Risk Management for Frozen Food Halal Supply Chain: A Case Study in Indonesian Company

Bunhamah Robiatul Adawiyyah and Dwi Agustina Kurniawati
Optimization, Operation Research and Industrial System Research Group (2ORIS-RG)
Industrial Engineering Department, Faculty of Science and Engineering
Universitas Islam Negeri Sunan Kalijaga
Yogyakarta, Indonesia
17106060036@student.uin-suka.ac.id, dwi.kurniawati@uin-suka.ac.id

Azanizawati Ma'aram, Noordin Mohd Yusof and Nor Hasrul Akhmal Ngadiman
School of Mechanical Engineering,
Faculty of Engineering
Universiti Teknologi Malaysia
Johor, Malaysia
niza@utm.my, noordin@utm.my, norhasrul@utm.my

Harisun Ya'akob
School of Chemical and Energy Engineering,
Faculty of Engineering
Universiti Teknologi Malaysia
Johor, Malaysia
harisun@utm.my

Abstract

The existence of halal products in Indonesia has been regulated by Islamic rule and government regulation. However, there is still a fairly high level of risk in the halal supply chain management that requires any special treatments. This research aims to identify and propose preventive actions against the risks that possibly affects the halal-ness of the product by using the Supply Chain Operations Reference (SCOR) and House of Risk (HOR) method. The case study is conducted at FF Company, a producer of halal frozen food with main product is *otak-otak bandeng* (a side dish made of steamed milkfish in bamboo leaves) located in Kotagede, Indonesia. Even though the company has been halal certified by LPPOM MUI, but FF Company has not implemented the halal supply chain risk management in its supply chain. Based on the risk identification, there are 28 risk events and 17 sources of risk with 8 priority risk sources have been selected for mitigation. From these risk sources, 7 proposed preventive measures could prevent or reduce the risk of consistency in its halal supply chain. Some of the preventive actions are mapping the activities in its supply chain to make easier in handling the supply chain risks and collaboration with relevant agencies to conduct training on good manufacturing practices and halal processes.

Keyword:
Halal Supply Chain, Risk Management, House of Risk, Frozen Food

1. Introduction

The halal lifestyle in Indonesia is currently becoming a high trend due to the large Muslim population, which reached 87.18 percent of the total population in Indonesia (www.bps.go.id). The trend includes various aspects of life, one of which is the consumption of halal products as well as a liability in Islamic law and has been ordered by Allah through the Quran surah An-Nahl verse 114 (16:114). Halal can be defined as something that is allowed by the rules and laws of Islam, while tayyiban is something good and clean. Therefore, the existence of halal products in Indonesia must contain the termination of halal and tayyiban simultaneously (Nuraini, 2018). Awareness in consuming halal products in Indonesia is very good and this awareness is largely influenced by the belief in religion followed by health reasons and certification logo (Kurniawati & Savitri, 2020). Now, there is a

phenomenon which is the consumers of the halal product are not just coming from Muslims, but also non-Muslims. Non-Muslims are interested to consume halal products because they claim that halal products are more hygienic and healthier than a non-halal products (Golnaz et al., 2010).

As a form of halal product assurance in Indonesia, every product that has passed the halal audit conducted by Lembaga Pengkajian Pangan, Obat-obatan, dan Kosmetika Majelis Ulama Indonesia (LPPOM MUI), then LPPOM MUI will issue a halal certification to the product. LPPOM MUI is the assessment institute and halal body certification for foods, drugs, and cosmetics in Indonesia. After that, the label of halal logo will be established on the packaging of the food products (Setyaningsih, 2019).

The halal supply chain is a concept that starts from suppliers to consumers who pay attention to the condition of halal and tayyib on the product of the supply chain system (Omar et al., 2011). Halal supply chain refers to Indonesian Government Law Number 33 the Year 2014 about Halal Product Guarantee. The assurance of the halal supply chain refers to the prevention of contamination. Halal assurance issues can be caused by the actions of parties along the supply chain from the source of halal product to the final consumer. The factors that determine the success of the halal supply chain are support from the government, transportation planning, information technology, human resources, halal certification and halal tracing (Talib et al., 2015). Even though halal product assurance has been set up by Islamic rule and government regulation, it still has a fairly high degree of risk. One of the biggest risks is maintain the halal status of the product which may turn to be non-halal because of the production process. The risk of such changes can also occur in the distribution and logistics activity which covers area of warehouses, transportation, and terminal (Tieman et al., 2015).

Frozen food product has a high risk and need special treatment to maintain its halal status. The required special treatment for frozen food can be such as maintaining the stability of low temperature from the procurement and preparation of raw materials, manufacturing, distribution and the retailer/consumer (BPOM, 2016). Halal supply chain has some vulnerabilities that can disrupt the supply chain activities, especially in the cold chain (Tieman, 2017). This risk can occur due to the lack of understanding and awareness of workers during processing the products. For example, the workers do a wrong sanitation and ignore the standard operating procedures of production process. Therefore, the risk management is needed to tackle this problem.

One of the frozen food producers who applying the halal supply chain is FF Company. It is located in Kotagede, Indonesia. The company focuses on the production of frozen food with fish and seafood as the raw materials. The company's main product is *otak-otak bandeng* which is the main raw material is from milkfish. Although the company has been halal certified by LPPOM MUI, but FF Company has not applied halal supply chain risk management to address the risks that may affect the halal-ness of the product at every supply chain activity. It was known from observations and interviews that have been done, many obstacles occur in the FF Company. One of them is the absence of a clear and clean production layout, the lack of labour discipline of the working procedure, and the lack of discipline in the hygiene that can lead to product cross-contamination. Cross-contamination is the mixing of halal food with impurities (non-halal) then make the halal product becomes non-halal (Nurlaela, 2011).

In this study, it is used the House of Risk (HOR) method which aims to identify the occurrence and sources of risk to the entire supply chain activities starting from the supplier, the production process, the distribution until the products are received by the customers. Since the HOR method did not take into consideration the supply chain activities in detail, then, Supply Chain Operations Reference (SCOR) method will be used to map the supply chain activities into five stages by outlining the general process in detail. The integration of these two methods, HOR and SCOR methods, can identify the risks and mitigate issues at each stage of the supply chain in FF Company. The contribution of this study is providing input to the company by identifying the source of the halal supply chain risks involved in halal products of FF Company and proposing the mitigation steps to minimize and prevent the halal supply chain risks.

2. Literature Review

There are several previous studies related to this research. Pujawan & Geraldin (2009) develop House of Risk (HOR) by combining two tools, namely House of Quality (HOQ) and Failure Mode Effect Analysis (FMEA) with the aim of facilitating the handling of risks contained in the supply chain system by reducing the impact caused by risk sources. Halim & Kurniawati (2017) conduct research to address the problem by identifying and compiling supply chain prevention measures in chicken slaughterhouses. By using the HOR method, the proposed strategy can be implemented, these are improving the communication system within the company, entering into contractual agreements with suppliers, and implementing the halal process and good manufacturing practices for all workers.

Ridwan et al. (2019a) conduct research to formulate proposed actions that can overcome the risk of the halal supply chain of Small and Medium Enterprise (SME) Sate Bandeng. From research using the HOR method, nine mitigation strategy were obtained that can overcome the risks in the halal supply chain of SME Sate Bandeng. In 2020, Wahyuni et al. (2020) conduct a research to determine the risks that can interfere with product performance in halal supply chain activities at abattoirs by using the HOR method and the SCOR approach as the tools. The study found that there are 28 risk events and 28 risk agents that can be identified. Then in 2021, Wahyuni et al. (2021) conduct research to determine risky activities that can interfere the halal-ness of fish cracker industry during the Covid-19 pandemic. The study found that there are seven risky activities. The greatest risk is in the distribution process that has the potential to be mixed/contacted with non-halal products/ingredients. According to Shafiee (2018), consuming halal food is important because it is associated with quality, safety, and hygiene as underlined by Islamic principles. The concept of halal emphasis on safety, cleanliness, and integrity of the food.

SCOR model is a series of processes, metrics, and best practices to identify, measure, rearrange, and improve the supply chain performance. SCOR model has five core elements, these are plan, source, make, deliver, and return (Lutfiana & Perdana, 2012). HOR is a method that can be used to analyze and know the risks that can be handled. This method is developed by Pujawan & Geraldin (2009) by combining the FMEA and HOQ. The HOR method can be used to determine the priority of risk and the mitigation steps to reduce the potential risks inherent in the supply chain. The HOR method has 2 (two) stages of completion, these are HOR 1 and HOR 2.

3. Methods

There are five steps used to implement the HOR and SCOR methods to the case study. The steps are activity mapping, risk identification, risk assessment, risk evaluation and risk mitigation. At the activity mapping stage, the SCOR method serves to map any activities in the supply chain by five elements; these are plan, source, make, deliver, and return. At the risk identification stage, the stage is performed to determine any risks that may arise in the supply chain activity. Risks are identified based on the mapping that has been done previously. The third stage is risk assessment. At this stage, the risk assessment is carried out by using a matrix HOR 1 in the incidence of risk and risk sources based on severity, prevalence and correlation. The assessment is carried out to determine the priority of the risk to be handled through the calculation of Aggregate Risk Potentials (ARP) as formulated in *equation (1)*. The fourth stage is risk evaluation. At the risk evaluation stage, the ARP value ranking is carried out based on the highest value to determine the selected risk source. Risk selection is done by using the Pareto diagram. The last stage is risk mitigation. The risk mitigation is done at HOR 2 with the aim is to design the mitigation actions or prevention against the high priority risks. Determination of mitigation is conducted by sorting the results of calculations from *equation (3)*. Based on the description above, the method used in this study can be described as a flowchart in Figure 1.

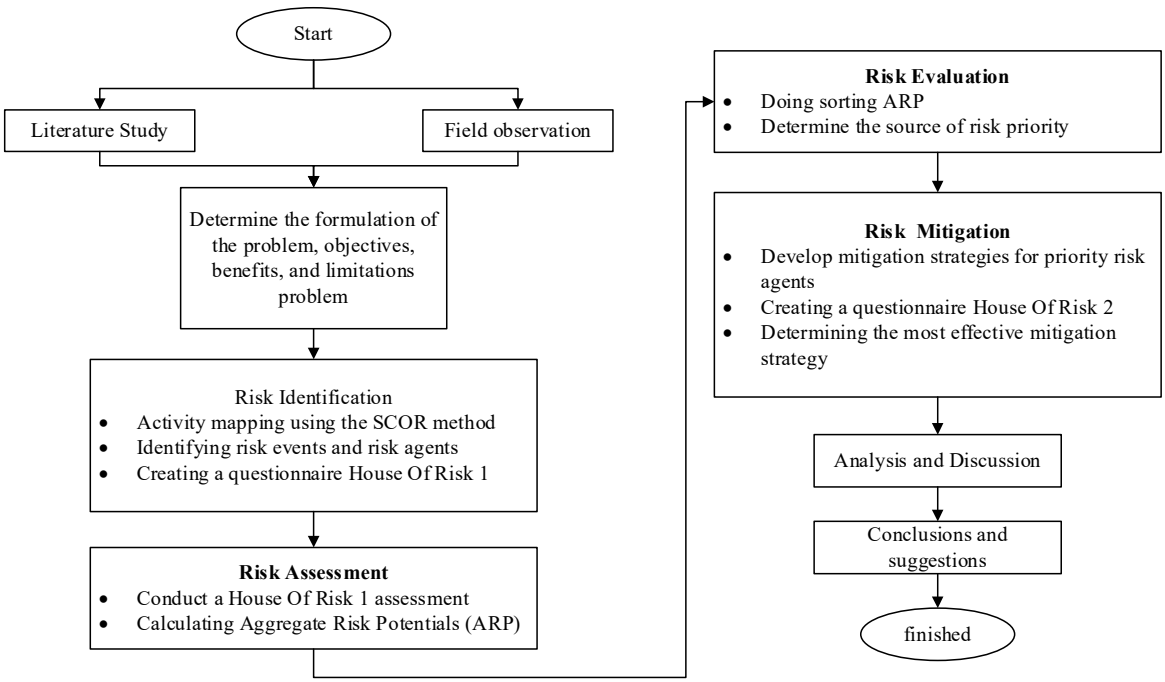

Figure 1. Research Flowchart

4. Data Collection

In this study, data collection is taken in two times through distributing questionnaires for HOR 1 and HOR 2. The HOR 1 questionnaire is used to determine which risk agents are prioritized to be mitigated through ARP calculations. In HOR 1, an assessment is carried out based on the severity of risk events, the occurrence of risk agents, and the relationship between risk events and risk agents. HOR 2 questionnaire is used to determine the risk mitigation to address priorities selected in the HOR 1. In HOR 2, it is performed the assessment of relationship between the risk agent and the proposed risk mitigation, and the assessment related with the difficulty level of the action.

The questionnaires for HOR1 and HOR 2 are developed based on observations and previous research. The HOR questionnaires are made based on previous research of Pujawan & Geraldin (2009), Halim & Kurniawati (2017), Ridwan et al. (2019a) and Ridwan et al. (2019b).

Then, before distributing the questionnaires, the questionnaires are validated using the face validity to validate the sentence structure or word in the statements/questions so that the meaning of the sentences in the questionnaire is clear. The questionnaire that has been developed is sent to the expertise to check whether the content of the questionnaire is suitable to be used for data collection. The questionnaire is validated by four experts, they are academicians who have expertise in the supply chain and halal industry. In face validity, there is no need to do a reliability test.

After obtaining the valid questionnaire, it is distributed to the respondents. The respondents in this study are risk owners or expert respondents, as refer to the research of Ridwan et al. (2019a) and Halim & Kurniawati (2017). In this study, respondents selected is the owner of FF company because the owner knows all business activities in the company.

5. Result and Discussion

As has been mentioned in the previous section, the analysis of the case study will cover identification of risk events, identification of risk agent, risk assessment, risk evaluation, and risk mitigation.

5.1. Identification of Risk Events

Identification of risk events is carried out in each supply chain activity to find out the risks that may arise along the halal supply chain and can cause changes to the halal status of the product. This step is conducted by mapping activities along the supply chain using the five elements in the SCOR model. Risk events were obtained from interviews with respondents (company owners) and field observations. The results of risk identification in FF Company's supply chain activities can be seen in table 1. There are 28 risk events were found.

Table 1. Risk Event

Process	Activity	Risk Event	Code
Plan	Raw material planning	Fish availability of raw materials from suppliers that cannot be predicted	E1
		Raw materials or additional materials not listed in LPPOM MUI	E2
	Production planning	Production planning administration has not implemented traceability	E3
		Work instructions and procedures have not considered halal	E4
		The order of *otak-otak bandeng* cannot be fulfilled	E5
Source	Raw material procurement	Delays in delivery of raw materials fish by suppliers	E6
		Raw materials potentially damaged fish (rot)	E7
		Raw materials contaminated fish unclean materials (metal / foreign)	E8
		Specifications milkfish raw material not following the standards required of companies	E9
Make		Washing water contaminated with filth / foreign body	E10

	Production process	Metal contamination in raw materials milkfish	E11
		Contamination of unclean/foreign objects in the process of separating meat and thorns	E12
		Dough contaminated with filth / foreign body	E13
		Use of machines and equipment that are not sterile and not following the standards required by the company	E14
		The operator does not adhere to standard operating procedures have been established	E15
		Damage to production equipment (grinding machine)	E16
	Environmental conditions of production	There is no clear production process flow allowing cross-contamination	E17
		The production process room is not sterile allowing contamination	E18
	Packing and checking process	The *otak-otak bandeng* products are not following company standards	E19
		There are unclean objects/foreign objects in *otak-otak bandeng* products	E20
		Packaging is not tight and unable to resist contamination unclean / foreign body	E21
Deliver	The process of delivering products to consumers and retail	*Otak-otak bandeng* products damaged / deteriorated	E22
		Products *otak-otak bandeng* mixed with non-halal products	E23
		Inaccuracy time delivery *otak-otak bandeng* to consumers	E24
		The number of products sent does not match the request	E25
		Unsuitable shipping conditions such as high temperature & too long delivery time	E26
Return	Product returns process	The products have reached the expiry date	E27
		The decline in product quality *otak-otak bandeng* when stored	E28

5.2. Identification of Risk Agent

Identification of risk agents is carried out according to risk events in table 1 that arise in halal supply chain activities at FF Company. Risk agents were obtained from interviews with respondents (company owners) and field observations. One risk agent can cause several risk events and a single risk event can be caused by several risk agents. Based on the results of the risk agents identification, there are 17 risk agents were found and an assessment of occurrence on the risk agent was performed. The identification of the risk agent is presented in table 2.

Table 2. Risk Agent

Risk Agents	Kode
Raw materials and auxiliary materials not listed in LPPOM MUI	A1
Natural disasters / accidents	A2
There is no standard operating procedure for halal	A3
Sudden orders from consumers	A4
Not checking raw materials by suppliers	A5
The use of cutting tools/knives and machines that do not fit the standard operating procedure	A6
A limited number of suppliers bandeng	A7
Cramped production space	A8
The lack of labour discipline	A9
There is negligence in sanitation activities	A10
Not maintained hygienic production environment	A11
Not maintained hygienic production equipment	A12
There is no quality control process for the finished product	A13
Inappropriate storage place and temperature (-18C)	A14
Not checking the *otak-otak bandeng* products before shipment	A15

Shipping mixed with non-halal goods	A16
Not checking contamination of fresh fish	A17

5.3 Risk Assessment

The risk assessment is carried out on HOR 1 using questionnaires given to the respondent. HOR 1 uses Aggregate Risk Potentials (ARP) value to determine the priority of risk events that will be mitigated by the sort of largest value. At this stage, three assessments are carried out, these are the assessment of the severity of the risk event, the assessment of the occurrence of the risk agent, and the assessment of the relationship between the risk event and the risk agent.

The scoring scale uses a Likert scale to make it easier for respondents to fill out the questionnaire. The score of severity is classified into five categories: 1 for have no impact, 2 for low impact, 3 for medium impact, 4 for high impact, and 5 for very high impact. The score of occurrence is classified into five categories: 1 (never happened), 2 (rarely happening), 3 (occurs under certain conditions), 4 (often occurs in every condition), and 5 (always happens in every condition). The score of relation is classified into four categories: 0 (no relationship), 1 (slightly related), 3 (medium relationship), and 9 (closely related). The results of the risk assessment being presented in Table 3.

Table 3. Matrix HOR 1

Business Process	Risk Event (Ei)	Risk Agent (Aj)																	Severity (Si)
		A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12	A13	A14	A15	A16	A17	
Plan	E1		1																3
	E2	9		3															1
	E3			9	1														2
	E4			9															2
Source	E5				9			3											2
	E6		9																4
	E7					9												1	3
	E8																	1	3
	E9			1		3												1	2
	E10			1						3	9	3	1						3
Make	E11			1		9	3											9	4
	E12			9							1	9	9						4
	E13			3					9	9	3	9	3						4
	E14			1			9		1	9	3	9	9						3
	E15			1						9									2
	E16									9			1						3
	E17			3					9	1									3
	E18			1					9	9	3	9	3						3
	E19			1						3				9					4
	E20			3						3			3	9					3
	E21			1						3				9		1			3
	E22			1						1					9	3			3
Deliver	E23			3						0							9		4
	E24		3							1						9			3
	E25				3					1						9			3
	E26			1						1					9				4
Return	E27									3						9			3
	E28			3						3				9	9				4
Occurrence (Oj)		1	2	3	4	3	4	3	3	4	3	3	3	3	2	2	2	3	
ARP		9	96	480	116	207	156	18	486	844	444	405	1152	378	198	186	72	132	

The ARP score is obtained by multiplying three factors. These factors are the possibility of a source of risk (O), severity risk (S), and relationships between sources of risk with risk events (R). ARP scores are ranked from the largest score to the smallest score. The formula to calculate the ARP value is as follows.

$$ARP_j = O_j \sum S_i R_j \quad (1)$$

For example:

$$ARP_j = O_j \sum S_i R_j$$

$$ARP = 2\,(\,(\,1x3) + (\,9x4) + (\,3x3)\,)$$
$$= 96$$

5.4 Risk Evaluation

The risk evaluation was done by priority selection of the risk source using Pareto chart. The priority risk agents to be mitigated are determined by 80% of cumulative ARP. This is based on the 20/80 Pareto concept where 20% of risk sources cause 80% of risk events. The priority and cumulative ARP are shown in Table 4. The Pareto figure is presented in Figure 2.

Table 4. Priority & Cumulative ARP

Code	Score ARP	Cumulative ARP	% Cumulative
A12	1152	1152	21.4
A9	844	1996	37.1
A8	486	2482	46.1
A3	480	2962	55.1
A10	444	3406	63.3
A11	405	3811	70.8
A13	378	4189	77.9
A5	207	4396	81.7
A14	198	4594	85.4
A15	186	4780	88.9
A6	156	4936	91.8
A19	132	5068	94.2
A4	116	5184	96.4
A2	96	5280	98.2
A16	72	5352	99.5
A7	18	5370	99.8
A1	9	5379	100
Total	5379		

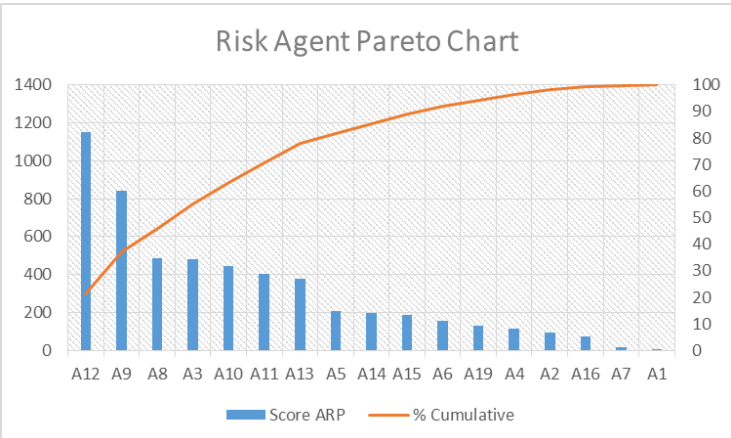

Figure 2. Pareto Chart Risk Agent

The table and the figure above show that 80% of risk agents that need to be focused for further risk mitigation and evaluation are:(1) not maintaining hygienic production equipment/A12, (2) the lack of labour discipline/A9 (3) cramped production space/A8, (4) not having standard operating procedures for halal/A3, (5) there is

negligence in sanitation activities/A10, (6) not maintained hygienic production environment/A11, (7) there is no quality control process for the finished product /A13, and (8) not checking raw materials by suppliers /A5.

5.5 Risk Mitigation

The design of risk prevention measures against the selected risk agents is carried out at HOR 2. The design of risk prevention measures is proposed by researchers based on some previous studies which then be discussed with the company. There are 7 preventive action plans for priority risk agents which can be seen in Table 5.

Table 5. Preventive Actions

Code	Preventive Actions
PA1	Conduct regular training on good manufacturing practices and halal processes for workers
PA2	Scheduling cleaning of rooms and equipment production
PA3	Expanding production space to prevent cross-contamination
PA4	Create and implement standard operating procedures for halal and hygienic production
PA5	Supervision of workers
PA6	Changing certified suppliers
PA7	Perform the quality control of the product

In HOR 2, it is performed the assessment of relationship between the selected risk sources and the handling action (E_{jk}), the assessment of the degree of difficulty of preventive action (D_k) and calculating the total effectiveness ratio of difficulties (ETD_k). The assessment of relationship between the selected risk sources and the handling action (E_{jk}) is used to calculate the total effectiveness of each action (TE_k) by using the formula in *equation (2)*.

$$TE_k = \sum_j ARP_j E_{jk} \quad (2)$$

For example:

$$TE_1 = \sum ARP \ x \ PA$$

$$= (9x844) + (9x1152) + (3x480) + (9x444) + (9x405)$$

$$= 27045$$

The level of difficulty is shown by the scale and should reflect the resources needed to take action. D_k is variable to assess the degree of difficulty at every preventive action. Calculation of the total effectiveness ratio of difficulties (ETD_k) is following the *equation (3)*

$$ETD_k = TE_k / D_k \quad (3)$$

For example:

$$ETD = TE / D$$

$$= \frac{27045}{3}$$

$$= 9015$$

The matrix HOR 2 is shown in Table 6. ETD_k is used to rank the priority of preventive actions in the halal supply chain risk of FF Company. The score of E_{jk} is classified into four categories: 0 (no relationship), 1 (slightly related), 3 (medium relationship), and 9 (closely related). The score of D_k are classified into three categories: 3 for low category, 4 for medium category, and 5 for high category. The rank of priority preventive action is shown in Table 7.

Table 6. Matrix HOR 2

Priority Risk Agent	Preventive Actions							ARP
	PA1	PA2	PA3	PA4	PA5	PA6	PA7	
A12	9	9	1	9	3			1152
A9	9	3		3	9			844
A8			9					486
A3	3			9	1			480
A10	9	3		9				444
A11	9	9		9	3			405
A13							9	378
A5			3			9		207
Total effectiveness action (TE_k)	27045	17877	6741	24861	12711	1863	3402	
Degree of difficulty performing action (D_k)	3	3	5	4	3	5	4	
Effectiveness to difficulty ratio (ETD_k)	9015	5959	1348	6215	4237	373	851	
Rank of Priority	1	3	5	2	4	7	6	

Table 7. Prevention Action Priority Rank

Preventive Action	Code	ETD	Rank of Priority
Conduct regular training on good manufacturing practices and halal processes for workers	PA1	9015	1
Create and implement standard operating procedures for halal and hygienic production	PA4	6215	2
Scheduling cleaning of rooms and equipment production	PA2	5959	3
Supervision of workers	PA5	4237	4
Expanding production space to prevent cross-contamination	PA3	1348	5
Perform the quality control of the product	PA7	851	6
Changing certified suppliers	PA6	373	7

Refer to Table 7, the prevention action priority rank is determined from the effectiveness to difficulty ratio results sorted from the largest to the smallest score. There are (1) conduct regular training on good manufacturing practices and halal processes for workers, (2) create and implement standard operating procedures for halal and hygienic production, (3) scheduling cleaning of rooms and equipment production, (4) supervision of workers, (5) expanding production space to prevent cross-contamination, (6) perform the quality control of the product, (7) and changing certified suppliers.

6. Conclusion

Based on the results of risk identification in FF Company's halal supply chain, it is identified there are 28 risk events and 17 risk agents. In addition, there are 8 sources of risk in FF Company's halal supply chain that have a major impact and are prioritized for prevention. Based on the analysis of HOR 1 and HOR 2, the proposed preventive measures to address the sources of risk selected are seven proposals. The seven proposals are: (1) conduct regular training on good manufacturing practices and halal processes for workers, (2) create and implement standard operating procedures for halal and hygienic production, (3) scheduling for cleaning the rooms and equipment of production, (4) supervision of workers, (5) expanding production space to prevent cross-contamination, (6) perform the quality control of the product, (7) and changing certified suppliers. Based on those proposed preventive actions, there are mitigation steps that can be done by FF Company. First is mapping the activities in the supply chain to make it easier to handle risks on the supply chain. Secondly is collaboration with relevant agencies such as the Public Health Office to conduct training on good manufacturing practices and halal

processes. Thirdly, making standard operating procedures that pay attention to the provisions of halal in every production activity, starting from receiving raw materials to product distribution to consumers, in accordance with halal guidelines from LPPOM MUI. Fourth, making a schedule for cleaning the room and production facilities. Fifth is supervising and assessing the performance of employees who carry out standard operating procedures properly. Lastly is conducting disciplinary action for workers to realize the importance of carrying out standard procedures.

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Biographies

Bunhamah Robiatul Adawiyyah is a graduate student from Industrial Engineering Department, Faculty of Science and Engineering, Universitas Islam Negeri Sunan Kalijaga, Indonesia. She just finished her bachelor's degree from Industrial Engineering, Universitas Islam Negeri Sunan Kalijaga in August 2021. Now, she becomes a research assistant in Mechanical and Industrial Engineering Department, Gadjah Mada University, Indonesia.

Dwi Agustina Kurniawati, Ph.D. is an Associate Professor in Industrial Engineering, Faculty of Science and Engineering, Universitas Islam Negeri (UIN) Sunan Kalijaga, Indonesia. She finished her bachelor's degree in Industrial Engineering from Bandung Institute of Technology (ITB), Indonesia in 2003. Then she pursued her master's degree in Advanced Manufacturing Technology, Universiti Teknologi Malaysia (UTM) in 2006. She got Ph.D degree from Nanyang Technological University (NTU) in 2016, in Systems and Engineering Management, School of Mechanical and Aerospace Engineering, NTU, Singapore. She has published numerous papers, both in journals and proceedings (conferences). She also has reviewed lots of papers in Industrial Engineering area. Her current research is in supply chain, cross-dock warehouse, modelling system, operation research, scheduling and special issue in halal supply chain. She has received many research grants in her research area. Her biography is included in Who's Who in the World year 2015 and 2018 and Who's Who in Science and Engineering year 2016 and 2017 by Marquis Publication, USA. She was the former head of Industrial Engineering Laboratory and former head of Industrial Engineering Department. Currently, she becomes the head of Quality System Controller in her faculty and the head of Optimization, Operation Research and Industrial Systems Research Group (2ORIS-RG). She also becomes the secretary of Halal Center UIN Sunan Kalijaga and becomes the member of INFORMS, IEOM and IAENG.

Noordin Mohd Yusof is a Professor at the School of Mechanical Engineering, Universiti Teknologi Malaysia. He joined UTM in 1987, and during his long service at UTM he has held numerous administrative positions both at the faculty and university level. His final administrative post was being the Dean of the Faculty of Mechanical Engineering. Prof Noordin is an experienced researcher who has written and presented numerous Industrial and Manufacturing Engineering publications.

Azanizawati Ma'aram is an Associate Professor at the School of Mechanical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia (UTM). She obtained her Bachelor of Engineering (Mechanical-Industrial) and Master of Engineering (Advanced Manufacturing Technology) from Universiti Teknologi Malaysia, Malaysia. She pursued her Doctorate of Philosophy (Ph.D) (Management) at the University of Liverpool, United Kingdom. She has held several positions including Head of Industrial Panel, Postgraduate Coordinator for Master of Science (Industrial Engineering), and Laboratory Coordinator for Industrial Engineering. She is certified as an Engineering Technologist (Ts.) from the Malaysia Board of Technologists (MBOT). She is a member of the International Association of Engineers (IAENG) and the Board of Engineers (BEM) Malaysia. She has taught courses in industrial engineering, supply chain management (undergraduate and postgraduate levels), engineering management and safety, work design, ergonomics and research methodology. Her research interests include supply chain management, performance measurement, lean manufacturing, sustainability, ergonomics, safety and medical devices. She is currently active as a Project Leader and a Project Member on numerous research projects and has secured several grants funded by the university, Ministry of Education (MoE) and industrial grants that involve hospitals, industry collaborators as well as international researchers.

Harisun Yaakob is a Senior lecturer at the School of Chemical and Energy Engineering, Universiti Teknologi Malaysia. She graduated from the University of East Anglia in 2010 where she obtained her Ph.D (Biological Sciences). Prior to that, she completed her MSc in 2006 and BSc. (1999) (Bioprocess Engineering) in Universiti Teknologi Malaysia. Her professional expertise is on food and nutraceutical, product development, probiotic, phytochemical, cell culture and drug delivery systems. She has published numerous papers, did many consultancies works and received a lot of higher prestigious award from local and international innovation competition. She has been invited as a keynote, plenary speaker and giving oral presentation on the international and national scientific meetings and seminars.

Nor Hasrul Akhmal Ngadiman is a Senior Lecturer in the Department of Materials, Manufacturing and Industrial Engineering, School of Mechanical Engineering, Faculty of Engineering (FE), UTM, Johor Bahru, Johor, Malaysia. He is a member of Institution of Mechanical Engineers and Chartered Mechanical Engineer. He is also Professional Engineer recognized by Board of Engineer Malaysia and Professional Technologist recognized by Malaysia Board of Technologist. Dr. Hasrul is involved (both as Project Leader and Project Member) in numerous research projects funded by the ministry and various industries as well as by the UTM. His

papers have been published in both international and national journals. In addition to this, he has presented papers at international and national conferences and seminars. He has won several international and national recognition such as best paper award, best presenter award and best invention award. He has obtained over 240 citations and H - index 8 in Scopus. Dr. Hasrul is engaged with several consultancy projects involving local companies and organizations and has conducted training on diverse courses organized by the university as well as industry.