, halal integrity (trust), and assurance quality, so as to overcome the risk consequences of operational supply management. Therefore, the study posits the following hypotheses:

H$_2$: *Behavior-based management mediates the relationship between operational supply risk and risk consequences.*

Buffer-based management (BFM) techniques are proposed to mitigate the RC of provider opportunistic conduct. It helps improve a company's capacity to alter or react to uncertainty and is important to the concept of flexibility (Sambamurthy et al., 2003; Stevenson & Spring, 2007). BFM techniques are viewed as reactive as well as proactive instruments and channels, including, for example, flexibility in procurement, production, and distribution that function as regulators for agency uncertainties in buyer-supplier interactions (Beach et al., 2000). Additionally, the reactive approach is buffer-oriented which encompasses keeping safety stock and utilizing multiple supply sources (Cheng et al., 2012). The reactive strategy seeks to mitigate the RC's adverse impacts. These techniques, for example, seek to mitigate the negative impact of the supplier's operations (Fayezi et al., 2019). RMS is likely to have a greater impact after a risk incident than proactive techniques do before one occurs even though both proactive and reactive procedures are developed in advance of an occurrence (Gouda and Saranga 2018). A recent study by Khan et al. (2019) identifies and prioritizes the risk aspects related to HFSC. The study found, to manage and mitigate the quality issue of raw material, the firms should use multiple suppliers. If the firm found out the supplier failed to supply, the principal may use other suppliers to get the items for production. Behzadi et al., (2018) also found in their literature review study, using multiple suppliers can contribute to increased robustness and mitigates risk in the food supply chain. Meanwhile, Kurniawan et al., (2017) and Vlajic et al., (2012) indicate in their study, supply chain flexibility (e.g., flexibility of supplier to supply products, use multiple modes of transportation) strategies positively affect supply chain effectiveness. Thus, the BFM strategy is the availability of supply sources, the availability of production facilities, the accessibility of means of transportation, and the replacement of one supply source with another. To mitigate the risks associated with OSR, it promotes a wide range of halal supply sources, halal transportation accessibility, and halal supplier facilities that are certified. As a result, the study proposes the following hypotheses:

H$_3$: *Buffer-based management mediates the relationship between operational supply risk and risk consequences.*

Having an appropriate traceability plan in place is critical to managing supply chain risks (Memon et al., 2015). The sources of risk in the food supply chain can be traced through the traceability system. Since there are so many different types of halal food, traceability is still a relatively new concept (Mat Aris & Soon, 2014; Shafii & Khadijah, 2012). According to Khan et al., (2018), halal traceability seeks to enhance transparency in halal manufacturing, which leads to increased customer trust in the end goods. In the long term, establishing traceability procedures in halal management can minimize cross-contamination risk and expenses (Abd Rahman et al., 2017; Mohamed et al., 2016; Zailani et al., 2010; Zhao et al., 2018). Traceability management might also be used as a communication tool, allowing information regarding halal food and other products across the food supply chain to be readily accessible and retrieved (Zailani et al., 2010). According to Rashid et al., (2018), the implementation of a halal traceability management is critical to improving the integrity of the HFSC as well as the performance of major corporations and SMEs. Being traceability-oriented can be a preventive approach to reduce supply risk. The firms are able to control their logistic management, production management, food quality, and food safety requirements by implementing a traceability approach (Ringsberg, 2014). A study by Handayani et al. (2019) found traceability-based management can prevent food safety problems and can be detected if problems occur along the food supply chain. This method supports businesses in detecting forbidden components in halal final products. Mattevi & Jones (2016) stated, the attitude toward traceability is good in terms of acknowledgment of its value, yet there is a reluctance to invest in improving traceability systems. TBM strategy includes being able to trace the quality of the halal product, imparting halal knowledge to the supplier, and evaluating if the product was transported or stored in compliance with halal specifications. This method may also respond to the risks associated with operational supply management. Therefore, the study posits the following hypotheses:

H_4: *Traceability-based management mediates the relationship between operational supply risk and risk consequences.*

2.3. Research model

The research model consists of three main dimensions which are operational supply risks (OSR), risk consequences (RC), and risk mitigation strategies (RMS). The study constructs OSR and RC based on a literature review of supply chain risk management. Meanwhile, constructs of RMS based on agency theory and literature review related to this field. The study believes OSR increases RC in the supply side of halal food manufacturers. Thus, the study proposes OSR as independent variables (IV) and RC as dependent variables (DV). Moreover, the study investigates the role of mediating effects of RMS to give a significant effect between the relationship of IV and DV. Fig. 1 illustrates the research model.

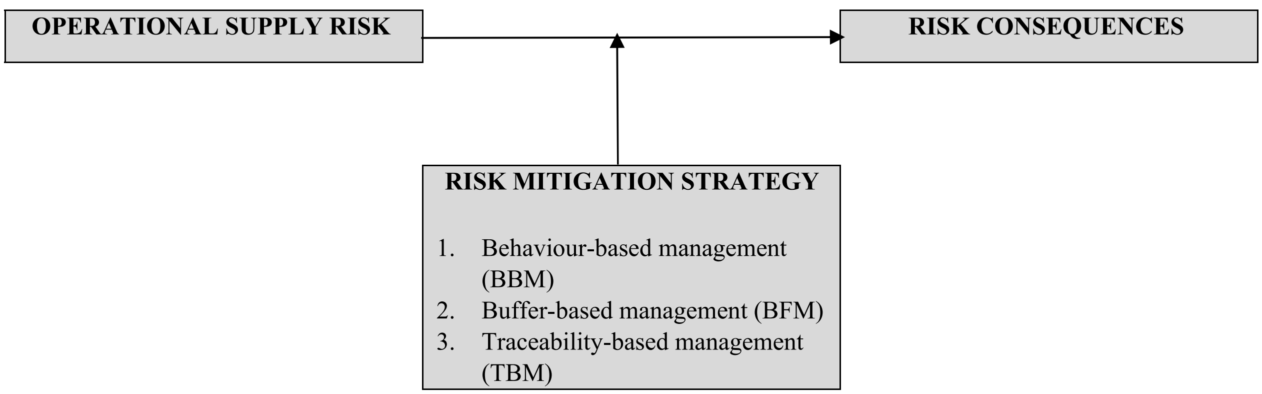

Fig. 1. Research model

3. Method

As the study employs a deductive technique, the aspect of the study is based on a positivist paradigm. After analyzing the literature, it produced hypotheses from theories, therefore verifying the hypotheses. This study used a survey strategy, which is frequently connected with a deductive approach. This study gathered a vast quantity of data to target Malaysian halal food manufacturers. A substantial amount of data is taken from the halal directory website of Jabatan Kemajuan Islam Malaysia (JAKIM). To acquire input for data measures from halal food manufactures, a series of questions is used as an instrument for the survey technique.

3.1. Sample of the study

Random sampling was employed to collect data from halal food producers. A useful approach for this study would be to collect a sample by visiting the JAKIM halal directory website and collecting data with variables such as industry type, firm name, e-mail address, the person in charge, and so forth. To achieve the research objectives, questionnaire data is used in the study. A total of 369 halal food manufacturers participated in the survey.

3.2. Instrument of the study (questionnaire)

Questionnaires are used as a survey instrument to gather information from halal food manufacturing firms to compile data measures. A good questionnaire should be direct, concise, and easily accessible (Frazer & Lawley, 2001). Content development and judgment stages are involved in developing a questionnaire (Lynn, 1986). The study develops the content domain through literature reading, creating relevant items, and constructing the instrument during the content generation stage. The study engaged the services of a specific group of experts (based on their domain knowledge) for a pre-test to confirm the proposed item in the questionnaire during the judging stage. Exploratory factor analysis was used to validate the questionnaire scale.

3.3. Structural equation modelling (SEM)

Structural equation modelling (SEM) was used in the study to construct the model and evaluate relations based on the research model and provided hypotheses via AMOS 24.0. There are two analyses that AMOS performs: confirmatory factor analysis (the measurement model) as well as regression analysis, which makes it a popular and strong data analysis tool (the structural model) (J. Hair et al., 2013; Hu & Bentler, 1999). A measurement model (representing how measured variables come together to represent constructs), and a structural model (showing how constructs are associated with each other) (J. Hair et al., 2013).

4. Results

4.1 Analyzing full measurement model

CFA (confirmatory factor analysis) was used as a pre-analysis step in this study's measurement model analysis (Byrne, 2010). Testing the validity of a construct's measurements is done to see if it matches up with the researcher's knowledge of the construct (Awang, 2015). To evaluate scale reliability (Cronbach's alpha) and construct reliability, as well as convergent and discriminant validity, the CFA method was used. This study applied Pooled Confirmatory Factor Analysis (Pooled-CFA). This procedure is beneficial in identifying the peculiarity in the model especially when some of the constructs are composed of less than four measuring items (Awang et al., 2015; Kashif et al., 2015). Pooled-CFA runs all the latent constructs concurrently, saving time because of its efficiency (Chong et al., 2013). With this technique, it is possible to examine the constructs' unidimensionality, validity, and reliability at the same time 0.6 and 0.7 are suggested for factor loadings and construct reliability (J. F. Hair et al., 2010). To verify that a measurement model is fit sufficiently before it can be used as a structural model, this study includes discussed goodness of fit statistics for each of the measurement models (see Fig. 2). The CFA findings indicated that 1 item (OSR3) of OSR and 1 item (RC5) of RC had a significantly high error correlation with the error term of the other item; hence, this item was deleted. As a result of removing this component, model fit indices improved significantly, showing good model fit (goodness-of-fit indices: χ^2 = 511.315, χ^2/df = 1.054, p < 0.001, CFI = 0.997, IFI = 0.997, TLI = 0.996, RMSEA = 0.012). Table 1 shows the CFA results, as well as Cronbach's alpha (α), composite reliability (CR), and average variance extracted (AVE). The findings revealed that all the items strongly loaded on their respective constructs, and the factor loading varied from 0.743 to 0.829, indicating high convergent validity. Furthermore, the AVE for all constructs is significantly higher than the suggested value of 0.5, confirming excellent convergent validity. Cronbach's alpha and the composite reliability score for all constructs are more than 0.8, suggesting that the measuring scales are reliable. The discriminant validity of the constructs was evaluated by comparing the square root of AVE to the correlation between any two constructs.

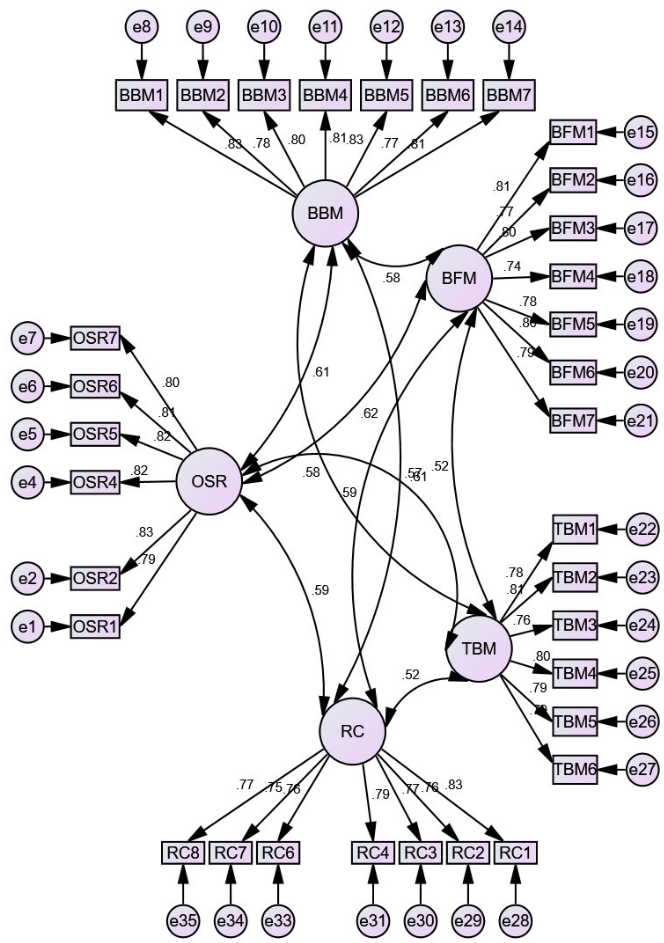

Fig. 2. Pooled-CFA

Table 1
Scale's reliability and validity analysis

Constructs	Items	Standardized	α	AVE	CR
OSR	OSR1	0.790	0.920	0.660	0.921
	OSR2	0.829			
	OSR4	0.821			
	OSR5	0.824			
	OSR6	0.813			
	OSR7	0.795			
BBM	BBM1	0.829	0.927	0.646	0.927
	BBM2	0.782			
	BBM3	0.801			
	BBM4	0.812			
	BBM5	0.825			
	BBM6	0.805			
BFM	BFM1	0.806	0.906	0.613	0.917
	BFM2	0.767			
	BFM3	0.801			
	BFM4	0.743			
	BFM5	0.778			
	BFM6	0.796			
	BFM7	0.789			
TBM	TBM1	0.775	0.908	0.621	0.908
	TBM2	0.814			
	TBM3	0.757			
	TBM4	0.796			
	TBM5	0.792			
	TBM6	0.794			
RC	RC1	0.829	0.914	0.605	0.915
	RC2	0.760			
	RC3	0.773			
	RC4	0.791			
	RC6	0.762			
	RC7	0.755			
	RC8	0.775			

Note(s): *Goodness-of-fit indices: χ^2 = 511.315, df = 506, χ^2/df =1.054, p < 0.001, CFI = 0.997, IFI = 0.997, TLI = 0.996, RMSEA = 0.012*

When each hypothesized concept is unique from others and does not measure the same thing, discriminant validity is shown (Gallagher et al., 2008; J. F. Hair et al., 2010). To validate, Kline (2015) suggests, the estimated correlations between latent constructs should not exceed 0.85. Table 2 reveals that the inter-construct correlations were not too high (all less than 0.85), indicating that each construct shares more variance with its own measures than with other variables. Second, discriminant validity was established by confirming that the square root of the AVE for each latent concept is greater than the levels of inter-construct correlations (Fornell & Larcker, 1981). According to the findings, all AVE square roots are greater than latent structural connections. The discriminant validity of all constructs in the measurement model is generally supported by the result.

Table 2
Discriminant validity tests

	TBM	OSR	BBM	BFM	RC
TBM	**0.788**				
OSR	0.606	**0.812**			
BBM	0.578	0.614	**0.804**		
BFM	0.521	0.622	0.577	**0.783**	
RC	0.522	0.593	0.573	0.591	**0.778**

4.2 Analyzing structural model

The proposed research model was tested using structural equation modelling (SEM) (figure 3). The results of SEM (table 3) showed good fit, as indicated by following model fit indices: χ^2 = 75.329, χ^2/df = 1.177, p < 0.001, CFI = 0.996, IFI = 0.996, TLI = 0.995, RMSEA = 0.022 and has been used as the basis for evaluation of the hypothesized relationships. This study revealed that OSR (β = 0.592, p < 0.01) has a substantial influence on RC, which means that the more OSR activity occurs, the more RC will influence the operation of firms. Meanwhile, the β value showed a 0.592 correlation coefficient, according to Schober et al., (2018), the value of correlation coefficient 0.40–0.69 portrays a moderate relationship. Thus, the relationship between OSR and RC showed a moderate relationship. Moreover, the path coefficient (B) of OSR on RC is 0.540. This value indicates that for every one-unit increase in OSR, its effect would contribute a 0.540 unit increase in RC. Therefore, the study proposes that H1 is highly acceptable.

Table 3
The results of direct effect

Direct effect			Unstandardised Beta (B)	Standardised Beta (β)	S. E	C.R	P-value	Results
RC	←	OSR	0.540	0.592	0.052	5.283	0.000	Sig.

Note(s): *Goodness-of-fit indices:* $\chi^2 = 75.329$, $df = 64$, $\chi^2/df = 1.177$, $p < 0.001$, $CFI = 0.996$, $IFI = 0.996$, $TLI = 0.995$, $RMSEA = 0.022$

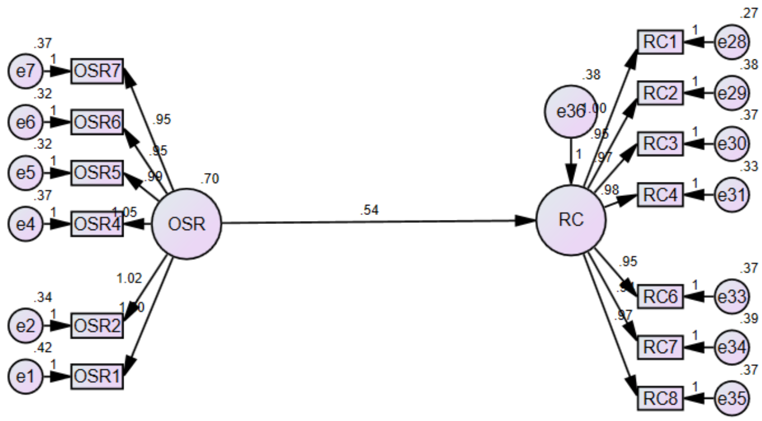

Fig. 3. Results of SEM (direct effect)

The analysis for mediation begins by calculating that the direct effect of OSR on RC is significant. The results of the SEM show that there is a significant direct positive relationship between OSR and RC (B = 0.540, p< 0.001). When the mediating variable enters the model, the value of beta coefficient for independent variables is expected to decrease (Awang, 2015), or in other words, the direct effect of OSR on RC would be reduced. This section (Table 4) describes the analyses required for testing mediational hypotheses as below:

Table 4
Steps of testing mediation

Steps	Descriptions
1.	• In a regression equation, use Y as the criterion variable and X as the predictor (estimate and test path c in Fig. 4 *unmediated model*). • This stage proves that an effect exists that can be managed.
2.	• In the regression equation, use M as the criterion variable and X as a predictor (estimate and test path a in Fig. 4 *mediated model*). • Essentially, this stage entails treating the mediator as if it were an outcome variable.
3.	• In a regression equation, use Y as the criterion variable and X and M as predictors (estimate and test path b in Fig. 4 "mediated model"). • It is not sufficient to simply correlate the mediator with the outcome since the mediator and the outcome are both caused by the causal variable X. • As a result, the causative variable must be controlled in order to determine the influence of the mediator on the outcome.
4.	• To demonstrate that M totally mediates the X-Y link, the effect of X on Y (path c') should be zero. • In Steps 3 and 4, the impacts are calculated using the same equation.

Source: Baron & Kenny (1986), James & Brett (1984), Judd & Kenny (1981)
Note: If all four of these steps are satisfied, the results support the hypothesis that variable M totally mediates the X-Y connection; if the first three steps are met but Step 4 is not, partial mediation is suggested.

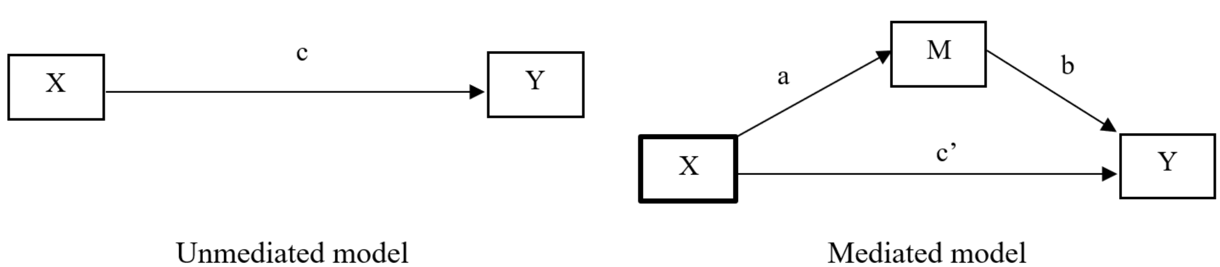

Fig. 4. The results of mediated and unmediated models

Based on the research model, there are five latent constructs which are OSR, RC, BBM, BFM, and TBM. The study needs to prove that BBM, BFM, and TBM are mediating the relationship between construct OSR and RC. Fig. 5 illustrates the indirect effect of OSR on RC via BBM. The direct effect of OSR on BBM showed a significant relationship at 0.000. Meanwhile, the direct effect of BBM on RC is a significant relationship at 0.000. The value beta coefficient linking OSR to RC reduced from

0.540 to 0.354. Based on Table 5, the p-value for the test is <0.01. The path coefficient of OSR on RC is 0.354. It implies that the implementation of the BBM strategy contributed to the reduction of OSR. This study revealed the absence of BBM will contribute highly to RC (0.540), indicating that for every one-unit increase in OSR, its effect would contribute a 0.540 unit increase in RC. Thus, if the firms implement BBM strategy, it shows the reduction of RC which is the path coefficient decrease to 0.354, indicating that for every one-unit increase in OSR, its effect will contribute a 0.354 unit increase in RC compared with the absence of BBM. Therefore, the study proposes that H2 is highly acceptable.

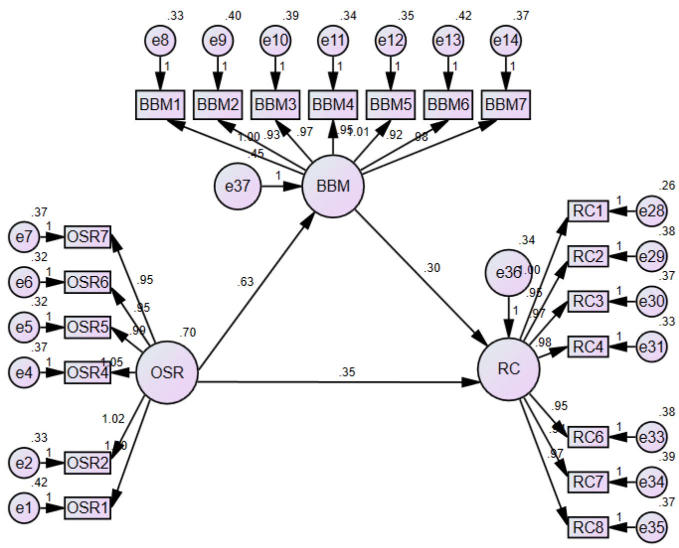

Fig. 5. Result of SEM (indirect effect for BBM)

Table 5

The results of indirect effect for BBM

Indirect effect			Beta estimate	S. E	C.R	P-value	Results
BBM	←	OSR	0.628	0.058	10.869	0.000	Sig.
RC	←	BBM	0.289	0.056	6.053	0.000	Sig.
RC	←	OSR	0.354	0.056	5.384	0.000	Sig.

Note(s): *Goodness-of-fit indices:* $\chi^2 = 199.191$, $df = 167$, $\chi^2/df = 1.193$, $p < 0.001$, $CFI = 0.994$, $IFI = 0.994$, $TLI = 0.993$, $RMSEA = 0.023$

Fig. 5 illustrates the indirect effect of OSR on RC via BFM. The direct effect of OSR on BFM showed a significant relationship at 0.000. Meanwhile, the direct effect of BFM on RC is a significant relationship at 0.000. The value beta coefficient linking OSR to RC reduced from 0.540 to 0.336. Based on table 6, the p-value for the test is <0.01. The path coefficient of OSR on RC is 0.336. It implies that the implementation of the BFM strategy contributed to the reduction of OSR. This study revealed the absence of BFM will contribute highly to RC (0.540), indicating that for every one-unit increase in OSR, its effect would contribute a 0.540 unit increase in RC. Thus, if the firms implement the BFM strategy, it shows the reduction of RC which is the path coefficients decrease to 0.336, indicates that for every one-unit increase in OSR, its effect will contribute a 0.336 unit increase in RC compare with the absence of BFM. Therefore, the study proposes that H3 is highly acceptable.

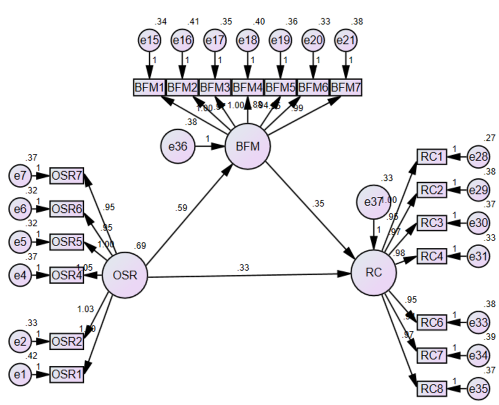

Fig. 6. Result of SEM (indirect effect for BFM)

Table 6
Indirect effect for BFM

Indirect effect			Beta estimate	S. E	C.R	P-value	Results
BFM	←	OSR	0.592	0.055	10.786	0.000	Sig.
RC	←	BFM	0.347	0.059	5.717	0.000	Sig.
RC	←	OSR	0.336	0.057	5.742	0.000	Sig.

Note(s): *Goodness-of-fit indices:* χ^2 *= 160.549, df = 167,* χ^2/df *=1.193, p < 0.001, CFI = 0.995, IFI = 0.993, TLI = 0.993, RMSEA = 0.020*

Fig. 6 illustrates the indirect effect of OSR on RC via TBM. The direct effect of OSR on TBM showed a significant relationship at 0.000. Meanwhile, the direct effect of TBM on RC is a significant relationship at 0.000. The value beta coefficient linking OSR to RC reduced from 0.540 to 0.397. Based on table 6, the p-value for the test is <0.01. The path coefficient of OSR on RC is 0.397. It implies that the implementation of the TBM strategy contributed to the reduction of OSR. This study revealed the absence of BFM will contribute highly to RC (0.540), indicating that for every one-unit increase in OSR, its effect would contribute a 0.540 unit increase in RC. Thus, if the firms implement the TBM strategy, it shows the reduction of RC which is the path coefficient decrease to 0.397, indicating that for every one-unit increase in OSR, its effect will contribute a 0.397 unit increase in RC compared with the absence of TBM. Therefore, the study proposes that H4 is highly acceptable.

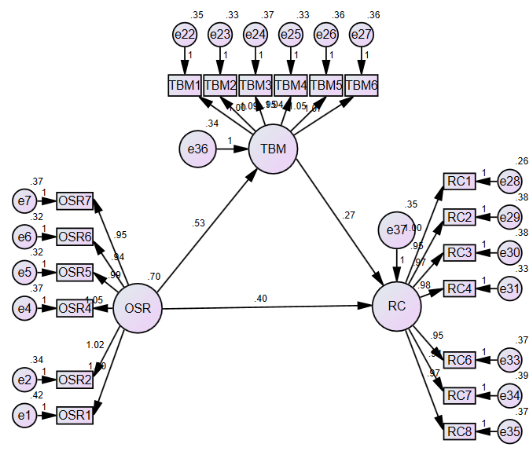

Fig. 7. Result of SEM (indirect effect for TBM)

Table 7
Indirect effect for TBM

Indirect effect			Beta estimate	S. E	C.R	P-value	Results
TBM	←	OSR	0.532	0.052	10.294	0.000	Sig.
RC	←	TBM	0.267	0.063	4.079	0.000	Sig.
RC	←	OSR	0.397	0.058	6.625	0.000	Sig.

Note(s): *Goodness-of-fit indices:* χ^2 *= 164.700, df = 149,* χ^2/df *=1.105, p < 0.001, CFI = 0.997, IFI = 0.997, TLI = 0.996, RMSEA = 0.017*

To conclude this analysis, The construct BBM, BFM, and TBM does mediate the relationship between OSR and RC. The type of mediation here is called a "partial mediation" since the direct effect of OSR on RC is still significant after BBM, BFM, and TBM entered the model even though the beta coefficient for OSR is reduced.

5. Discussion

5.1. Operational supply risk and risk consequences

Risk consequences can be dependent on the specific supply chain context and influence the approach to supply risks (Jüttner et al., 2003). The study shows that the more OSR activity occurs, the more RC will influence the operation of firms. The halal food manufacturers pay strong attention to the cause of risk on the supply side. The manufacturers are aware that the exposure of risk in operation would affect the integrity of the halal food supply chain. Eliasi & Dwyer (2002) explained that food is considered halal or haram by looking at the whole food chain. A study by Fujiwara, (2017) found violations of halal requirements and invalidation of the halal certification can be risk consequences for supplier management. Violations of halal requirements in this context of study are sources of supply risks such as quality risk, delivery risk, and price & cost risk. If the supplier fails to follow the requirement of halal, the halal food manufacturer will face consequences in the operational parts whereby the products are unable to be processed. Handayani et al., (2019) stressed that once the raw material is contaminated by the haram element, the final product is considered haram. For example, cross-contamination occurs when a halal food product has direct contact with non-halal food or nonfood product (Riaz & Chaudry, 2018).

5.2. Operational supply risk and risk mitigation strategy

The analysis proved that the implementation of risk mitigation strategies would reduce risk consequences on the supply side. This study revealed the interaction of buffer-based management in the halal supply chain gives more effect in order to reduce risks that come from operational supply risks. Tieman, (2017) mentioned this strategy for effective supply chain risk management ensures both robust and resilient halal supply chains. This strategy will utilize multiple sources of supply, retain safety stock, and different routes of delivery for the same items (Ho et al., 2015; Ivanov et al., 2017). Using various sources is one way to reduce the risk of supply disruptions and create a more competitive supply environment (Klassen & Vereecke, 2012). For example, if the raw material quality is contaminated with prohibited materials the company might change one halal supplier. Furthermore, using halal logistics service providers, such as halal warehouses, may protect the companies' raw materials from contamination by the forbidden element (Tieman et al., 2013; Zailani et al., 2018). The source of halal risk in operational supply may come from quality, price/cost, and delivery. If the risk event occurs (e.g., raw material contaminated, late delivery, raw material cost, etc.) on the operational supply-side, this strategy act as a mitigation effort in order to respond to the risk. If the firms face an increase in operational supply risk, it will help to reduce the risk event in their operation. However, due to supplier pressure, firms would experience significant financial costs in order to adapt to this strategy (Azmi et al., 2021). Teng et al., (2016) claim that the cost of the supplier's investment in finished products inventory is frequently passed on to the purchasing business in the form of a higher price. Thus, this strategy is not favorable among halal food manufacturers in Malaysia. Moreover, the study revealed the interaction of behavior-based management contributes to reducing risk on the supply side. According to Fayezi et al., (2019), this strategy ensures that the provider achieves the quality requirements while also improving the supplier's competence. For example, companies may take the effort to develop a halal quality management program with their suppliers to verify that the material supplied satisfies halal requirements and is delivered in excellent form. Lastly, the study revealed the interaction of traceability-based management contributes to reducing risk on the supply side. According to Khan et al. (2018), traceability management seems to be a medium to assure the integrity of the halal food supply chain. Halal manufacturers can acquire information about the product from the halal authority, such as the names of suppliers that have halal certification (Ab Talib & Chin, 2018). One of the benefits of this method is the capacity to channel information about halal standards, allowing food manufacturers or buyers to check halal items and ensure the specification of the halal requirement. Furthermore, this strategy may benefit the downstream supply chain by guaranteeing the halal integrity of food and beverage products in every supply chain stage (Hew et al., 2020).

6. Conclusion and Implication of the Study

From the analysis, the study has shown H1, H2, H3, and H4 are highly acceptable by statistical analysis. It portrays that halal firms in Malaysia prefer to implement mitigation strategies in their upstream supply chains to prevent or reduce risk events. In halal practice, once the final product was contaminated by forbidden elements, the products were considered haram to consume. The firms are unable to do anything to the final product unless making a product recall in the market or hold the production. These conditions make the reputation of firms become fragile and face losses. Even though the firms proactively prevent risk, there is still a risk that can occur. Meanwhile, this study contributed to the industrial practices to prevent or reduce risk in the halal food supply chain. They should proactively implement a risk mitigation strategy instead of a reactive approach. A proactive approach may not involve lots of costs compared to a reactive approach. This study reveals significant data on the management of halal food manufacturing. However, due to the limitations of this survey, further study is necessary to analyze how other halal's sectors manage their supply chain risk management.

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